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# ORTHOPAEDIC SUPPLEMENT

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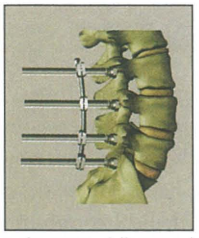
# CONTENTS

# FOREWORD

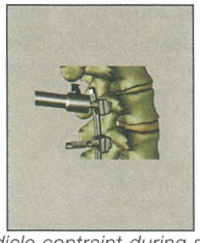
**David S K Choon**
**President 2000-2001**
**Malaysian Orthopaedic Association**

I would like to express my great pleasure and gratitude that this 2nd Orthopaedic Supplement to the Medical Journal of Malaysia has been published. Much hard work has gone into collating the material to be found in the following pages. The main driving force behind this publication has been the Editor, Dato' Dr K. S. Sivananthan and my predecessor, Professor Mohd. Razak. The Executive Committee of the Malaysian Orthopaedic Association and the Editorial Board are deeply indebted to the Editorial Board of the Medical Journal of Malaysia for giving our members the opportunity to present our research and views in this format. By arranging all the orthopaedic materials in one edition, our research output has been made easily accessible to the members of the medical community at large and the local orthopaedic community in particular. The Malaysian Orthopaedic Association is very proud to be associated with this publication and I hope that this annual publication will become a feature of the Medical Journal of Malaysia.

*A solution for exact srew placement and reduced intraoperative adjustment*



*Simple assembling saving operative time*



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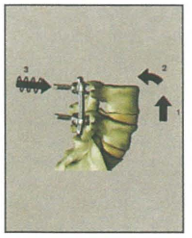

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EDITORIAL

# Supracondylar Fractures of the Humerus in Children

**S Sengupta**

Supracondylar fractures of the humerus are one of the commonest fractures in childhood. In a four year period between 1983 to 1987, out of 1836 fractures seen in children under the age of 12 in University Hospital, 257 or 14% involved supracondylar area, being the third most common only after fractures of distal radius (29%) and both bones of forearm (16%). In other studies its incidence has varied between second to tenth commonest. Though the fracture always unites, neurovascular damage may lead to grave consequences. Fortunately vascular injuries are rare and nerve injuries tend to recover spontaneously. In an ongoing prospective study, of 131 consecutive supracondylar fractures treated in University Hospital, median nerve injury were found in five, radial in four and ulnar nerve were affected in one. The injury occurs as a result of fall on hyper-extended elbows, and therefore more common in children between the ages of 5 to 8 years when joint capsule is more lax. As a result, the distal fragment tilts and displaces backwards, anterior displacement being extremely uncommon.

The thick young periosteum, though torn anteriorly, remains intact posteriorly and helps to stabilise reduction once the elbow has been flexed sufficiently. Minor residual posterior tilt or displacement in the sagittal plane corrects quickly with growth and restoration of full flexion is seldom a problem. Unfortunately, tilt and displacement medially and less commonly laterally in the coronal plane does not correct with growth and results in ugly cubitus varus - "gun stock" deformity or occasionally cubitus valgus deformity. The deformity is the result of malunion and not due to growth disturbance and, therefore, noticed as soon as the elbow has regained full extension and does not progress thereafter. Malunion is either due to inadequate reduction in the coronal plane or due to re-displacement within plaster cast once swelling subsides or if elbow has not been sufficiently flexed. The standard practice of treating these fractures in our hospital has been reduction by manipulation under general anaesthesia using image intensifier, followed by immobilisation with "three-quarter" posterior plaster slab which were converted into full cast once swelling had settled, failed to prevent cubitus varus deformity in a significant percentage of cases. Out of the 257 fresh supracondylar fractures seen in our hospital between 1983 and 1987, 175 needed manipulation under general anaesthesia. Only 110 cases could be followed up for over three months and 29 or 26% of them had developed significant (>2°) cubitus varus. As these results were unsatisfactory, from 1990 we gradually opted for percutaneous cross K-wire fixation following reduction under anaesthetic. A plaster cast is applied, which together with the pins are removed after three weeks. Encouraged with our results in grade III displacements, we now recommend percutaneous pinning for all grade II and III fractures. In the ongoing prospective study of 131 fractures of all grades seen between August 1997 and February 1999, 57 displaced fractures were treated by this method and none has developed varus of more than 2°. If facilities are available, this should be the method of management of all displaced supracondylar fractures in children. However, in places where facilities, such as image intensifier are not available, open reduction with cross K-wire fixation is a viable alternative, with satisfactory anatomic reduction and functional result, as described by S. Srivastava in this issue. Closed reduction with casting under expert hands may on other hand, will avoid prolonged hospitalisation and scar formation. Only absolute indication of open reduction is when closed reduction fails due to soft tissue interposition.

If the child presents late, specially following treatment by traditional bone setters, it is best to accept the malunion and once full extension has recovered, to correct the deformity by an osteotomy. I have found a step-cut or triangular osteotomy fixed with two K-wires can correct coronal, sagittal and rotational deformities and to be entirely satisfactory.

SPINE

# HUKM Instrumentation System in Surgical Treatment of Adolescent Idiopathic Scoliosis - An Early Experience

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**Summary**

Between May 1992 through October 1998, twenty-two patients who had adolescent idiopathic scoliosis were treated using Universiti Kebangsaan Malaysia (UKM) spinal instrumentation and fusion. The minimum length of follow-up was 2 years with an average of 2.9 years. Nineteen patients were female and three patients were male. The mean age at the time of the operation was 16.2 years (range, 13 to 24 years). The average blood loss was 1,878ml and the average operating time was 291 minutes. The mean pre-operative curve was 61.2 degrees, with a range of 40 degrees to 90 degrees. The average post-operative correction of the Cobb's angle was 53.5 per cent, with a range of 33 per cent to 81 per cent. Post-operative immobilization consisted of a maximum of six months in a body cast. There were no neurological injuries, no deep wound infections, and no evidence of pseudoarthroses. Only three complications occurred and these did not disturb the progress of the fusion. This technique safely achieves the objectives of scoliosis correction, and is cost-effective in the treatment of adolescent idiopathic scoliosis.

*Key Words:* HUKM Instrumentation system, Adolescent Idiopathic Scoliosis and Posterior fusion

## Introduction

Idiopathic scoliosis can develop in healthy children at any stage of growth. Early prevalence studies were based on review of radiographs taken for tuberculosis screening, or of children referred for treatment, who generally had large curves. In the United States, the school screening studies showed prevalence rates between 0.3% and 15.3%, the range reflecting different techniques, populations screened and definitions of scoliosis[1]. The prevalence of scoliosis in Malaysia is unknown. Adolescent Idiopathic Scoliosis (AIS) is the most common spinal deformity seen. Adolescent idiopathic scoliosis is defined as a lateral spinal curvature of greater than $10^0$ for which no pathologic cause can be determined. It is seen in children over 10 years of age and is by far the most common presentation of scoliosis.

Numerous systems of instrumentation have been used over the years. Spinal instrumentation and arthrodesis generally are recommended for curves greater than $40^0$. The purpose of this study is not to determine whether one system is superior to another, but to analyze the results of Universiti Kebangsaan Malaysian (UKM) spinal instrumentation technique. The UKM spinal instrumentation technique is aimed to provide an effective, safe, stable and cost effective method in the correction of scoliotic curves. The principle of this technique is a fixation of implant to the base of the spinous process using Kirschner wires and specially contoured stainless steel rods.

## Materials and Methods

Between May 1992 through October 1998, thirty-nine patients with adolescent idiopathic scoliosis underwent surgery with the Universiti Kebangsaan Malaysia technique of instrumentation. They were treated with posterior translation technique and fusion. To be included in the study, patients must have been diagnosed with adolescent idiopathic scoliosis between ages of 11 and 19 years, with operative treatment occurring either in adolescence or adulthood. Only twenty-two patients had a minimum follow-up of two years were included. In this group of patients, there were nineteen girls and three boys. Their mean age at operation was 16.2 years (range thirteen years to twenty-four years). There were seventeen patients with thoracic scoliosis, four thoracolumbar scoliosis and one lumbar scoliosis. The mean curvature before operation was 61.2° (range, 40° to 90°).

Preoperative radiographic assessments include anteroposterior and lateral views of the whole spine. Anteroposterior supine bending films are used to determine the flexibility of the scoliosis. The severity of the scoliosis were measured using Cobb's method on anteroposterior and lateral spinal radiographs taken with the patient standing, before and after surgery, at 6 months, at 1 year and at final follow-up. The loss of correction was the difference between the angle measured on the immediate post-operative radiograph and that measured at the last examination. The apex of the scoliosis is identified through the anteroposterior film and the fusion levels are determined. All radiographs were inspected for any evidence of hooks and rod displacement, wire breakage, or pseudoarthorosis. Clinical examination consisted of a description of pain symptoms, neurological examination, and a search for signs of rod prominence or back tenderness.

### Operative technique

The indication for surgical intervention is when Cobb's angle is greater than 40°. The technique of arthorodesis involves routine posterior exposure of the spine. Subperiosteal dissection exposes the spine up to the transverse process. A burr and a special bone awl is used to make a hole at the base of spinous process. Then, 0.9-mm wire loops are introduced through the hole in pairs at each level, one on each side. Two Kirschner wires of size 2.0mm are threaded through the wire loops, one on either side. Hooks are placed at the transverse process and the pedicle proximally, and at the lamina distally, and two stainless steel rods are then contoured to create the thoracic kyphosis and lumbar lordosis. One of the rods is then placed on the concave side first, and the wire loops are tied to the rod. The other rod is then placed on the convex side and the wire tied to the rod. Distraction is applied to the concave side and compression force is applied at the convex side. Meticulous decortication and facet excision are done. Bone graft is then obtained from the posterior iliac crest. Finally, the bone graft is placed within the fusion level. The wound is closed in layers and redivac drain used.

Surgery was carried out under hypotensive general anaesthesia with the patient lying prone on the Wilson frame. Spinal cord monitoring was not done routinely. Only six patients had the Stagnara wake-up test done due to severe curve.

## Results

### Pre-operative data

#### *Sex*

There were twenty-two patients, nineteen females and three males, who had been on minimum follow-up of 24 months. The mean follow-up period was 2.9 years (range, 2 years to 6 years).

#### *Age, Race and Menarche*

The mean age at the time of operation was 16.2 years (range, thirteen to twenty-four years) as shown in Table I. Two patients were operated at the age of twenty and twenty-four years old, although they were diagnosed at the aged of fourteen and seventeen years old. There were slightly more Malays than Chinese or Indians (Table II). Nineteen female patients had a mean menarchal age of 12.9 years with a range from 11 years to 15 years (Table III).

The curve patterns of these patients are listed in Table IV. Thoracic curves are the most commonly seen, about 77.3% followed by thoracolumbar curves.

**Table I**
**Age Distribution**

| Age of the Patients (Years) | Number | Percentage |
|---|---|---|
| 11 - 15 | 11 | 50 |
| 16 - 20 | 10 | 45.5 |
| > 20 | 1 | 4.5 |

**Table II**
**Race Distribution**

| Race | Number | Percentage |
|---|---|---|
| Malay | 12 | 54.5 |
| Chinese | 9 | 41 |
| Indian | 1 | 4.5 |

**Table III**
**Menarchal Age**

| Menarchal Age (Years) | Number | Percentage |
|---|---|---|
| 11 | 1 | 5.3 |
| 12 | 8 | 42.1 |
| 13 | 4 | 21.0 |
| 14 | 3 | 15.8 |
| 15 | 3 | 15.8 |

**Table IV**
**Curve Patterns**

| Curve | Number | Percentage |
|---|---|---|
| Thoracic | 17 | 77.3 |
| Thoracolumbar | 4 | 18.2 |
| Lumbar | 1 | 4.5 |

Pre-operatively, the curves that were treated with instrumentation averaged 61.2° (range 40° to 90°) (Table V).

### Intra-operative data

The average operating time was 291 minutes (range, 225 to 390 minutes) as in Table VI. The average intra-operative blood loss was 1,878ml (range, 800 to 3,100ml), shown in Table VII. The mean number of units transfused per case was 3 (range, 2 to 6 units). An average of 11.8 vertebrae (range, 10 - 13) per patient was instrumented. The levels of the lowest instrumented vertebra is shown in Table VIII.

**Table V**
**Pre-operative Cobb's Angle**

| Cobb's Angle (Degree) | Number | Percentage |
|---|---|---|
| 40 - 50 | 6 | 27.3 |
| 51 - 60 | 9 | 41.0 |
| 61 - 70 | 1 | 4.5 |
| 71 - 80 | 2 | 9.0 |
| 81 - 90 | 4 | 18.2 |

**Table VI**
**Operating Time**

| Operating Time (Mins.) | Number | Percentage |
|---|---|---|
| 180 - 240 | 6 | 27.3 |
| 240 - 300 | 8 | 36.4 |
| 300 - 360 | 7 | 31.8 |
| 360 - 420 | 1 | 4.5 |

**Table VII**
**Amount of Blood Loss**

| Blood Loss (ml) | Number | Percentage |
|---|---|---|
| 1000 | 1 | 4.5 |
| 1000 - 2000 | 17 | 77.4 |
| 2000 - 3000 | 3 | 13.6 |
| > 3000 | 1 | 4.5 |

### Post-operative data

The average hospital stay was 12 days (range, 6 to 18 days). All patients wore a body cast post-operatively for an average of 3.9 months (range, 1.5 to 6 months).

After surgery, the mean Cobb's angle in the coronal plane was 28.9° (range, 10° to 50°), or a mean of 53.5% (range, 33% to 81%) correction (Table IX). There was a 47.6% (range, 22.2% to 84.6%) of correction in the frontal plane of the apical vertebra translation towards the midline. As in Table X, lumbar curve has better correction post-operatively compare with thoracic and thoracolumbar curves.

**Table VIII**
**Lowest Instrumented Vertebra (LIV)**

| LIV | Number | Percentage |
|---|---|---|
| L1 | 1 | 4.5 |
| L2 | 8 | 36.4 |
| L3 | 10 | 45.4 |
| L4 | 3 | 13.6 |

**Table IX**
**Post-operative Cobb's Angle**

| Cobb's Angle (Degree) | Number | Percentage |
|---|---|---|
| 10 - 20 | 6 | 27.3 |
| 21 - 30 | 10 | 45.5 |
| 31 - 40 | 2 | 9.0 |
| 41 - 50 | 4 | 18.2 |

### Follow-up data

One patient with lumbar curve, loss 23.4% of correction, four patients with thoracolumbar curves had lost 16.6% of correction at final follow-up. Because the sample size for these two groups were relatively small, conclusions relating to these curve types could not be made with any statistical certainty. The average loss of correction of thoracic curve is 17% at final follow-up.

The average curve of all patients at six-month was 33.6° (range, 13° to 62°); at one-year was 36.1° (range, 20° to 65°); and the average final curve was 39.6° (range, 20° to 68°).

The mean loss of correction at six-month was 4.9° (8.5%, ranged 0° to 27°), at one-year was 7.2° (12.5%, ranged 0° to 30°), and at final follow-up was 11° (18.8%, ranged 0° to 30°).

### Complications

There were three complications in this study. There was no intra-operative complications, and to date there have been no wound infections either deep or superficial, and no neurological injuries. No pseudoarthoroses were noted in all patients at final follow-up.

One patient had rod and wire breakage at the thoracolumbar junction, was asymptomatic. The implant failure was noted after one year. He was advised for removal of implant, but the patient refused. Although there is a broken rod, this does not affect stability of the instrumentation, and the fusion mass progressed satisfactorily. No evidence of pseudoarthroses.

Another patient had implant failure, where the distal hook at the concave side was dislodged. This was noted three months after surgery. This happened after she was involved in a motor vehicle accident prior to that. This was later revised, and the correction did not appear to be appreciably changed. She did not require subsequent external immobilization. This did not affect the progress of the fusion. The implant was removed after one and a half years as she developed bursitis at the distal end of the rod. Culture and sensitivity of the fluid obtained had no growth.

The third patient had a prominent distal part of the rod at the convex site of the curve when the distal hook was dislodged. She noted this three years after correction. However, she had no back pain. The distal part of the rod was irritating the skin, therefore only the prominent portion was removed. The other portion of the rod was left in situ because is difficult to remove, as the fusion mass was solid. There was no evidence of pseudoarthroses. She was well and could do normal daily activities.

**Table X**
**Correction According to Curve Patterns**

| Curve Pattern | Pre-operative Curve (Degree) | Post-operative Curve (Degree) | Percentage Correction |
|---|---|---|---|
| Thoracic | 66.6 | 31.7 | 52.4 |
| Thoracolumbar | 54.5 | 24.2 | 56 |
| Lumbar | 60 | 23 | 62 |

## Discussion

The treatment of scoliosis has been directed towards stabilizing or reducing the lateral curve. Operative correction and stabilization of the lateral curve has been accomplished with a variety of spinal instrumentation systems. The UKM spinal instrumentation system comprises rods, hooks and wire-in-wire constructs. The wires are passed through the spinous processes to encircle the rods, and when tightened, pull the spine to the midline. The Wisconsin spinal instrumentation was first introduced by Drummond *et al*[2]. It is a hybrid system comprising Harrington distraction rods, Luque rods, and button-wire constructs. Both these techniques are simple, relatively easy, of short duration, and less expensive than many of the currently available systems.

Post-operative correction in this study was 53.5%, which is comparable with other studies using the Wisconsin spinal instrumentation. Jeng *et al*[3] reported 46% correction immediately post-operatively for all patients. Drummond[2] reported as much as 54%, and Herzenberg *et al*[4] reported 52% correction immediately after surgery. The differences may be due to:-

1. Measurement techniques,
2. The amount of intraoperative distraction applied to the spine, or
3. The degree of tightening of the wires.

Loss of correction compared favourably with the other systems: in this study, the lost of correction was 7.2° (12.5%) during the first year of follow-up. Other articles have documented loss of correction at 1 year to be 8.1° with Harrington rod instrumentation, 3.5° with Luque instrumentation, and 1.8° with Cotrel-Dubousset instrumentation. The Wisconsin instrumentation had a 2.4° loss of correction[5,3,6].

When the type of curve is analyzed separately, thoracic, lumbar and thoracolumbar curves attain the best immediate correction at 52.4%, 62% and 56%.

In this study, the mean operative time was 291 min with blood loss of 1878ml. Birch *et al*[7] demonstrated correction from 57° to 23° with an average operating time of 225 min and blood loss of 1,000ml in 25 patients. Herndon *et al*[8] reported 36 patients with an average operating time was 233 min and average blood loss was 1,548ml in the entire group of Cotrel-Dubousset instrumentation patients. Immediate frontal place correction was 57% but decrease to 43% at follow-up.

There is a dissimilarity of results between all the studies. Results differ with respect to operating time, blood loss, curve correction in all planes. Different surgeons achieve different results with different systems. Our mean correction in the coronal plane was 28.9° (53.5%; range, 33% to 81%). Jarvis and Greene[9] in a series of 24 patients, reported the mean correction in the coronal plane was 23° (43%; range, 20% to 69%) for the curves that had been treated with Wisconsin spinal instrumentation.

None of the patients who had an arthorodesis to the middle or caudad level of the lumbar spine had problems that necessitated an additional operation to extend the fusion more distally. In this study, none of the patients had a late infection that necessitated removal of the instrumentation. All of the patients received a first-generation cephalosporin prophylactically before the operation and was continued for three days post-operatively.

At final follow-up, mean coronal decompensation was 18.8% in this study. Bridwell *et al*[10] experienced post-operative decompensation and noted that all thoracic curves were shifted to the left post-operatively.

Mielke *et al*[11] stated that immobilization was a critical factor in maintaining correction. He found in his series of patient treated with Harrington rod with sublaminar wire, and divided into two groups. The patients who were immobilized after instrumentation had no difference in correction at 2-year follow-up. Those who were not immobilized had an average loss of twice as much correction at 2-year follow-up.

Luque[12] described a system of segmental spinal instrumentation with greater reported stability than the Harrington rod standard. The sublaminar construct provided correction for the sagittal plane deformity, minimized the need for post-operative immobilization, and decreased the loss of correction in scoliotic spinal fusion.

However, the dangers of repeatedly passing sublaminar wires became readily apparent through the results of multiple studies. Major neurological complications have been reported in up to 4% of patients undergoing this procedure[8,13,14]. In this study, no neurological complications were encountered with interspinous wiring. This was also noted by Jeng *et al*[3] with Wisconsin spinal instrumentation.

Jarvis and Greene[9] also reported the mean derotation of the apical vertebra with Wisconsin instrumentation of 6 degrees. From twenty-two of the thirty curves, the apical vertebra was medially derotated, a mean of 6 degrees in relation to the midline of the body. In this study, apical vertebra rotation was not studied, as there is not enough data available. There are difficulties in getting axial computed tomographic scan of the apical vertebra, and the plain radiographs were obscured by the implant.

However, based on Wisconsin instrumentation system, the apical vertebra derotation can occur with the system. Jarvis and Greene[9] showed a mean vertebral derotation of 6 degrees when it was evaluated using computed tomography. Computed tomography has been recognized as the most accurate method of determining vertebral rotation. Several methods have been used to quantify vertebral rotation. With Cobb method, the image of the spinous process is evaluated in relation to the vertebral body. With the method of Nash and Moe, the image of the pedicle is evaluated in relation to the vertebral body. Perdriolle and Vidal[15] devised a template to measure vertebral rotation by assessing the position of the pedicle. However, they have been shown to be inaccurate for the measurement of several curves and to be difficult to use after spinal instrumentation, which obscures osseous landmarks on radiographs.

Marchesi *et al*[16] used computerized tomography to assess vertebral rotation in patients who had been managed with Harrington instrumentation and also with Luque sublaminar instrumentation. The mean rotation of the apical vertebra was 16% in Harrington instrumentation and 12% in Luque instrumentation. If he combined Harrington and Luque sublaminar instrumentation, the apical mean derotation was 13%. Jarvis and Greene[9] found that the magnitude of derotation of the apical vertebra was 23%. Therefore the authors concluded that the magnitude of derotation of the apical vertebra with Wisconsin instrumentation was equal or better than that reported in association with other instrumentation systems.

In this study, at final follow-up the frontal Cobb's angle correction is relatively preserved in thoracic curves. The greatest loss of correction occurred in lumbar and thoracolumbar curves. These findings are also similar to that reported by Jeng *et al*[3] with the Wisconsin instrumentation.

There have been reports of permanent neurological complications in-patients who had idiopathic scoliosis and were treated with sublaminar wiring[13]. In this study, there were no neurological complications. Although there were three complications with the implant, all the three patients had a solid arthrodesis. Wilber *et al*[13] reported the incidence of neurological complications with sublaminar wiring of 17% with major spinal cord injury occurring in 4% of the sixty-nine patients.

There were no pseudoarthroses encountered in this study, although there were three implants failure. The solid fusion was established when there was no defect in the fusion mass on radiographs. The incidence of pseudoarthroses has been quite low as mentioned by other studies between zero to four per cent only[17]. One patient who has broken rods and K-wire in this study was asymptomatic. However, the curve did not progress. This incidence of asymptomatic fracture of the rod without loss of correction is similar to that reported by Erwin *et al*[18].

The study has revealed that the correction of the curve with this system is not far different from other techniques of instrumentation, which is in the range of 40 to 80% for patients who have idiopathic scoliosis. Loss of correction in the present study was 12.5% which is comparable with that in other studies on the use of Wisconsin instrumentation and Harrington instrumentation which was about 10%[3,17].

Contouring of the rods allow better closure or less leverage on the hooks, since distraction tends to straighten any curve, regardless of whether it is in the frontal or the sagittal plane. Therefore it is important to be careful when performing distraction especially in the lumbar region to avoid loss of lumbar lordosis.

## Conclusion

The University Kebangsaan Malaysia (UKM) spinal instrumentation and fusion technique safely achieves the objectives of scoliosis correction, and is effective in the treatment of adolescent idiopathic scoliosis. Its ability to maintain corrections is comparable with other systems, and its decreased risk for neurological injury compared to sublaminar wiring, should be considered in the treatment of idiopathic scoliosis more so when the cost is the main concern to the patient.

## References


1. Lonstein JE. Adolescent Idiopathic Scoliosis. The Lancet 1994; 344: 1407-12.
2. Drummond D, Guadagni J, Keene JS. Interspinous process segmental spinal instrumentation. J Pediatr Orthop 1984; 4: 397-404.
3. Jeng CL, Sponseller PD, Tolo VT. Outcome of Wisconsin Instrumentation in Idiopathic Scoliosis. Spine 1993; 18: 1584-90.
4. Herzenberg JE, Coonrad RW, Ross DB. Spinous process segmental instrumentation for scoliosis. J Spinal Disorders 1988; 1: 206-10.
5. Fitch RD, Turi M, Bowman BE, Hardaker WT. Comparison of Cotrel-Dubousset and Harrngton rod instrumentations in idiopathic scoliosis. J Pediatr Orthop 1990; 10: 44-7.
6. Liu SL, Russo SS, Borowiecki T, Schroeder FW. Fusion of scoliosis by Harrington distraction rod: interspinous process and sublaminar wiring compared in 42 cases. Acta Orthop Scand 1991; 62: 519-23.
7. Birch JG, Herring JA, Roach JW, Johnston CE. Cotrel-Dubousset Instrumentation in Idiopathic Scoliosis: A preliminary report. Clin Orthop 1988; 227: 24-9.
8. Herndon WA, Sullivan JA, Yngve DA. Segmental spinal instrumentation with sublaminar wires. A critical appraisal. J Bone Joint Surg (Am) 1987; 69(A): 851-9.
9. Jarvis JG, Greene RN. Adolescent Idiopathic Scoliosis: Correction of Vertebral Rotation with use of Wisconsin Segmental Spinal Instrumentation. J Bone Joint Surg (Am) 1996; 78(A); 1707-12.
10. Bridwell KH, McAllister JW, Betz RR, Huss G, Clancy M, Schoenecker PL. Coronal decompensation produced by Cotrel-Dubousset "derotation" maneuver for idiopathic right thoracic scoliosis. Spine 1991; 16: 769-77.
11. Mielke CH, Lonstein JE, Denis F, Vandenbrink K, Winter RB. Surgical treatment of adolescent idiopathic scolioisis. Acomparative analysis. J Bone Joint Surg (Am) 1989; 71(A): 1170-7.
12. Luque ER. Segmental spinal instrumentation for correction of scoliosis. Clin Orthop 1982; 163: 192-8.
13. Wilber RG, Thompson GH, Shaffer JW. Post-operative neurological deficits in segmental spinal instrumentation. J Bone Surg (Am) 1984; 66(A): 1178-87.
14. Winter RB, Lonstein JE. Adult idiopathic Scoliosis treated with Luque or Harrington rods and sublaminar wirng. J Bone Joint Surg (Am) 1989; 71(A): 1308-13.
15. Perdriolle R. Letter to editor. J Pediatr Orthop 1991; 11: 789.
16. Marchesi DG, Transfeldt EE, Bradford DS, Heithoff KB. Changes in vertebral rotation after Harrington and Luque instrumentation for idiopathic scoliosis. Spine 1992; 17: 775-80.
17. Lovallo JL, Banta JV, Renshaw TS. Adolescent idiopathic scoliosis treated by Harrington-rod distractin and fusion. J Bone Joint Surg (Am) 1986; 68(A): 1326-30.
18. Erwin WD, Dickson JH, Harrington PR. Clinical review of patients with broken Harrington rods. J Bone Joint Surg (Am) 1980; 62(A): 1302-7.

# Short Segment Posterior Instrumentation, Reduction and Fusion of Unstable Thoracolumbar Burst Fractures - A Review of 26 Cases

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## Summary

From January 1994 to January 1998, 26 patients of unstable thoracolumbar burst fracture were treated by a short segment posterior instrumentation (pedicular screw plate/rod system), reduction and fusion in Kuala Lumpur and Universiti Kebangsaan Malaysia Hospital. Majority of them were young and in a productive age group (mean age were 30 year-old). The mean duration of follow-up was 24.4 months. The injuries were caused by fall from height (69%) and motor vehicle accident (31%). Most of the fracture occurred at 1st and 2nd lumbar vertebrae (24/26). Twelve of the patients did not have neurological deficits. Out of 14 patients with neurological deficits, 64.4% of them showed an improvement of at least one Frankel's grade. There was no defect correlation between canal compromise and neurological deficit. Kyphotic angle improved from 20° to 7° immediately after surgery. In the last follow-up average kyphotic angle was 9° with average lost of 2°. The average length of hospitalization following surgery was 24 days. A posterolateral bony fusion was achieved in all cases at an average of 3 months. Complication included 2 loosening and 3 misplacement of pedicle screw fixation. We concluded that short-segment fixation with posterolateral decompression and fusion is effective in the treatment of unstable thoracolumbar burst fracture.

*Key Words:* Unstable thoracolumbar burst fracture, Short segment posterior instrumentation, Fusion

## Introduction

Thoracolumbar burst fractures is a fairly common injury associated with fall from height or following motor vehicle accident. The management and evaluation of this fracture have changed tremendously in the last 10 years with improvement of imaging technologies and spinal instrumentation systems which has guided orthopaedic surgeons to more objective and scientific approach in the overall management of this problem.

McAfee *et al*[1] has recognized the importance of 'Posterior Ligamentous Complex' disruption in burst fracture. They noticed the potential of these fractures to develop late instability characterized by decreased vertebral body height, posterior laxity and progressive kyphosis. Their criteria for unstable burst fracture were based on; progressive neural deficit, posterior ligamentous complex disruption, kyphotic deformity ≥20°, ≥50% loss of vertebral body height and the presence of free bony fragment within spinal canal with incomplete

neural deficit. Their conclusions supported previous observations by Bradford and colleagues[2] that the patient with unstable burst fractures who were treated conservatively tends to develop post-traumatic spinal stenosis, increase in kyphosis and progressive neurological deficits.

The surgical procedures for thoracolumbar burst fracture varies, based on the surgeon's experience and familiarity to spinal instrumentation. Laminectomy alone has been shown not only to be ineffective but also would allow further progression of deformity and neurological injury[3]. Accepted method of operative procedures include posterior reduction with distraction instrumentation and arthorodesis without decompression[4,5,6] posterolateral arthrodesis with instrumentation followed by anterior decompression/ fusion[7], anterior decompression and fusion with instrumentation[8], and posterolateral decompression, fusion and instrumentation[1,9].

Generally most authors agree that surgical decompression and stabilization of unstable thoracolumbar injuries promotes early rehabilitation, speedier recovery and lesser complication of prolong bed rest[7,10,11].

## Materials and Methods

From January 1994 to January 1998, 26 patients of unstable thoracolumbar burst fracture were treated surgically at the Orthopaedic Department Kuala Lumpur and University Kebangsaan Malaysia Hospital. The criteria of unstable thoracolumbar burst fractures were based from McAfee's *et al* work in 1983; progressive neural deficit, posterior ligamentous complex disruption, kyphosis progressing 20° or more with neural deficit, more than 50% loss of vertebral body height with facet joint subluxation, CT scan demonstration of free bony fragments within a compromised spinal canal associated with incomplete neural deficit.

All operations were done by standard midline posterior approach. Posterolateral decompression performed through small laminotomy at the fractured vertebra. Free fragment in spinal canal pushed back to their original position by using bone impactor. Three different types of instrumentation used in this series i.e. Socon, Isola and Steffe plate spinal fixation devices and only the vertebrae above and below the injured one were stabilized. Posterolateral bone grafting was performed after completion of fixation procedure. Two of the cases required dural repair.

Prophylatic antibiotic of a second-generation cephalosporin was routinely used for 24 to 48 hours post-operatively. A thoracolumbar orthosis was prescribed to all patients post-operatively and encouraged to be used for about 3 months.

Hospital and outpatient record were analyzed and reviewed to look into epidemiology, mechanism/type of injury, outcome of neurological deficits, degrees of kyphotic deformity, complication and length of hospitalization. The mean duration of follow-up was 24.4 month (range from 6 months to 4 years). The latest clinical and radiological evaluations were conducted in June 1998.

## Results

There were 24 male and 2 female patient with average age 30 years. Majority of patients were admitted within 24 hours after injury (80%) and the others (5 patients) were referred from other hospitals within 72 hours of injury. Sixty nine percent of the injury was due to fall from height and the rest due to motor vehicle accidents. Associated injuries included tibia plateau, calcaneum, distal radius and ulnar bones fracture. Sixteen patients suffered fracture in the 1st lumbar, 8 patients in the 2nd lumbar and 2 patients in the 3rd lumbar vertebrae.

### Neurological function and spinal canal compromise

In 20 cases where CT scan or MRI was performed, there were no direct correlation between the degree of spinal canal compromise and neurological deficit (Table I).

64.4% of patient showed neurological recovery of a least 1 Frankel grade following the surgery (Table II).

Majority of patients with neurological deficit were operated within 2 weeks of injury (Table III). Sixty four percent (9/14) of the patients showed neurological

**Table I**
**Degrees of Spinal Canal Compromise and Neurological Deficit (by Frankel's Grade, 1969)**

| % of Canal | Neurological Grading | | | | |
|---|---|---|---|---|---|
| Compromise | A | B | C | D | E |
| <30 | | | | | 2 |
| 30 - 39 | | | 2 | 2 | 4 |
| 40 - 49 | | | 2 | | |
| 50 - 59 | | | | 2 | 2 |
| 60 - 69 | | | | | |
| >70 | | | 2 | 2 | |

**Table II**
**Neurological Recovery Following Surgery**

| Pre-operative Status | Neurological Status at Follow-up | | | | | |
|---|---|---|---|---|---|---|
| No of Patient | A | B | C | D | E | % of Recovery |
| A : 0 | | | | | | |
| B : 2 | | 1 | | 1 | | 50% |
| C : 6 | | | 2 | 4 | | 66.6% |
| D : 6 | | | | 2 | 4 | 66.6% |
| E : 0 | | | | | | |

*Average percentage of recovery is 64.4%*

improvement. There were no direct correlation between neurological recovery and the timing of surgery however vast majority of patients (6/8) whom operated within 2 weeks showed neurological improvement.

### Kyphotic Deformity

Kyphotic deformity was measured by Cobb's angle (sagittal view). The average kyphotic angle before surgery was 20°. Immediately after surgery it was improved to 7°. However in the last follow up the average angle was 9° with lost of 2° angle of kyphosis.

### Bony Union

A posterolateral bony fusion was achieved in all cases at the average of 3 month post-operatively.

**Table III**
**Timing of Surgery in Relation to Neurological Recovery**

| Timing of Surgery (Days) | No of Patients | Neurological Function | |
|---|---|---|---|
| | | Improved | Not Improved |
| < 7 | 3 | 2 | 1 |
| 8 - 14 | 8 | 6 | 2 |
| > 14 | 3 | 1 | 2 |

### Hospital Stay

Hospital stay ranged from 7 to 109 days. Patients without neurological deficits, the majority of them were discharged within 7 days after surgery. Patients with significant neurological deficits (6 of them with Franked grade C) have taken longer time for rehabilitation programme in the hospital especially those (4 patients) with bladder and bowel involvement.

### Complications

There were 5 complications related to surgical technique, which due to screws misplacement. All of them were revised within 5 days after the first surgery. However, there was no neurological deterioration seen. There were no post operative wound infection in this series.

## Discussions

The indication for surgical treatment of unstable burst fracture are controversial[4,7,10,12]. In the study of 42 patients with unstable thoracolumbar burst fracture, Mumford *et al.*[11] found none had worsening of their neurological status and 17% improved at follow-up. Only 3 patients required late operation to correct kyphotic deformity and post-traumatic stenosis. However, Denis *et al*[3] in a series of 52 burst fracture without neurologic deficit, compared operative and conservative treatments. In non-operative group 25.6% were unable to return to work full-time. Late neurological deterioration developed in 18% of conservative group compare to none of the operative group. They concluded that the patients of operative group seemed to do significantly better in terms of

kyphosis, pain, return to work and neurologic stability. Most authors agree that operative stabilization of unstable burst fracture promotes early rehabilitation and return work[2,13,10].

In this study, majority of patients were young, aged between 15 to 33 years old (average 30 years). Mechanism of injury were mainly fall from height (69%) and remaining were due to motor vehicle accident (31%). This may reflect the reality that Malaysia is a developing country in which construction of high-rise building are the major activities, particularly in Kuala Lumpur. In the Malaysian community especially in lower and middle-income groups, the uses of motorcycle is widespread. This explains the reason for high incidence of thoracolumbar injuries among the motorcyclists. This trend is comparable with other authors[11,12].

The goals of surgical treatment in thoracolumbar burst fracture are to restore anatomical alignment, stable fixation, neural decompression when necessary, early ambulation and in the long run, a functional painless spinal column. The principle controversy centred on how best to achieve those goals. Gertzbein *et al*[14] and Esses *et al*[5] compared anterior and posterior decompression/instrumentation in thoracolumbar burst fracture with incomplete neurologic deficits. They found no statistical differences in neurologic recovery, maintenance of reduction and hardware failure. Although the residual canal stenosis was significantly lower in the anterior group but they significantly had more blood loss.

In this series there is no direct correlation between neurologic deficits and spinal canal compromise. Neurological recovery of at least one Frankel's grade was seen in 64.4% of the patient. All patients were operated within 2 to 21 days. Those operated within 2 weeks of injury seem to show greater chance for neurological improvement. Correction of kyphotic deformity was very encouraging (from 20° to 7°) and the loss of correction was acceptable (2°). Bony union was achieved in all patients. Overall the results were comparable to other series of posterior instrumentation and fusion[15,16,17,18,19]. Complication in this series can be considered as minimal with 2 screw loosening and 3 misplacement.

There were no neurologic and vascular injury noted. No surgical infection was seen in this series which was probably due to use of prophylatic antibiotic in all patients.

We concluded that short-segment pedicular fixation with posterolateral decompression and fusion is efficient and safe in the treatment of unstable thoracolumbar burst fracture: It improved kyphotic deformity and neurological status, results in a stable fusion and preserve lumbar sagittal alignment and motion of segments above and below the fusion area at least in short term follow-up.

## References


1. McAfee PC, Yuan HA, Fredrickson BE, *et al*: The value of computed tomography in thoracolumbar fractures: An analysis of one hundred consecutive cases and a new classification. J Bone Joint Surg Am 1983; 65: 461.
2. Bradford DS, Akbarnia BA, Winter RB: Surgical stabilization of fracture and fracture dislocations of the thoracic spine. Spine 1977; 2: 185.
3. Denis F: The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 1983; 8: 817.
4. Benson DR, Keemen TL: Evaluation and treatment of trauma to the vertebral column. AAOS Inst. Course Lecture 1990; 39: 577.

5. Esses SI, Bradford DJ, Kostuik JP: Evaluation of surgical treatment for burst fractures. Spine 1990; 15: 667.

6. Saso RC, Cotler HB, Reuben JD: Posterior fixation of thoracic and lumbar spine fractures using DC plates and pedicle screw. Spine (Suppl) 1991; 16: 134.

7. Bradford DS, McBride GG: Surgical management of thoracolumbar spine fractures with incomplete neurological deficits. Clin Orthop 1987; 218; 201.

8. Kaneda K, Taneichi H, Abumi K, *et al*: Anterior decompression and stabilization with Kaneda device for thoracolumbar burst fractures associated with neurological deficits. J Bone Joint Surg 1997; 79: 69-83.

9. McNamara MJ, Stephen GC and Sprengler DM: Transpedicular short-segment fusion for treatment of lumbar burst fracture. J Spinal Disord 1992; 5: 183-87.

10. Jacob RR, Asher MA, Snider RK: Thoracolumbar spinal injuries: A comparative study of recumbent and operative treatment in 100 patients. Spine 1980; 5: 463.

11. Mumford J, Weinstem JN, Spratt KF and Goel VK: Thoracolumbar burst fractures. The clinical efficacy and outcome of non-operative management. Spine 1993; 18(8); 955-70.

12. Knight RQ, Stornelli DP, Chan PK, *et al*: Comparison of operative versus non operative treatment of lumbar burst fractures. Clin Orthop 1993; 293: 112-21.

13. Denis F, Armstrong GWD, Searls K, *et al*: Acute thoracolumbar burst fracture in the absence of neurologic deficit: A comparison between operative and non-operative treatment. Clin Orthop 1984; 189: 142.

14. Gertzbein SD, Crowe PJ, Fazl M, *et al*: Canal clearance in burst fracture using the AO internal fixator. Spine 1992; 17: 558.

15. Aebi M, Etter C, Kehl T: Stabilization of the lower thoracic and lumbar spine with the internal spinal skeletal fixation system: Indication, technique and first results of treatment. Spine 1997; 12: 544.

16. Chang K W: A reduction-fixation system for unstable thoracolumbar burst fractures. Spine 1992; 17(8): 879-86.

17. Mozes GC, Kollender Y and Sasson AA: Transpedicular screw-rod fixation the treatment of unstable lower thoracic and lumbar fractures. Bull Hosp Joint Dis 1993; 53(1): 37-44.

18. Sangkaew C, Damrogvanich P and Rangsrijamras C: Short segment pedicle screw plating for thoracolumbar spine burst fractures. J Asean Orthop Assoc 1995; 9(2): 29-35.

19. Shiba K, Katsuki M, Ueta T, *et al*: Transpedicular fixation with Zielke instrumentation in the treatment of thoracolumbar and lumbar injuried. Spine 1994; 19(17) 1940-49.

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# Thoracolumbar Fracture - Dislocation Results of Surgical Treatment

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**Summary**

Fifteen cases of unstable fracture-dislocation of the thoracolumbar spine have been treated by open reduction, short segment transpedicular fixation and fusion in Universiti Unit, Kuala Lumpur Hospital from January 1994 until December 1997. Twelve male and three female patients were injured; their age ranged from 18 to 45 years. Five fracture-dislocations occurred in the lower thoracic spine (T8 to T11), eight at the thoracolumbar junction (T12 to L2) and two in the lumbar spine (L3 to L5). All the patients had neurological deficit. Seven patients with incomplete or cauda equina lesions regained some neural function, while all eight with complete lesions remained unchanged. Ten of the fifteen cases were grossly unstable and translated beyond 50% of the width of the spinal column. At the time of follow up (more than one year in all patients), no loss of reduction or of fixation was noted in any patient. Solid fusion was achieved in all patients. The advantages of this method of treatment include stable fixation, with maintenance of sagittal and coronal spinal alignments, to allow early rehabilitation.

*Key Words:* Thoracolumbar fracture-dislocation, Open reduction short segment transpedicular fixation, Spinal fusion

## Introduction

The treatment of unstable fracture-dislocation of the thoracolumbar region has involved some controversy. Both operative[1,2] and non-operative[3,4] modes of treatment have been recommended. However, recently most of the authors[5,6,7,8,9,10] agree that surgical stabilization is indicated in patients with grossly unstable fracture-dislocation of the thoracolumbar region. Non-operative reduction in this injury is almost impossible and a redisplacement/dislocation would occur easily. The goals of surgery in these complex injuries are reduction of the deformity, adequate decompression of dural contents with stabilization and resultant fusion of the spine[11]. With advanced technique of spinal stabilization and anaesthetic care the risk of neurological injury, progressive deformity and complication of prolonged bed rest are avoidable.

The purpose of this paper is to report on the results found in a retrospective study of 15 patients with very unstable fracture-dislocation of the thoracolumbar region treated by open reduction, transpedicular short segment instrumentation and spinal fusion during a four-year period.

## Materials and Methods

The hospital records and roentgenograms of all patients with fracture dislocation of the thoracolumbar spine treated with short segment transpedicular screw-rod/plate instrumentation and spine fusion at the University Unit, Kuala Lumpur Hospital from 1994 to 1997 were reviewed. All stabilization procedures were performed within three weeks of injury.

There were 12 male and 3 female patients whose age at the time of injury ranged from eighteen to forty-five years. Ten injuries were caused by automobile accidents, four by falls and one by a heavy blow. Five patients had associated injuries. These included haemopneumothorax in two; clavicular and scapular fracture in one; cranial injury in one; and ankle injuries in one.

A standard posterior approach was used with exposure performed from normal areas proximal and distal to the injury toward the area of injury. Once the vertebral injuries were assessed and instrumentation levels were selected, transpedicular screws were inserted one level above the and below the injury level in the usual manner. Translation and dislocation were reduced with distraction/compression devices and checked by an image intensifier. Once reduction was achieved full construct of instrumentation was performed with application of the rods. The rods were contoured sagitally based on the level of injury. Posterolateral bone grafting was performed in all cases. Routine muscle, fascial and skin closures were then carried out. Postoperatively, each patient was managed on a regular bed and turned frequently by the log-rolling technique. A Jewett hyperextension brace or bivalve poly propylene body jacket was applied to all patients. These orthoses were used for an average of five months. Following surgical stabilization and application of orthoses, patients participated in a full rehabilitation program compatible with their neurological status and associated injuries.

## Results

The operative time ranged from two to four hour with an average time of two hours and forty minutes. Estimated operative blood loss was on average, two litres.

### Deformity

Adequacy of reduction of these severe injuries at the time of last follow-up was based on restoration of continuity of the anterior spinal column. Except in one patient with severe coronal and sagittal translation, the other 14 patients accomplished almost normal anatomical restoration. Radiographs at the time of final follow-up evaluation documented solid healing of each fusion mass. None of the patients had a clinically detectable gibbus deformity or excessive kyphosis. No redisplacement or dislocation was seen in any of the cases.

### Types of Injury

Based on Denis (1992) classification of fracture-dislocation, the type of injury were:

1. Flexion-Rotation : 8 patients
2. Flexion-Distraction : 5 patients
3. Shear-type : 2 patients

### Neural function

No patient with complete neurologic deficits regained function. Of seven patients with incomplete lesion; both the patients with Frankel's C improved to D. Our of five with Frankel's B, one improved to D and another four to C.

### Hospitalization

The average hospitalization (from the day of injury to the day of discharge from the rehabilitation program) was 110 days for 8 patients with complete neurological deficit, and 82 days for 7 patients with incomplete lesions.

### Complications

Two out of seven patients with complete neurological deficit developed pressure sore due to delayed surgery (more than two weeks). However, they healed by daily dressing and a regular turning program after the operation. No instrumentation failure was seen.

**Table I**
**Neurological Recovery in Incomplete Lesion**

| Pre-operative Status & Number of Patient | Neurological Status at Follow-up | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| A : 0 | | | | | |
| B : 5 | | | 4 | 1 | |
| C : 2 | | | | 2 | |
| D : 0 | | | | | |
| E : 0 | | | | | |

## Discussion

Fracture-dislocation of the thoracolumbar spine is a very unstable injury with disruption of all three osseo-ligamentous column of the spine[12]. There are various ways of treating this injury. However, despite continuing controversy regarding the 'best' treatment regime, even fairly rigid proponents of non-operative therapy agree that surgical reduction and stabilization are indicated in these grossly unstable injuries[5]. Although Guttmann[4] reported a high incidence of fixation failure and recurrence of deformity when spinal plate was used, the concept of plating (through spinous process) at that particular time was so much different as compared to the present technology. Subsequently, most authors[1,2,12,13,14,15] reported low failure and high fusion rate of thoracolumbar injuries treated with modern instrumentation. Flesh *et al*[1] stressed the importance of post-operative immobilization with spinal orthosis to substantiate the stability of the spinal column. We totally agree with this idea and our results showed no redislocation/redisplacement in the final follow-up. Post-operative spinal orthosis also didn't delay the rehabilitation program.

The most important reason for performing surgery is to establish stability, which will encourage bony union. Furthermore, reduction of the fracture-dislocation and restoration of normal sagittal and coronal alignment permits maximum recovery of neural tissue[1]. Neurological improvement of at least one Frankel's grade occurred in all patients with incomplete cord or cauda equina lesion but there was no recovery in any patient with complete lesion. The percentage of patients showing improvement after an incomplete lesion was higher than in other series of patients treated by postural reduction[3], or laminectomy[17] and comparable to those treatment with Harrington rods and sublaminar wire fixation[2]. However, whether recovery was related to any of the treatment variables or whether it reflected the natural tendency of incomplete cord lesions to improve cannot be determined. As noted by Bedbroak[17] the most important determining factor is the extent of damage to the neural tissue at the time of injury. No patient in this series showed any deterioration of neural function during or after treatment.

No local data on total hospitalization time is available for patients treated by conservative means, but the length of hospitalization in this series compare favourably with that reported on by other spinal centers[13,15,18,19].

The use of short segment transpedicular-rod fixation in 15 cases with unstable thoracolumbar fracture-dislocation has provided stable internal fixation and solid fusion without system failure. This method of treatment has allowed early post-operative mobilization with a shortened hospitalization and rehabilitation program.

## References


1. Flesh J, Leider L, Erickson D *et al.*: Harrington instrumentation and spine fusion for unstable fracture and dislocation of the thoracic and lumbar spine. J Bone Joint Surg Am 1977; 59: 143-53.
2. Gaines R, Breedlove R, Munson G: Stabilization of thoracolumbar fracture-dislocations with Harrington rods and sublaminar wires. Clin Orthop 1984; 189: 195-203.
3. Frankel H, Hancock D, Hyslop G *et al.*: The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. Part I. Paraplegia 1969; 7: 179-92.
4. Guttmann and Ludwig: Spinal deformities in traumatic paraplegics and tetraplegics following surgical procedures. Paraplegia 1969; 7: 38-49.

5. De Oliveira: A new type fracture-dislocation of the thoracolumbar spine. J Bone Joint Surg Am 1987; 60: 481-88.

6. Edward C, Levine A: Early rod-sleeve stabilization of the injured thoracic and lumbar spine. Orthop Clin North Am 1986; 17: 120-45.

7. Floman Y, Fast A, Pollack D *et al.*: The simultaneous application of an interspinous compressive wire and Harrington distraction rods in the treatment of fracture-dislocation of the thoracic and lumbar spine. Clin Orthop 1986; 205; 207-15.

8. Heller JG, Garfin SR, Abitbol JJ: Disc herniations associated with compression instrumentation of lumbar flexion-distraction injuries. Clin Orthop 1992; 284: 91-8.

9. Levine AM, Edwards CC: Complication in the treatment of acute spine injury. Orthop Clin North Am 1986; 17: 183-203.

10. Mc Guire RA, Freeland AE: Flexion-distraction injury of the thoracolumbar spine. Orthopaedics 1992; 15: 379-81.

11. Levine AM, Bosse M, Edwards CC: Bilateral facet dislocations in the thoracolumbar spine. Spine 1988; 13: 630-40.

12. Denis F: The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 1983; 8: 817-31.

13. Kinoshita H, Nagota Y and Hirakawa H: Thoracolumbar fracture-dislocation: a study of 30 patients. Paraplegia Aug 1989; 27(4): 289-95.

14. Sasp RC, Cotler HB: Posterior instrumentation and fusion for unstable fractures and fracture-dislocation of the thoracic and lumbar spine. A comparative study of three fixation devices in 70 patients. Spine Mar 1993; 18(4): 450-60.

15. Stambough JL, Nayak S: Frankel A paraplegia a comparison of two spinal instrumentation systems. Southern Med J Jun 1996; (6): 597-602.

16. Kaufer, Herbert and Hayes JT: Lumbar fracture-dislocation. A study of twenty-one cases. J Bone Joint Surg June 1966; 48A: 712-30.

17. Bedbroak GM: Use and disuse of surgery in lumbo-dorsal fracture. J Western Pacific Orthop Assn., Dec 1969; 6: 5-26.

18. Meyer PR: Annual report, Midwest regional spinal cord injury care system. Chicago 1973.

19. Wilcox NE, Staufer ES, Nickel VL: A statistical analysis of 423 consecutive patients admitted to the Spinal Cord Injury Centre, Rancho Los Amigo Hospital. Paraplegia 1970; 8: 27-35.

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# Spinal Infection - An Overview and the Results of Treatment

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**Summary**

A retrospective review of thirty-eight patients (16 males and 22 females) with spinal infection between 1993 and 1998 revealed that the mean age was 39.9 years and the peak incidence was in the 5th decade of life. Infections in thirty-two patients (84.2%) were tuberculous in origin, 13.2% were pyogenic and 2.6% were fungal. Back pain was a symptom in 94.7% while 55.8% had neurological deficits, of which two-thirds were tuberculous in origin. Twenty-two patients (57.9%) had an impaired immune status secondary to pulmonary either tuberculosis, diabetes mellitus, intravenous drug abuse, prolonged steroid treatment, malnutrition, or advanced age. History of contact with tuberculous patients was elicited in 31.3%, extraskeletal tuberculosis was found in 28.1%, while Mantoux test was only positive in 53.1% of tuberculous patients. Majority of the cases (57.9%) involved lumbar vertebra. The histopathological examination was only positive in 22.2% from material taken via CT guided biopsy but 93.3% were found to be conclusive from open biopsy. 4 out of 5 patients who had a pyogenic infection were treated conservatively and produced a good result. There was no difference in outcome for tuberculosis patients treated with either the 3 drug or 4 drug regimen. Anterior decompression and bone grafting in tuberculous patients was superior in terms of a faster fusion rate, early pain relief and prevention of kyphotic deformity. The initial neurological deficit did not reflect the future prognosis of patients with spinal infection.

*Key Words:* Spinal infection, Pyogenic and tuberculous infections, Conservative and surgical treatment, Neurological recovery

## Introduction

Infection of the spine has been recognized throughout the history of humankind where the most common type is tuberculous spondylitis. Historically, spinal infection used to be a devastating disease with exceedingly high morbidity and mortality rates. With the advent of antimicrobial chemotherapy and powerful new diagnostic techniques, the prognosis has improved dramatically in recent years. However, there are still many pitfalls in the management of spinal infections which one needs to be aware of.

An early diagnosis of spinal infection will guide an orthopedic surgeon to implement appropriate treatment to minimize the risk of complications that may arise from this pathology, particularly cord or nerve involvement as well as kyphotic deformities.

The aim of this study is to review all cases of spinal infections retrospectively that were treated at Universiti Kebangsaan Malaysia Orthopedic Department, Kuala Lumpur Hospital and Universiti Kebangsaan Malaysia Hospital from January 1993 to October 1998 and to evaluate:

1. the epidemiological pattern of spinal infection of the patients who were treated in this unit.
2. the presentation and duration of the symptoms prior to treatment.
3. the type of spinal infection (bacteriology), methods of diagnosis, and levels of infections.
4. the neurological involvement due to spinal infection.
5. the outcome of various methods of treatment.

## Materials and Methods

There were forty-seven patients with spinal infection treated at the Orthopaedic and Traumatology Department, Universiti Kebangsaan Malaysia (UKM) at Hospital Kuala Lumpur and Hospital Universiti Kebangsaan Malaysia from January 1993 until October 1998. All the records were traced from the medical record office, Hospital UKM. Only cases of primary tuberculous, pyogenic, and fungal infection were included in this study. Spinal infection secondary to post-surgical procedures or instrumentation, or caused by direct inoculation such as penetrating or stab wounds were excluded. In this retrospective study the total number of patients reviewed were 38 and nine cases were excluded from this study due to the above reasons.

The area of origin was assessed base on majority period of time where the patients stay before the diagnosis - either from rural or urban areas. In terms of their socio-economic status, they were classified as low, middle or high based on the criteria suggested by the Economic Planing Unit (EPU) of the Prime Minister's Department.

In terms of neurological assessment, we use Frankel *et al's*[1] classification:

Grade A - Complete neurologic deficit distal to the lesion
Grade B - Sensory sparing but no motor function distal to the lesion
Grade C - Sensory sparing and useless motor function distal to the lesion
Grade D - Sensory sparing and useful motor function distal to the lesion
Grade E - Normal neurological status

We classified the immune status based on the history, clinical and laboratory assessment. Any history of chronic diseases or medical illnesses such as diabetes mellitus, pulmonary tuberculosis, chronic renal disease or impairment, prolonged steroid treatment, age more than 70 years old, HIV positive, malnourishment with hypoalbuminemia and hypoproteinemia were categorized as immunocompromised patients.

The diagnoses were established via various methods of investigation i.e. a direct smear or culturing acid-fast bacilli from a CT Scan guided or an open biopsy, and histopathological examination of material from the spinal lesion. In cases where no spinal tissue could be obtained nor could a histopathological report or culture be demonstrated, possible extraspinal sources such as urine and sputum were investigated. The radiographic findings, Mantoux test, Erythrocyte Sedimentation Rate (ESR), white blood cell differential count, and response to appropriate treatment were considered diagnostic tools as well. A biopsy was carried out when it was necessary to establish the diagnosis.

All cases of vertebral tuberculosis were referred to the National Tuberculosis Centre (NTBC) of Malaysia at Jalan Pahang, Kuala Lumpur for consultation in terms of anti - tuberculous chemotherapy. They were treated with the following drugs but in various combinations: Isoniazid (5 to 10mg/kg/day; maximum, 300mg/day); Rifampicin (10 to 20mg/kg/day; maximum, 600 mg/day); Ethambutol (15mg/kg/day; maximum, 1200mg/day); Pyrazinamide (25mg/kg/day; maximum, 2g/day); Streptomycin (15 to 20mg/kg/day; maximum, 1g/day); and Vitamin B6 (25mg/day). Liver and renal function tests were routinely done prior to starting anti-tuberculous chemotherapy and monitored throughout the duration of the course. None of the patients had significant liver or renal insufficiency secondary to the chemotherapeutic agents. One patient who had chronic renal failure was treated with reduced dosages of Isoniazid, Rifampicin, and Pyrazinamide for period of 9 months with regular monitoring of liver and renal function.

Definitive surgery was reserved for those patients who failed to improve with conservative measures, or those who had severe or progressive neurological deficit,

persistent abscess, and spinal instability. The presence of instability was based on clinical assessment and radiological evidence of vertebral destruction. Anterior or posterior grafting with or without instrumentation was carried out when indicated.

Plain radiographs were taken during follow-up at our orthopaedic clinic to assess bony fusion of the infected vertebrae. Fusion was considered achieved when there was an evidence of optimal bony bridging at or between the affected vertebrae.

Cobb's angle of kyphosis was determined during data collection in all plain lateral radiographs before and after treatment up to a minimum six months' follow-up. Any progression of the angle was considered as an increase in kyphosis.

## Results

### Epidemiology

The mean patient age at presentation was 39.9 years (range 2 -72 years) and the peak incidence was in the 5th decade of life. Males constituted 42% (16 patients) and female 58% (22 patients) of the patients. Malays comprised almost half of the patients (47.2%). This was followed by Chinese (26.2%), Indians (13.2%), Orang Asli (8.0%), and Indonesians (5.2%).

A majority of the patients (71.0%) were from the lower income group and none were from the high socioeconomic status group. Twenty-three patients were from rural areas (61.0%) (Figure 1).

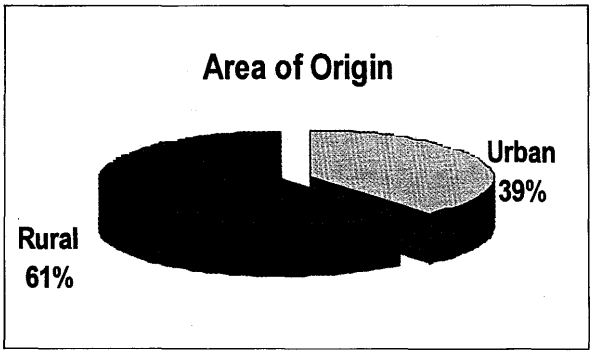


**Fig. 1: The distribution of the area of origin.**

### Clinical Features

#### *Type of Infection*

The majority of spinal infection was of tuberculous origin (84.2%) (Table I). Two out of the 32 tuberculous patients presented in an atypical form. Both had neural arch involvement and one of them mimicked a vertebral tumour.

#### *Symptoms*

Back pain was the predominant complaint and presented in 94.7% of the patients. Other presenting complaints were symptoms of neurological deficit, spinal deformity, and flank mass (Table II). The average duration of symptoms was 3.7 months (range 1 week to 1 year).

Over half the patients had neurological involvement (55.8%). The severity of neurological deficit is shown in Table III. Almost two-thirds of the patients with tuberculous vertebral infection and two out of five of those with pyogenic infection had neurological deficit.

#### *Immune Status*

Twenty-two out of 38 patients (57.9%) had compromised immune status. One of the 3 intravenous drug abusers was confirmed as HIV positive, whilst the

**Table I**
**Type of Spinal Infections**

| Type of Infections | Number of Patients | Percentage |
|---|---|---|
| Tuberculosis | 32 | 84.2% |
| Pyogenic | 5 | 13.2% |
| Fungal | 1 | 2.6% |
| Total | 38 | 100.0% |

**Table II**
**Presenting Symptoms of Patients**

| Symptoms | Duration (month) | Percentage |
|---|---|---|
| Back Pain | 36 | 94.7% |
| Neurology | 25 | 55.8% |
| Spinal Deformity | 4 | 10.5% |
| Flank Mass | 1 | 2.6% |

**Table III**
**Neurological Status of the Patients with Spinal Infection**

| Neurological Grading | Number of Patients |
|---|---|
| Frankel A | 8 |
| Frankel B | 6 |
| Frankel C | 3 |
| Frankel D | 8 |
| Frankel E | 13 |
| Total | 38 |

rest were negative. All of them were suffering from tuberculous spinal infection. Of the 5 patients with pyogenic infection, 4 were noted to be immunocompromised. Two patients had chronic pulmonary tuberculosis with hypoalbunemia and hypoproteinemia; one had diabetes mellitus on with prolonged steroid therapy, and an elderly patient with poor nutritional status, respectively.

History of contact with a tuberculosis patient was elicited in 10 out of 32 patients (31.3%). One of the patients, a medical doctor gave history of frequent contact with pulmonary tuberculosis patients at Seremban General Hospital.

Extraskeletal tuberculosis occurred in 9 out of 32 tuberculous patients (28.1%). Eight had pulmonary tuberculosis while one had both pulmonary and renal tuberculosis.

## Diagnosis

### *Laboratory Result*

#### *Total White Count*

Most of those with tuberculosis had normal white count (87.5%). The mean of the white count was 7.7 x $10^9$ (range 2.8 - 14.2 x $10^9$). Lymphocytosis was noted in 58.4% of the tuberculosis patients. In contrast, 80.0% of the patients with pyogenic infection had leukocytosis of an average 18.6 x $10^9$ (range 10.6 - 28.2 x $10^9$).

#### *Erythrocyte Sedimentation Rate (ESR)*

ESR was raised in 28 out of 32 tuberculosis patients (73.7%) with a mean of 86.6mm/hour (range 2 - 150mm/hour). All the pyogenic patients had increased ESR ranging from 101 - 153mm/hour (mean 127.6 mm/hour).

#### *Mantoux Test*

Of the 32 patients with tuberculosis of the spine, only 17 had a positive mantoux test (53.1%).

#### *Culture and Bacteriology*

Sputum tested for Acid Fast Bacilli was positive only in one patient with tuberculosis of the spine. In pyogenic infection, blood culture and sensitivity yielded positive result in 40.0%. Urine cultures were negative in all cases. Tissue culture was obtained in 19 patients but only 2 were positive. Both of them were pyogenic in nature. None of the tuberculosis patients had a positive result. The causative agents for pyogenic infections were mainly Staphylococcus aureus, which was found in two patients - one was obtained from a blood culture and another from a tissue culture, and ß - Streptococcus which was obtained from a tissue culture in one patient. The other two pyogenic infections had no positive cultures.

### *Histopathology*

Only 17 patients (44.7%) had their diagnosis confirmed by histopathological examination, which included 2 of the 9 cases (22.2%) who underwent CT-scan guided biopsy. 14 out of 15 open biopsies (93.3%) produced conclusive histopathology results.

## Treatment

### *Conservative*

Twenty-ones out of 38 patients (55.3%) were treated non-surgically. With respect to the type of infection, 4 patients had a pyogenic vertebral infection while 17 were tuberculous. Therefore, 80% of the patients (4 out of 5) who had a pyogenic infection and 53.1% of the tuberculous patients (17 out of 32) were treated conservatively.

#### *Chemotherapy*

Antituberculous chemotherapy was administrated in all tuberculous infection as suggested by National Tuberculosis Center (NTBC). The detailed regimes that had been prescribed are shown in Table IV. The drugs were given for duration of between 9 to 12 months depending on the clinical response.

**Table IV**
**The Various Anti-Tuberculous Regimes**

| Anti-TB Regime | Number of Patients |
|---|---|
| RHZ | 16 |
| SRHZ | 6 |
| SRHE | 2 |
| REHZ | 2 |
| SEHZ | 1 |
| SRH | 2 |
| EHZ | 1 |
| SHZ | 2 |
| Total | 32 |

*R - Rifampicin; H - Isoniazid; Z - Pyrazinamide; S - Streptomycin; E - Ethambutol*

All cases of pyogenic vertebral osteomyelitis were treated by broad-spectrum antibiotics based on the culture and sensitivity results or commonest possible infectious organism in cases where the cultures were negative. The duration of drug therapy was 6 to 8 weeks.

### *Surgery*

Out of 38 patients, 17 were underwent various type of surgical treatment (44.7%). The details of the surgical procedures are shown in Table V.

One of the patients who underwent anterior decompression with strut bone grafting was a 29 weeks pregnant woman. The procedure was done immediately after cesarean section. Both mother and baby were healthy and well.

### Outcome

### *Pain*

Overall, in twenty patients (52.6%) the symptom of back pain subsided in a mean period of 6.95 months. Nine of them were spinal tuberculous infections and were treated surgically. In tuberculous patients, 10 out of the 17 patients (59%) who were treated conservatively had persistent back pain at the end of their follow up, but only 6 out of the 15 tuberculous patients (40%) who underwent various surgical treatments had persistent symptoms. The average pain relief period in the group, which received anti-tuberculous chemotherapy alone, was 9 months in contrast with only 7.8 months in the tuberculous patients who were treated surgically. All 4 pyogenic infection patients who received antibiotics alone had no back pain within a 2-week to 6-month period, but one patient who underwent posterior decompression and instrumentation had persistent symptoms.

### *Neurological Improvement*

Twenty-four patients had a neurological deficit at the time of presentation (21 tuberculosis, 2 pyogenic and 1 fungal infection). Twenty-one patients (87.5%) improved at least one Frankel grade following treatment. Out of the 21 patients with tuberculosis of the spine, 11 were treated conservatively. Of these, 9 had neurological improvement (81.8%). Another 10 patients underwent surgery and in this group of patients, 9 showed improvement (90.0%).

**Table V**
**The Various Types of Surgical Procedures**

| Surgical Procedures | TB | Pyogenic | Fungal | Total |
|---|---|---|---|---|
| Anterior | | | | |
| - Decompression alone | 4 | 0 | 0 | 4 |
| - Decompression + BG | 6 | 0 | 0 | 6 |
| - Decompression + Inst. | 0 | 0 | 0 | 0 |
| Posterior | | | | |
| - Decompression alone | 0 | 0 | 0 | 0 |
| - Decompression + Inst. | 1 | 1 | 0 | 2 |
| - Decompression + Inst. + BG | 4 | 0 | 1 | 5 |

*BG - Bone Grafting; Inst. - Instrumentation*

Both the patients with pyogenic infection, who were treated conservatively had neurological improvement. One patient with fungal infection of the spine who underwent posterior decompression, bone grafting and instrumentation improved from grade B to grade E. Overall, 11 out of 13 patients (84.6%) who were treated conservatively and 10 out of 11 (90.9%) who were treated surgically experienced some improvement in their neurological status (Table VI).

**Table VI**
**The Outcome of Various Treatments in Term of Neurological Status**

| Type of Infection | Improve (No) | Not Improve (No) | Total |
|---|---|---|---|
| Tuberculosis | | | |
| - Surgery | 9 | 1 | 10 |
| - Conservative | 9 | 2 | 11 |
| Pyogenic | | | |
| - Surgery | 0 | 1 | 1 |
| - Conservative | 2 | 0 | 2 |
| Fungal | | | |
| - Surgery | 1 | 0 | 1 |
| - Conservative | 0 | 0 | 0 |

Generally, the average time for neurological improvement was 2.1 months (range 0.5 to 6 months) in the surgically treated group and 3.3 months (range 0.5 to 18 months) for those treated conservatively. In the tuberculous group, surgically treated patients showed an improvement after an average of 1.35 months (range 0.5 to 6 months) while the non-surgically treated group took an average of 4 months (range 0.5 to 18 months) to improve.

The severity of the initial neurological deficit does not reflect the future prognosis in either tuberculous or pyogenic patients regardless of the type of treatment that has been constituted. Out of 6 patients with Frankel A, 5 of them improved to Frankel D and E. One patient with pyogenic infection whom presented with Frankel A was Frankel E at the end of treatment, as illustrated in Table VII and VIII.

**Table VII**
**The Neurological Outcome after Treatment in Spinal Tuberculosis**

| Before Treatment | After Treatment | | | | | Total |
|---|---|---|---|---|---|---|
| | Frankel A | Frankel B | Frankel C | Frankel D | Frankel E | |
| Frankel A | 0 | 1 | 0 | 2 | 3 | 6 |
| Frankel B | 0 | 0 | 1 | 2 | 2 | 5 |
| Frankel C | 0 | 0 | 0 | 1 | 2 | 3 |
| Frankel D | 0 | 0 | 0 | 3 | 4 | 7 |
| Frankel E | 0 | 0 | 0 | 0 | 11 | 11 |
| Total | 0 | 1 | 1 | 8 | 22 | 32 |

**Table VIII**
**The neurological outcome after treatment in pyogenic spinal infections**

| Before Treatment | After Treatment | | | | | Total |
|---|---|---|---|---|---|---|
| | Frankel A | Frankel B | Frankel C | Frankel D | FrankelE | |
| Frankel A | 1 | 0 | 0 | 0 | 1 | 2 |
| Frankel B | 0 | 0 | 0 | 0 | 0 | 0 |
| Frankel C | 0 | 0 | 0 | 0 | 0 | 0 |
| Frankel D | 0 | 0 | 0 | 0 | 1 | 1 |
| Frankel E | 0 | 0 | 0 | 0 | 2 | 2 |
| Total | 1 | 0 | 0 | 0 | 4 | 5 |

**Table IX**
**The Outcome of Various Treatments in Terms of Progession in Kyphotic Deformity in Tuberculous Patients**

| Treatment | Number of Patients | Kyphosis Not Increase | Kyphosis Increase |
|---|---|---|---|
| Surgery | | | |
| - Anterior | | | |
| + Decompression | 4 | 2 | 2 |
| + Decompression + BG | 6 | 5 | 1 |
| - Posterior | | | |
| + Decompression + Inst. | 1 | 1 | 0 |
| + Decompression + BG + Inst. | 4 | 2 | 2 |
| Conservative | 17 | 7 | 10 |

### *Fusion*

All patients who underwent surgical or nonsurgical treatment eventually achieved fusion. In other words, there were no patients with pseudarthrosis. In general, the average duration to achieve fusion was 7.9 months. In the group of patients who were diagnosed as tuberculous spinal infection the average fusion period was 9 months for those treated conservatively while in those who were treated surgically, it was only an average of 7.6 months. On the other hand, the pyogenic group achieved bony fusion in average time of 5.2 months.

### *Kyphosis*

In general, 55.3% (21 out of 38 patients) of the patients showed no progression of the kyphotic deformities at the end of their follow-up. Eleven were treated conservatively. All pyogenic patients who were treated conservatively had no increase in kyphotic deformity as compared to the surgically treated group. There was also an increase in the bony deformity in the fungal infected patient. The detail of the results in tuberculous patients is shown in the Table IX. Among surgically treated patients, an anterior decompression and bone grafting procedure achieved the best result. Majority of the patient (84%) showed no progression of kyphosis.

## Discussion

This study shows that spinal infections affect all age groups, where the peak incidence was between the ages of 51 to 60 years (mean was 39.9 years), and that females have slightly higher incidence compared to males. If we focus on spinal tuberculosis, it is primarily an adult disease as seen in Saudi Arabia, Europe and North America[2,3]. The average age for spinal tuberculosis in our study is 38.3 years (range, 2 to 65 years) and only one out of the 32 tuberculosis patients falls in the pediatric age group. A study by Lifeso *et al.*[4] found a similar pattern. This was in marked contrast to other studies that have been reported from Africa and most Asian countries. For example, in Hong Kong, 69 percent of the patients were reported to be less than ten years old[5]. Similarly, pyogenic spinal infections were also found across all age groups but adults between 41 and 60 years of age were particularly predisposed[6]. However, the number of pyogenic infections in this study was only in 5 patients, statistically it is not insignificant.

The majority of patients were from rural areas, which comprised 61%. We also found that Malays are the predominant ethnic group to be affected compared to others in this multiracial country. This can be due to the fact that the Malays are the predominant population staying in rural areas. We also believe that ethnic group was not a contributing factor to spinal infection since the distribution is similar to the population pattern in this country.

Obviously, the low socioeconomic status has a major role in spinal infection. Seventy-one percent of the patients are in the low socioeconomic group while none of them are from a high socioeconomic status. Many authors[7,8]

have reported the similar findings. The immune status was also noted as a significant contributing factor. Twenty-two out of 38 patients (57.9%) have a compromised immune status. Diabetes mellitus, intravenous drugs abuse, prolonged steroid treatment, poor nutritional status and old age were the high-risk groups. This findings was comparable to other studies[9,10,11]. Broner *et al.*[12], added that besides the above factors, sickle cell anemia, tuberculous infection, and alcoholism were also contributing factors for spinal infections. Each of these factors negatively alters the humoral and cellular immune response of the body to infectious agents.

Various reports stated that vertebral pyogenic osteomyelitis represents between 2% to 16% of all cases of vertebral infections. The incidences have been claimed to be increasing recently and largely related to the increase in intravenous drug abuse and immunocompromised patients[1,4,10,13,14,15]. Our figure for pyogenic infection was 13% of all the spinal infections. Tuberculosis was still the main aetiology in spinal infections while the fungal infection was rare. Atypical spinal tuberculosis occurred in as much as 6% (2 out of 32 tuberculous patients) and this figures was comparable to other series (between 2% to 10%) as reported by Babhulkar *et al.*[16] and Travos *et al.*[17].

Back pain still the primary complaint in all the patients with spinal infections as reported by other authors[2,4,18,19]. The average time between onset of symptoms and diagnosis in our series (3.7 months) was comparable with the figures given by other authors[4,18,19] that ranged from 2.8 months to 20 months. We found that the tuberculous group was more prone to develop neurological involvement as compared to the pyogenic group. More than 65% of the tuberculous patients presented to us with various degrees of neurological deficit. This a higher percentage as compared to other reported series (up to 50%) is probably due to our hospital being a referral center where more severe cases were referred for further management.

We believe a history of contact with tuberculous patients as one of the predisposing factor to spinal tuberculosis. Our study showed that 31.3% of the spinal tuberculosis patients had a positive history of contact including one unfortunate young medical doctor from Seremban Hospital who had close contact to pulmonary tuberculosis patients. Her chest radiographs showed no evidence of pulmonary tuberculosis. She had extensive anterior bony destruction of L3/L4 but no neurological deficit. Clinically, her lumbar vertebra was not stable. We proceeded with an anterior decompression and debridement followed by bone grafting. The surgery was performed almost 3 weeks after the diagnosis. The chemotherapy was completed for a duration of 12 months. She recovered very well with disappearance of her back pain. She conceived at the end of the chemotherapy course and subsequently delivered a healthy baby boy.

Total white cell count has clinical significance in differentiating between tuberculous and pyogenic spinal infection although it is a non-specific laboratory evaluation. We found that 87.5% of tuberculous patients had normal count while 80% of pyogenic patients had marked leukocytosis. The erythrocyte sedimentation rate (ESR) has less clinical value in differentiating between these two spinal infections. Another laboratory evaluation that has less clinical value in diagnosing spinal tuberculosis is the Mantoux test which was positive in only 53.1% of tuberculous patients.

Tissue culture in our series shows disappointing results particularly in tuberculous patients. It is probably because the quantity of material obtained from spinal lesions via a CT-guided biopsy was inadequate.

There were slightly different findings in terms of the level of vertebral involvement. Most of the literature including Lifeso *et al.*[4], found that the majority of spinal tuberculosis was confined to the thoracic level but in our study lumbar vertebrae were commonly effected. However, the figures for the level of pyogenic vertebral involvement, skip lesions and psoas abscess formation in tuberculous patients, seems to be similar to other reported senes.

Histopathological examination was supposed to be a definitive tool in diagnosis of spinal infections. Based on our results, we were able to demonstrate the definitive diagnosis in as high as 93.3% of the patients if the tissue material was obtained from an open biopsy. In contrast,

tissue material taken from the CT guided needle biopsy produced disappointing conclusions. The low percentage of 22.2% was far below the results given by other authors[4,20], which was around 60% to 80%.

None of our pyogenic patients developed septicemia or died secondary to the spinal infection and all of them achieved bony fusion between 4 to 12 months (average of 5.6 months). In terms of pain, symptoms subsided in 4 out of 5 patients from between a period of 2 weeks to 6 months. Furthermore, all patients achieved bony fusion an average period of 5.2 months, only one patient showed increase in kyphotic angle during follow-up, while 2 out of 3 patients who presented with neurological deficit improved. The patient who had persistent back pain and neurological deficit (Frankel Grade A), and progressive kyphotic deformity was the only patient that underwent posterior decompression and instrumentation one week after developing progressive paraplegia. These results show that 6 weeks of high dose antibiotics (including a 2-week period of parental dosage) was adequate, in treating pyogenic infections of the vertebrae. However, the course of antibiotic treatment can be prolonged if the diseases show a slower responses clinically or radiologically. Our findings were in keeping with other studies by Sapico *et al.*[21] and Rothman[22].

In tuberculous spinal infection there was no difference in either the 3 or 4 drug combination regimens used. There was also no significant advantage in treating them with surgical debridement to improve the neurological deficit. Our findings definitely support the findings that have been reported by the MRC[4,5,23,24,25,26,27]. They found that 75% to 88% of patients with chemotherapy alone would achieve a favorable result over 3-year period.

The only advantage that surgically treated tuberculous patients achieved were the fusion rate and pain relief. In our study, the mean period of bony fusion was 7.6 months in the surgically treated group while in the group which were treated by chemotherapy alone, it was 9 months. In addition, the pain relief after surgical treatment was much faster and had a higher percentage. The average period of pain relief in the surgically treated group was 7.8 months, in contrast to the conservatively treated group which was 9 months. Furthermore, only 40% of surgically treated tuberculous patients' experience persistent pain at the end of their follow-up while in the other group it was 62.5%. The study by the MRC[5,23,28] also found a similar result. Lifeso *et al.*[4] stated that the average duration to achieve pain relief after chemotherapy alone was 9.5 months in contrast to 4.3 months in the group which underwent anterior decompression and fusion.

In view of preventing further bony deformity, anterior debridement and fusion produce better result compared to posterior debridement and stabilization, and conservative treatment. Since our series was confined to a small number, statistically it was not significant but at least showed a similar finding to the study done in Hong Kong by the MRC[26].

This study also found that the severity of initial neurological deficit does not actually reflect the future prognosis in either tuberculous or pyogenic spinal infections regardless of the type of treatment that has been constituted. It was suggested that even the patients who presented with no useful neurological function still hoped to recover at the end of the treatment.

## Conclusions

Although many reports have mentioned that spinal infection rates are increasing, in this study we found that it does not follow this pattern. However, we found that spinal infection is still primarily an adult disease, and highly influenced by immune status. It mainly affects the low socioeconomic group. Clinically, a majority of the patients had experienced chronic back pain and neurological involvement is a significant presentation especially in tuberculosis group. Spinal tuberculosis is still the main cause of spinal infection in this region, and an atypical presentation is not uncommon. Besides extraskeletal tuberculosis as a possible origin of infection, we conclude that a history of contact with an active pulmonary tuberculosis patient a significant predisposing factor to the disease. Although a conclusive diagnosis is based on histopathology examination, positive culture and smears, clinical parameters may be a helpful guide to the diagnosis. A simple white blood count may able to differentiate between pyogenic and tuberculous spinal infection.

We also concluded that a 6 week course of high dose antibiotic, 2 weeks of which is via the intravenous route is adequate in treating pyogenic spinal infection. There were significant advantages of surgery as compared to conservative methods in the treatment of pyogenic spinal infection. In tuberculous vertebral infection, the 3 drug-combination of antituberculous chemotherapy using rifampicin, isoniazid, and pyrazinamide is as effective as other 4 drug combinations. The results of the conservatively treated group were not significantly inferior to the surgically treated group although bony fusion and pain relief was earlier in the latter.

## References


1. Frankel HL, Hancock DO, Hyslop G, Melzak J, Michaelis LS, Ungar GH, Walsh JJ, and Vernon JDS: The Value of Postural Reduction in the Initial management of Closed Injuries of the Spine with Paraplegia and Tetraplagia. Part 1. Paraplegia. 1969; 7: 179-92.
2. Kemp HBS, Jackson JW, Jeremiah JD, and Hall AJ: Pyogenic Infections Occurring Primarily in Intervertebral Discs. J Bone Joint Surg. 1973; 55B: 698-714.
3. Martin NS: Pott's Paraplegia: A Report of 120 Cases. J Bone Joint Surg. 1971; 53B: 596-608.
4. Lifeso RM, Weaver P, and Harder EH: Tuberculous Spondylitis in Adults. J Bone Joint Surg. 1985; 67A: 1405-13.
5. Medical Research Council Working Party on Tuberculosis of the Spine: A Controlled Trial of Debridement and Ambulatory Treatment in the Management of Tuberculosis of the Spine in Patients on Standard Chemotherapy. A Study in Bulawayo, Rhodesia. J Trop med Hyg. 1974; 77: 72-92.
6. Malawski SK, and Lukawski S: Pyogenic Infection of the Spine. Clin Orthop. Rel Res. 1991; 272: 58-66.
7. Bonakdar-pour A, and Gaines VD: The Radiology of Osteomyelitis. Orthop Clin North Am. 1983; 14: 21-37.
8. O'Brien JP: Kyphosis Secondary to Infectious Disease. Clin Orthop. Rel Res. 1977; 128: 56-64.
9. Bonfiglo M, Lange TA, and Kim YM: Pyogenic Vertebral Osteomyelitis. Disc Space Infections. Clin Orthop. 1973; 96: 234-47.
10. Digby JM, and Kersley JB: Pyogenic Non-Tuberculous Spinal Infection. An Analysis of Thirty Cases. J Bone Joint Surg. 1979; 61B(1): 47-55.
11. Eismont FJ, Bholman HH, Soni PL, Goldberg VM, and Freehafer AA: Pyogenic and Fungal vertebral Osteomyelitis with Paralysis. J Bone Joint Surg. 1983; 65A:19-29.
12. Broner FA, Garland DE, and Zigler JE: Spinal Infections in the Immunocompromised Host. Orthop Clin North Am 1996; 27: 37-46.
13. Garcia AJr., and Grantham SA: Hematogenous Pyogenic Vertebral Osteomyelitis. J Bone Joint Surg. 1960; 42A: 429-36.
14. Jones NS, Anderson DJ, and Stiles PJ: Osteomyelitis in General Hospital. J Bone Joint Surg. 1987; 69B: 779-84.
15. Patzakis MJ, Rao S, Wilkins J, Moore TM, and Harvey PJ: Analysis of 61 Cases of Vertebral Osteomyelitis. Clin Orthop. Rel Res. 1991; 264: 178-83.
16. Babhulkar SS, Tayade WB, and Babhulkar SK: Atypical Spinal Tuberculosis. J Bone Joint Surg. 1984; 66B: 239-42.
17. Travos J, Du Toit G: Spinal tuberculosis. Beware the Posterior Elements. J Bone Joint Surg. 1990; 72B: 722-3.
18. Fang D, Cheung KMC, Dos Remedos IDM, *et al*: Pyogenic Vertebral Osteomyelitis: Treatment by Anterior Spinal Debridement and Fusion. J Spinal Dis. 1994; 7: 173-80.
19. Liebergall M, Chaimsky G, Lowe J, Robin GC, and Floman Y: Pyogenic vertebral Osteomyelitis with Paralysis. Prognosis and Treatment. Clin Orthop. Rel Res. 1991; 269: 142-50.

20. Asitava M: Cytological Diagnosis of Vertebral Tuberculosis with Fine Needle Aspiration Biopsy. J Bone Joint Surg. 1994; 76A: 181.

21. Sapico FL, Montgomerie JZ: Pyogenic Vertebral Osteomyelitis: Report of nine cases and Review of the Literature. Rev Infect Dis. 1979; 1: 754-76.

22. Perrone C, Saba J, Behloul Z, *et al*: Pyogenic and Yuberculous Spondylodiskitis (Vertebral Osteomyelitis) in 80 Adult Patients. Clin Infect Dis 1994; 19: 746-50.

23. Medical Research Council Working Party on Tuberculosis of the Spine: A Controlled Trial of Ambulant Outpatient Treatment and Inpatient Rest in Bed in the Management of Tuberculosis of the Spine in Young Korean Patients on standard Chemotherapy. A Study in Masan, Korean. J Bone Joint Surg. 1973; 55B: 678-97.

24. Medical Research Council Working Party on Tuberculosis of the Spine: A Controlled Trial of Plaster-of-Paris Jackets in the Management of Ambulant Outpatient Treatment of Tuberculosis of the Spine in Children on Standard Chemotherapy: A Study in Pusan, Korea. Tubercle, 1973; 54: 261-82.

25. Medical Research Council Working Party on Tuberculosis of the Spine: A Controlled Trial of Anterior Spinal Fusion and Debridement in the Surgical Management of Tuberculosis of the Spine in Patients on Standard Chemotherapy. A study in Hong Kong. J Bone Joint Surg 1974; 61B: 835-66.

26. Medical Research Council Working Party on tuberculosis of the Spine: A 10-years assessment of a Controlled Trial Comparing Debridement and Anterior Spinal Fusion in the Management of Tuberculosis of the Spine in Patients on Standard Chemotherapy in Hong Kong. J Bone Joint Surg. 1982; 64B: 393-8.

27. Moon MS: Spine Update. Tuberculosis of the Spine: Controversies and a New Challenge. Spine 22(15). Lippincott, 1997; 1791-9.

28. Medical Research Council Working Party on Tuberculosis of the Spine: Five Year Assessments of controlled Trials of Ambulatory Treatment, Debridement and Anterior Spinal Fusion in the Management of Tuberculosis of the Spine: Study in Vulawayo (Rhodesia) and in Hong Kong. J Bone Joint Surg. 1978; 60B: 163-7.

# Selective Thoracic Fusion of King II Scoliosis with Segmental Spinal Instrumentation

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## Summary

Segmental spinal instrumentation with Harrington rod secured to the spine by sublaminar wires was a popular method of scoliosis correction in 1980's. It was gradually replaced by newer rod-hook systems due to concern about neurological complications. However, correction of type II and III curves by selectively fusing the thoracic curves with these new instruments has resulted in poor results in some cases. The aim of this study is to review the result of selective thoracic fusion treated by segmental spinal instrumentation.

Between January 1989 to October 1994, 31 patients with King II scoliosis were treated operatively in our unit. These consisted of 29 girls and 2 boys. The mean age of these patients were 11.3 years. The study population consisted of 21 Chinese, 5 Malays and 5 Indians. In one patient, the thoracic curve was convex to the left whilst the thoracic curves in the majority were to the right.

The surgery was performed by three surgeons using harrington rods and posterior fusion with autograft. Anterior releases were also required in eight patients to increase flexibility. The curve correction obtained was an improvement from a average preoperative cobb's angle of 71.5° to 39.5° postoperatively.

After an average follow-up period of 77.9 months, the correction deteriorated by 22% in the thoracic curve and 59% in the lumbar spine without disturbance to truncal balance. Only one sublaminar wire broke. However, no implant failure or removal has to be performed as yet. This technique appears useful in our institution with minimal morbidity.

*Key Words:* Harrington rod, Idiopathic adolescent scoliosis, King II curves, Scoliosis, Selective thoracic fusion, Sublaminar wires

## Introduction

Adolescent idiopathic scoliosis has been classified by King *et al*[1] into five groups according to the curve pattern. This classification system has been used in many scoliosis centres as a useful guide to scoliosis correction. King's type II curve is a major thoracic curve with compensatory lumbar curve which may be amenable to treatment by selectively correcting the thoracic curve and allowing the lumbar curve to re-adjust physiologically. When the newer methods of rod-hook instrumentation was used to treat this curves, the problem of truncal imbalance became an issue[2,3,4]. However, when older method of Harrington rodding did not seen to have create similar imbalance. The proposed reasons for this decompensation is numerous and confusing. They include incorrect fusion level, over-correction of thoracic curve and rigid lumbar curve. The aim of this retrospective study was to review King II curves treated by selectively fusing with segmental instrumentation with Luque wiring and Harrington rodding in our institution.

## Materials and Methods

Between January 1989 and October 1994, 31 patients with King II scoliosis with compensatory lumbar curves, correctable to below 30° on bending films, were treated with segmental spinal instrumentation using Harrington rods and sublaminar wirings. There were 29 girls and 2 boys with the mean age of 17.9 years (range=15 to 20 years) in this review. They consisted of 21 Chinese (68%), 5 Malays (16%) and 5 Indians (16%). The average age at presentation was 9.2 years and the menarche of 29 girls was 9.4 years. Twenty-four patient had prior conservative treatment with TLSO braces.

The mean-age at surgery was 11.3 years (range=9 to 14 years) and the Risser's sign was 0 in 2 patients, 1 in 12 patients, 2 in 16 patients and 3 in 1 patient at the time of surgery. Twenty-five patients were operated upon for curve deterioration and 6 for cosmesis.

Preoperative management included a lung function test, erect PA and lateral spine films and erect lateral bending films. Eight anterior releases were performed for curves greater than 70 degrees that did not correct to 30 degrees on lateral bending.

The procedures were performed by three experienced surgeons using a standard posterior approach. Selection of fusion level was based on central sacral line as described by King *et al.* Harrington bifid pedicle hooks and #1254 supralaminar hooks were placed in the upper and lower stable vertebrae. A square-ended Harrington rod contoured to the desired kyphosis and size 18G Luque sublaminar wires were carefully passed beneath the laminar subsequently tied to the Harrington rod. All patients had autogenous bone grafting. Intra-operative wake-up tests and somato-sensory evoke potential monitoring were used. No thoracoplasty was performed. The average intra-operative blood loss was 1,540ml (range=1,150 to 2,600ml) and median hospital stay was 9.8ml (range=7 to 20 days).

Postoperatively, standing PA and standing spine x-rays were done and a custom-made TLSO was worn until union occurred.

The patients were reviewed retrospectively. Their subjectively satisfaction and pain was noted. Clinical

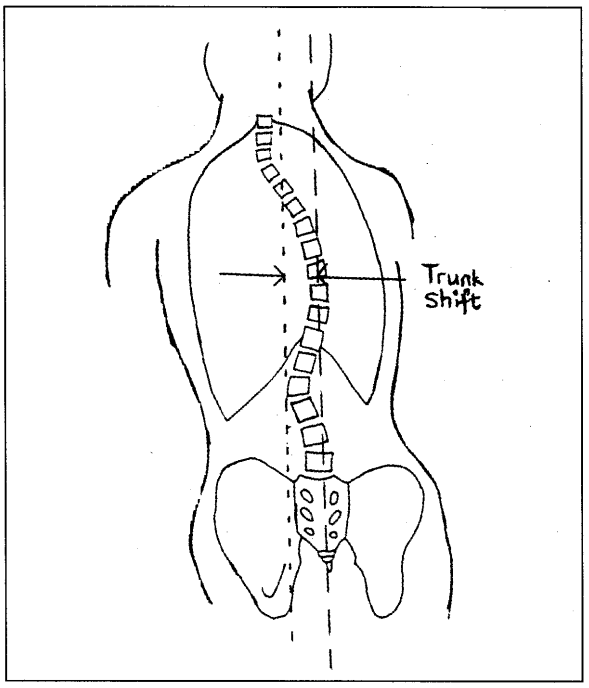



**Fig. 1: Trunk shift.**

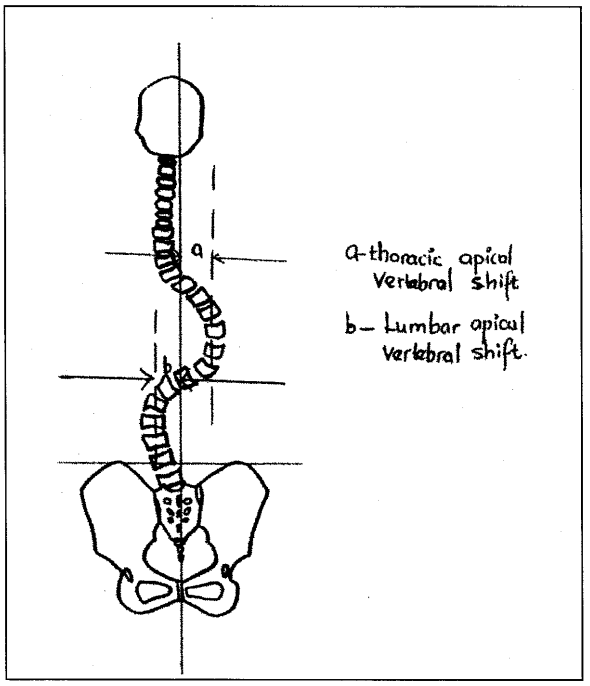



**Fig. 2: Apical vertebrae shift.**

**Table I**
**Clinical Assessment**

| | | Preop | Postop | 6 months | Final | % Change |
|---|---|---|---|---|---|---|
| Plumbline | | 0.81cm | 0.60cm | 0.64cm | 0.64cm | 20% |
| Scoliometer | Thoracic | 22.5° | 16.2° | 17.4° | 18.2° | 19% |
| | Lumbar | 17.5° | 16.4° | 16.4° | 16.0° | 9% |

**Table II**
**Selected Fusion Levels**

| | Stable Zone | Stable Vertebrae | Stable Vertebrae + 1 |
|---|---|---|---|
| Thoracic | 31 | 16 | 15 |
| Lumbar | 31 | 29 | 2 |

assessment of truncal, shoulder and buttock balance as well as the plumb-line and scoliometer readings were noted in each visits. PA and lateral spine radiographs were taken to assess the Cobb's angles, and the sagittal alignment, the apical vertebrae rotation, the fusion of the spine, the head shift, trunk shift (Figure 1), as well as the apical vertebrae shift[5] (Figure 2).

## Results

None of the patients suffered from backache and all were gainfully employed. Fourteen patients participated in sport but only in non-contact sports. Thirty patients said that they would undergo the same procedure again and the one who would not had a neurological complication.

None of the patients had complained of worsening head, truncal, shoulder or hip balance. The final average plumb-line measurement was improved by 20% compared to the preoperative measurement. The rib hump as measured by scoliometer was not significantly changed (see Table I).

Radiologically, two types of curve pattern were encountered. A higher curve of the thoracic apex at T8/T9 disc with lumbar apex at L2/L3 disc and a lower pattern of thoracic apex at T9/T10 disc with lumbar apex at L3 vertebra. The choice of fusion levels were determined by the traditional central sacral line and stable zone (see Table II). In the lumbar spine, ninety-four percent of the cases were fused to the stable vertebra but all were fused within the stable zone.

The Cobb's angle improved in the thoracic spine by 44.8% from the preoperative angles but later deteriorated by 22% in the final assessment (see Table III). Similarly, the Cobb's angle was corrected by 35.8% but later this deteriorated by 59% in the final review. Radiological derotation of the apical vertebrae as measured by the Pedriolle's method was 9.2% in the thoracic and 4.6% in the lumbar spine during the final review.

The trunk shift was measured by the method described by Benli and Tandogan et at[6] was 1.6cm before operation, 0.6cm immediate postoperatively and 0.7cm in the final review. The stable vertebral shift was 0.6cm preoperatively, 0.4cm postoperatively and 0.6cm in the final review. The thoracic apical vertebral shift was 5.3cm preoperatively, 2.3cm immediate post-operation and 2.4cm at last follow up whereas the lumbar apical vertebral shift was -4.6cm preoperatively, -3.4cm immediate postoperatively and -4.2cm at last review.

There were 10 episodes of complications in 9 patients. These included 4 atelectasis, 2 haematomas, 1 superficial wound infection, 1 transient neurological deficit, 1 wire breakage and 1 hook dislodgment. In the patient with transient neurological deficit, grade 4 loss of right ankle dorsiflexion was noted soon after operation which recovered spontaneously without the need for further intervention.

## Discussion

Harrington rodding and sublaminar wiring was a popular method of scoliosis correction in the 1980's.

**Table III**
**Radiological Assessment**

| | | Preop | Bending | Postop | Six Month | One Year | Final | % Change |
|---|---|---|---|---|---|---|---|---|
| Cobb's Angles | Thoracic | 71.2° | 43.6° | 39.5° (45%) | 47.2° | 48.2° | 48.2° | 22% |
| | Lumbar | 40.5° | 22.6° | 25.0° (36%) | 32.5° | 36.4° | 39.8° | 59% |
| Apical derotation | Thoracic | 18.4° | | 16.4° | 16.6° | 16.5° | 16.7° | 9.2% |
| | Lumbar | 15.3° | | 14.3° | 14.5° | 14.6° | 14.6° | 4.6% |
| Trunk shift | | 1.6 cm | | 0.6 cm | | 0.8 cm | 0.7 cm | |
| Stable vertebral Shift | | 0.6 cm | | 0.4 cm | | 0.5 cm | 0.6 cm | |
| Apical Vertebral Shift | Thoracic | 5.3 cm | | 2.3 cm | | 2.6 cm | 2.4 cm | |
| | Lumbar | 4.6 cm | | 3.4 cm | | 3.6 cm | 4.2 cm | |

This procedures was the main method of scoliosis correction in our institution since 1989. However, apprehension about the risk of neurological injury with sublaminar wiring had influenced many spinal surgeon into looking at other methods of scoliosis correction. In our institution, this method of treatment has a role in scoliosis correction in neuromuscular patients.

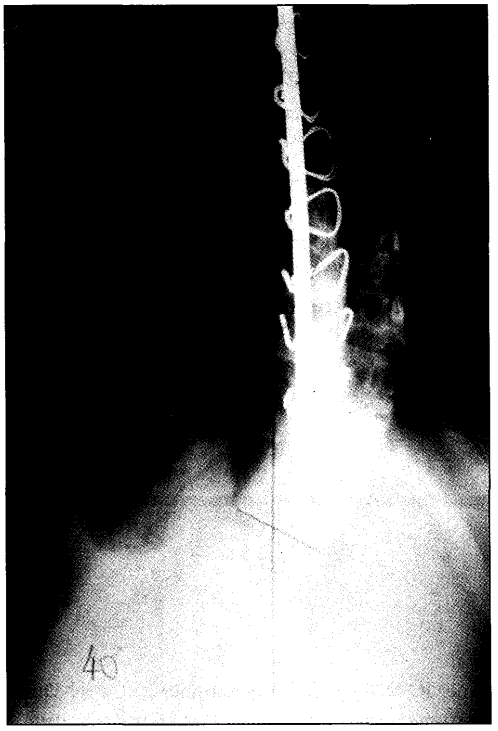
Cotrel and Dubousset[6] had initiated the use of multiple hook-rod system which is able to stabilise the spine sufficiently to obviate the need for external bracing. Many reports[7,8] claimed of better scoliosis correction can be found. Newer designs of double rod-hook instrumentation have been produced e.g. ISOLA, MOSS-MIAMI which have similar advantages.

However, some practical problems started to surface with the use of newer rigid rod-hook system. Bridwell[9] reported cases of worsening truncal balance with the use of derotation maneuvers. This problem occurred with selective thoracic fusion in King II curve. Reasons put forward for this phenomenon include incorrect fusion levels, over correction of thoracic curve, rigid lumbar curve which cannot compensate and failure to recognise a structural upper thoracic curve. The truncal imbalance phenomenon also occurs with anterior correction of King II scoliosis with the Kaneda Anterior Spinal System[10].

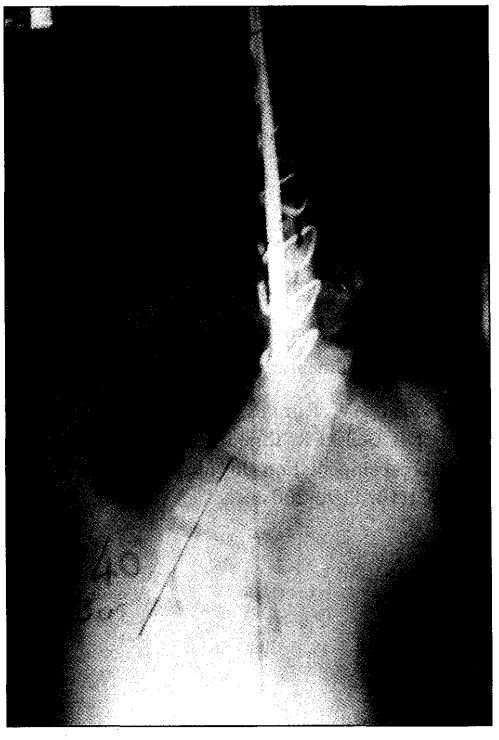
Mason and Carango[11] reported a lower incidence of this complication in 4% of King II curve treated by Segmental Spinal Instrumentation compared to 41% of King II treated with Cotrel Dubouset Instrumentation. The reasons for this could be that the correction obtained in Segmental Spinal Instrumentation is less or that derotation maneuvers were not a feature. Hence, the aim of this study was to determine the characteristics of scoliosis correction using segmental spinal instrumentation in particular incidence of and to analyse the problem of truncal imbalance. In this study, we excluded double major curves and select those with flexible lumbar curve that is correctable to 30 degrees on bending film.

In this series, none of the patients had worsen truncal balance but the curve increase by 22% in the thoracic curve and by 59% with time and growth. This did not translate to worsening truncal balance as the trunk shift deteriorated by only 1mm comparing the postoperative and final x-rays. Growth was seen in the instrumented thoracic spine as the lower end of the rod disengaged from the lower hook (see Figure 3). Furthermore, none of the lumbar curves deteriorated severing enough to require further extension of fusion.

Traditionally, the choice of fusion levels is determined by the central sacral line and the stable zone. Wrong



a



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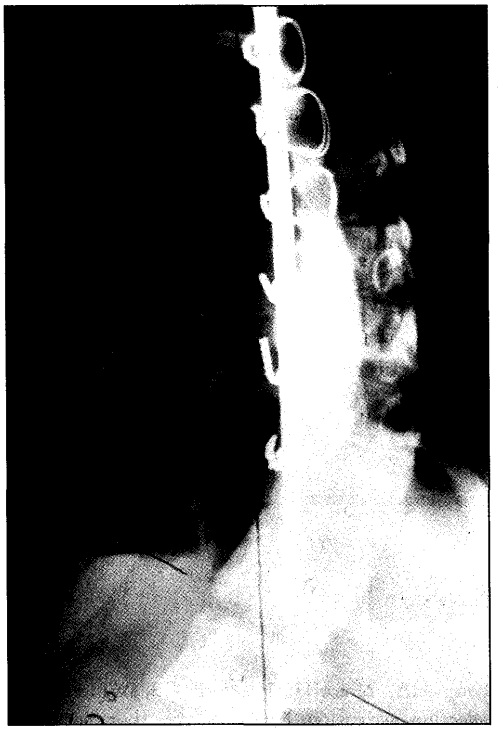

c

**Fig. 3: (a), (b), (c) : Continued growth of the thoracic spine with time.**

fusion level was not found in this study as all the most proximal and distal vertebrae fused were within the stable zone and 94% of the cases was the lumbar vertebral bisected by the central sacral line.

Although, the segmental spinal instrumentation with sublaminar wire was designed to offer spinal derotation but this effect was insignificant in our series as measured by the pedriolle meter method.

The Cobb's angle was improved postoperatively by 44.8% in the thoracic spine and 35.8% in the lumbar spine. This is very much less than that obtainable by rod-hook system.

Overcorrection of the thoracic curve and inability for the lumbar curve to compensate is a popular reason for truncal decompensation. How much correction is considered as too much?

Patwardhan and Ibrahim[12] state that in a mathematical model, the relative apical distance must not be too small. According to these authors, the relation of the thoracic apical vertebral shift to the lumbar vertebral shift is very important. For instances, in a constant thoracic curve of twenty degrees and a lumbar curve of twenty-five degrees, the relative apical distance must not exceed 30mm whereas with a lumbar curve of thirty degrees, the relative apical distance must not exceed 34mm. Otherwise, truncal imbalance will result. In other words, the lumbar curve can only compensate if the thoracic curve is not brought too close to the central sacral line.

In this study, the apical vertebral shift improved postoperatively by 57% in the thoracic spine and 30% in the lumbar spine. This deteriorated with time by 24% in the thoracic curve and 43% in the lumbar curve in the final review. The relative apical distance was 5.7cm postoperatively and 6.6cm in the final review.

The findings in our study would suggest that Patwardhan hypothesis is worth investigating further clinically. In our institution, the use of sublaminar wires with Harrington rod in the correction of King II scoliosis has not resulted in permanent neurological deficit and has retained a role in treating spinal deformity.


1. King HA, Moe JH, Bradford DS, Winter RB: The selection of fusion levels in the thoracic idiopathic scoliosis. J Bone Joint Surg 1983; 65A: 1302-13.
2. Thompson JP, Transfeldt EE, Bradford DS, Ogilvie JW, Boachie-Adjei O: Decomposition after Cotrel-Dubousset Instrumentation of idiopathic scoliosis. Spine 1990; 15: 927-31.
3. McAllister JW, Bridwell KH, Betz: Coronal decompensation produced by Cotrel Dubuset rotational maneuver for idiopathic right thoracic scoliosis. Orthop Trans 1989; 13(1): 79.
4. West JL, Boachie-Adjei O, Bradford DS, Ogilvie JW: Decomposition following Cotrel Dubousset Instrumentation: A worrisome complication. 1989: Orthop Trans 13 (1): 78-9.
5. Benli IT, Tuzuner M, Abalin S, Aydin E, Tandogan: Spinal imbalance and decomposition problems in patients treated with Cotrel-Dubousset Instrumentation. Eur Spine J. 1996; 5: 380-86.
6. Cotrel Y, Dubousset J, Guillaumat M: New Universal Instrumentation in spinal surgery. Clin Orthop 1988; 227: 10-23.
7. Bauer R, Mostegl A. Hingshammer R: Cotrel-Dubousset Instrumentation for correction of spinal curvature. Arch Orthop Trauma Surg 1988; 107: 364-68.
8. Gray JM, Smith BW, Ashley RK, La Groune MO, Mall J: Derotational analysis of Cotrel-Dubousset Instrumentation in Idiopathic Scoliosis. Spine 1991; S391-93.
9. Bridwell KH, McAllister JW, Betz RR, Huss G *et al*: Coronal decompensation produced by Cotrel-Dubousset "derotation maneuver" for idiopathic right thoracic scoliosis. Spine 1991; 16: 769-77.
10. Kaneda K, Shono Y, Satoh S, Abumi K: Anterior correction of thoracic scoliosis with Kaneda Anterior Spinal System. Spine 1997; 22 (12): 1358-68.
11. Mason DE, Carango P: Spinal decompensation in Cotrel-Dubousset Instrumentation. Spine 1991: 16(8): S393-403.
12. Patwardhan AV, Rimkus A, Gavin TM, Bueche M, Meade KP, Bielski R, Ibrahim K: Geometric Analysis of coronal decompensation in idiopathic scoliosis. Spine 1996: 21(10: 1192-200.

# Experience in Snuffbox Arteriovenous Fistulae for Hemodialysis

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**Summary**

Sixty-five patients with "Snuffbox" arteriovenous fistulae for hemodialysis were reviewed. The procedure was performed under local anaesthesia as an outpatient procedure. It was done as a "standby" procedure for 41.5% of patients with Chronic Ambulatory Peritoneal Dialysis. 58.5% of patients had the procedure done for primary hemodialysis. Patency was assessed as presence of an engorged vein and presence of thrill. This was assessed routinely at 4 to 6 weeks after the procedure. Patency rate was noted to be 83%. The commonest complication was thrombosis of the arteriovenous anastomosis. Some patients required repeated procedure at a more proximal site. Further study to determine the blood flow rate provided by the anastomosis, and comparison with other anatomical sites is necessary.

*Key Words:* Snuffbox, Arteriovenous fistula, Hemodialysis

## Introduction

The success of chronic hemodialysis in terminal renal failure depends on repeated access to blood vessels that will provide a continuous flow of up to 250 to 300ml per minute. (Brescia 1966)[1] Vascular access can be obtained by either external means such as the Scribner Teflon-silastic shunt cannula (Quinon 1960[2], Hegstrom 1961)[3] or by creating an internal arteriovenous fistula. In view of the various complications associated with the Scribner Teflon-Silastic shunt cannula namely infection, sepsis, serious local hemorrhage from displacement of the cannula and pressure necrosis of the overlying skin which led on to frequent hospitalization, repeated surgical procedures for reimplantation of the cannula and decline in patient morale (Saloman 1968)[4], an internal arteriovenous fistula is preferable for chronic hemodialysis.

Brescia and associates were the first to describe a method of creating an internal arteriovenous fistula without the use of a prosthesis. (Brescia 1966) They reported a side to side anastomosis between the radial artery and the adjacent vein in the forearm. A modified technique using end to end anastomoisis was described by J. Saloman *et al* (1968). The snuffbox arteriovenous fistula was first described by John Thomas Mehigan and Robert A. McAlexander in 1982[5]. They reported their series of 154 snuffbox fistulae performed over a period of five years. In their study, 86% of patients produced satisfactory blood access which functioned for 6 to 60 months. There were no wound complications.

## Materials and Methods

Over a two year period, 65 patients had snuffbox arteriovenous fistulae done for hemodialysis at University Hospital, Kuala Lumpur. The procedure was performed on out-patient basis.

The radial artery was palpated at the anatomical snuffbox between the extensor pollicis longus and

extensor pollicis brevis and its outline was marked out. The outline of the cephalic vein was marked out after applying a tourniquet on the forearm. Standard aseptic draping was done. Local anaesthetic was given using 1% lignocaine. A transverse incision measuring 2.5cm was made on the anatomical snuffbox. The cephalic vein immediately underneath the incision was mobilized. This was followed by deep retraction between extensor pollicis longus and extensor pollicis brevis. The radial artery underneath the thick fascia was exposed and mobilized. Side to side anastomosis between the radial artery and cephalic vein was created. This was followed by ligation of the cephalic vein distal to the anastomosis to prevent engorgement of the vein distal to the anastomosis. The wound was then closed with absorbable suture, followed by light dressing.

The patient was encouraged to perform exercises to encourage rapid vein enlargement. All patients were reviewed at four weeks post-operatively to assess the patency of the fistulae. The patency was assessed based on the presence of thrill and enlargement of veins proximal to the anastomosis. All patients were examined for the presence of hand swelling and the status of would healing.

There were two groups of patients in our study. The first group of patients consisted of those who required primary hemodialysis. The fistulae were tapped at about six weeks after surgery. The second group consisted of those patients who were undergoing Chronic Ambulatory Peritoneal Dialysis (CAPD) and having the fistula done as a standby procedure.

## Results

There were 43 Chinese, 16 Malays and 6 Indians, 40 were male and 25 were female. The age ranged from 15 to 83 years old with a mean age of 42.1 years old. There were 27 patients (41.5%) undergoing CAPD who had the fistulae created as standby procedure, 38 patients (58.5%) had primary hemodialysis.

Patency was first assessed at 4 weeks post-operatively. The fistulae were patent in 56 patients (86%) with the presence of both engorged veins proximal to the anastomosis and thrill. Nine patients (14%) were found to have non-patent fistulae.

Thrombosis was the commonest problem encountered. This was divided into early thrombosis (within 4 weeks) and late thrombosis (after 4 weeks) post-operatively. Nine patients had early thrombosis and another 2 patients developed thrombosis between 4 weeks and 6 weeks, bringing the patency rate down to 83%.

One patient developed gross hand swelling. This was due to the slippage of the ligature at the cephalic vein distal to the anastomosis. This was re-explored and the cephalic vein was re-ligated. The hand swelling subsided tremendously following the procedure. However, he developed similar swelling in which re-exploration was again carried out. At the second exploration, the ligature was noted to have slipped out again and the cephalic vein was found to have re-opened. A segment of the cephalic vein distal to the anastomosis was resected following re-ligation of the cephalic vein. Unfortunately, he developed a similar swelling involving the whole hand with superficial venous ulceration over the knuckles. Angiography was carried out, gross dilatation of veins was noted with multiple communication between the veins in the dorsum of the hand. Resection of the fistula followed by creation of a more proximal fistula was planned at the time of writing of the paper.

None of the patients developed bleeding secondary to the fistula or any wound complication.

Redo rate was found to be 18.5%. The commonest cause of the redo was thrombosis. There were 9 patients with early thrombosis and 2 patients with late thrombosis who underwent repeat procedure. One patient with gross swelling of the hand required re-exploration of the anastomosis.

## Discussion

Snuffbox arteriovenous fistula is one of the means of access for hemodialysis in chronic renal failure patients. It was first described by John Thomas Mehigan and Robert A. McAlexander in 1982. In our hospital, arteriovenous fistula used to be performed by Urologists and General Surgeons using various methods. Since September 1993, most of the arteriovenous fistula have been performed by our Hand and Reconstructive Microsurgery Unit.

Snuffbox arteriovenous fistula described above is the technique routinely performed in our unit.

We report our experience with 65 patients as an audit study to look into the patency rate as well as the complication related to the surgical technique.

In our study, our 4 week patency rate is 83% at 4 weeks, almost equivalent to the result described by Mehigan and McAlexander (1982)[5]. It is noted to be lower than other studies such as the study by N. Sekar (1993)[6] which showed patency rate of 94.8%.

The commonest problem encountered was thrombosis. This could be due to technical problems while performing the anastomosis, such as anastomosis which is too narrow, traumatized vessel wall or catching of the posterior wall of the cephalic vein with sutures. Most of them require to be redone in order to create a patent anastomosis.

Infrequently, we encountered the problem of swelling of the hand secondary to slippage of the ligature on the cephalic vein distal to the anastomosis. This could again be a technical problem. The hand swelling can be minimal or can be disastrous leading to gross swelling and ulceration of the hand as in our patient. Care in venous ligation as close as possible to the anastomosis would reduce the possibility of opening up of the venous communication leading to the problem of gross hand swelling and ulceration.

There was no patient with wound problem or bleeding secondary to the fistulae.

The almost constant anatomic juxtaposition of the radial artery and the cephalic vein in the snuffbox location makes performance of the fistula exceptionally straightforward (Mehigan 1982).

In terms of ease of the technique, we find that the technique is relatively simple with minimal dissection required. It is performed under local anaesthesia with a forearm tourniquet. It is done as an outpatient procedure to minimize the problem of bed shortage in the hospital.

By preserving the more proximal sites, this technique allows us a reserve of vascular access in future in case of failure of the snuffbox arteriovenous fistula.

From the conversations with Nephrologists in our hospital, occasionally they encounter the problem of inadequate blood flow (less than 200ml/min) with the snuffbox arteriovenous fistula compared with the more proximal sites. We do not have definite value on blood flow rate from the snuffbox fistula done in our unit. We hope that further study comparing the snuffbox fistula with other sites based on the blood flow rate on tapping the fistula can be carried out in future.

## Conclusions

Based on our study, we find that creation of the snuffbox arteriovenous fistula is technically simple due to its anatomical advantage. The patency rate is generally satisfactory overall in providing adequate blood access for hemodialysis despite occasional verbal reports of inadequate blood flow at this distal site. The complications are minimal if care is taken while performing the anastomosis. The technique has various advantages such as minimal dissection required and preserving the more proximal sites for future use.

## References


1. Michael J. Brescia, James E. Cimino, Kenneth Appel and Baruch J. Hurwich. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. The New England Journal of Medicine 1966; 275: 1089-92.
2. Quinton, WE Dillard, D, and Scribner, BH. Cannulation of blood vessels for prolonged hemodialysis. Tr. Am. Soc. Artf. Int. Organs, 1960; 6: 104-13.
3. Hegstrom, R M, Quinon, WE, Dillard, DH Cole, JJ, and Scribner, B H. One year's experience with use of indwelling teflon cannulas and bypass. Tr. Am. Soc. Artf. Int. Organs, 1961; 7: 47-56.
4. J Salomon, B Vidne, M Robson, J Rosenfeld, MJ. Levy our experience with the use of arteriovenous fistula in chronic dialysis: Modified surgical technique. Surgery, 1968; 63: 899-902.
5. John Thomas Mehigan, Robert A. Mc Alexander Snuffbox arteriovenous fistula for hemodialysis. The American Journal of Surgery, 1982; 143: 252-53.
6. N. Sekar Snuffbox arteriovenous fistula. Int. Surgery, 1993; 78: 250-51.

# Supracondylar Fractures of the Humerus in Children - An Epidemiological Study of 132 Consecutive Cases

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**Summary**

132 consecutive cases of supracondylar fractures of the humerus admitted between July, 1997 and February, 1999 were included in a prospective study. There were 93 boys and 39 girls. The age ranges from one to 14 years old.

The non-dominant arm was more often injured. Ethnic Malay constituted the majority. Accidents mainly occurred at home with a peak between 4pm and 8pm. Majority was presented within 24 hours of injury.

Type III fracture with distal fragment in extension predominated.

Nerve injuries occurred in 9 cases in which median nerve was the most commonly affected. There was only one open fracture and it was complicated by absent radial pulse and median nerve injury.

*Key Words:* Children, Elbow injury, Epidemiology, Supracondylar fracture, Humerus

## Introduction

Supracondylar fracture of the humerus is a common childhood injury and accounting for 3 - 7% of all fractures in children[1,2]. It is the most common fracture in the elbow[2,3]. Displaced supracondylar fractures can be difficult to treat and may result in significant morbidity in the form of elbow deformity[4,5]. Neural and vascular injuries are not uncommon at presentation[6,7,8]. Long term complication such as cubitus varus deformity was noted to be as high as 33%[9]. It is now widely accepted that accurate reduction of the fracture is crucial to avoid malunion. Many studies have looked at the surgical treatment and outcomes of these fractures[4,10,11]. However, there are few reports analyzing the epidemiological and demographic aspects of this fracture[12,13]. The purpose of this study is to analyze the demographic and aetiological aspect of this important childhood fracture and provide basic data for the implementation of preventive measures and treatment strategies.

## Materials and Methods

This prospective study was conducted at the University Malaya Medical Centre (UMMC). All the children presented to our Emergency Department from 30th July 1997 to 26th February 1999 who satisfied the inclusion criteria were included in the study. Inclusion criteria were children under the age of 15 years of old, injury presented within one week, and radiologically confirmed supracondylar fracture of the humerus.

Demographic, clinical and radiological data were collected at presentation and at follow-up clinic. Detailed history were taken from the patients if feasible, if not, from their parents or guardians. All the admission and follow-up assessment were conducted by the above authors.

## Results

A total of 132 children were collected consecutively in this prospectively study. There were 93 boys and 39 girls and the Male to Female Ratio was 2.45:1. The age range is from one to 14 years old with a mean age of 6.2 years old. The mean age of boys was 1.8 years older than the girls. There was no girl older than 10 years in this study. We have 86 Malays (65.1%), 20 Chinese (15.1%), 24 Indians (18.1%) and 2 foreigners (<2.0%) (Figure 1).

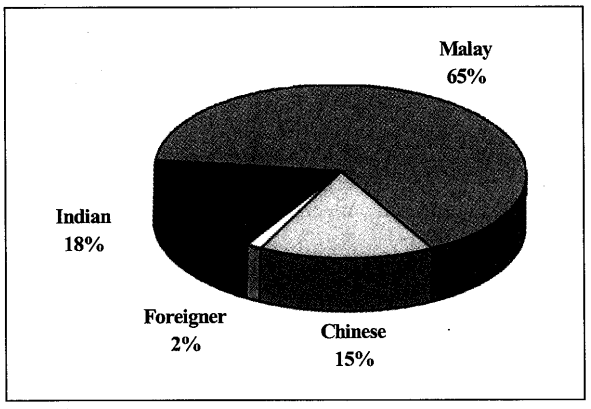


**Fig. 1: Ethnic Distribution.**

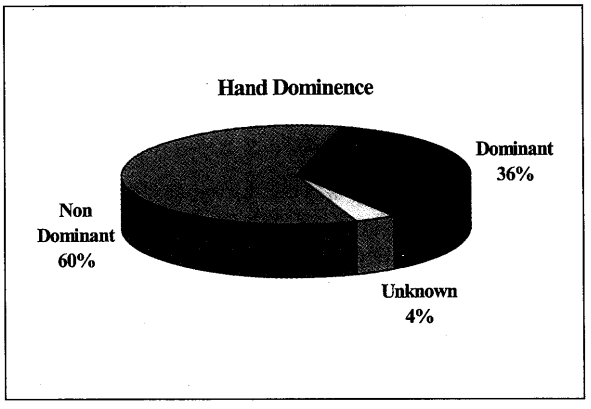


**Fig. 2: Hand Dominance.**

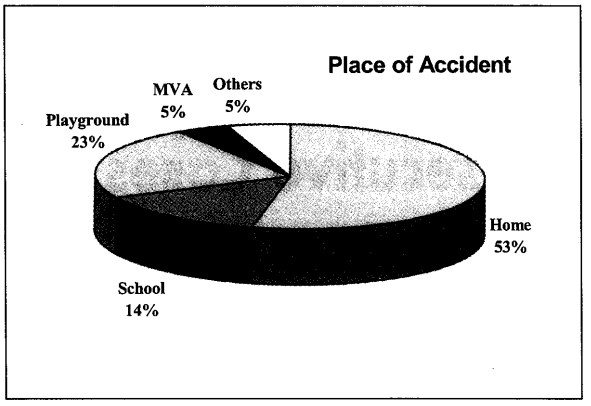


**Fig. 3: Place of Accident.**

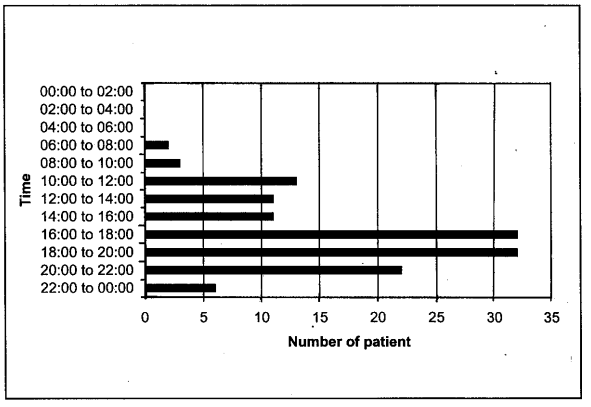


**Fig. 4: Time of Accident.**

The non-dominant arm was more often injured with 79 cases compared with only 48 cases in the dominant arm (Figure 2). Hand dominance was unable to be determined in 5 children, as they have not developed their hand preference.

Injury mainly occurred at home which accounted for 53%, followed by playground 23%, school 14% and others 10% (Figure 3). Those injuries sustained at home were mainly as a result of fall from height, for example, falling from bed, desk, sofa and chair. Playground injuries were generally associated with swings, see saw, and Monkey Bar. Injuries at school were relatively similar to those sustained in the playground, and in addition, they also prone to fall from desks and chairs.

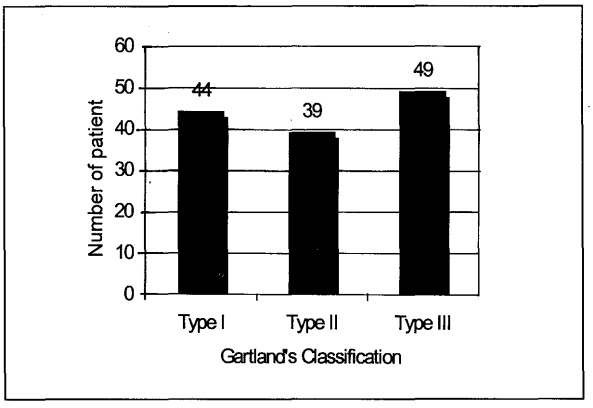


**Fig. 5: Gartland's Classification.**

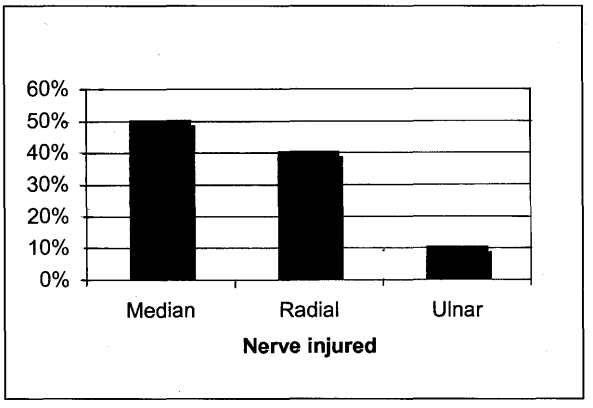


**Fig. 6: Nerve Injured.**

Falls from bicycle were the commonest injury occurred on the roads or pavements. There were also a few cases of fall occurred at shopping centres or car parks.

Injuries mainly occurred between 4pm and 8pm (48.9%) (Figure 4). Majority of the cases (84%) presented within 24 hours of injury. The main reason for delay in presentation to this hospital was due to the seeking of traditional treatment.

Garland's Classification was used to evaluate the fracture type. There were 49 Type III (37.1%), 39 Type II (29.5%) and 44 Type I (33.3%) fractures (Figure 5). Extension type of displacement of distal fragment constituted 87 cases (65.9%). There was only one case showing flexion type of displacement. Medical displacement of distal fragment was twice as common as lateral displacement.

At presentation, nerve injuries were noted in 9 cases (6.8%). One of the cases had a double nerve involvement (Median and radial nerve. Median nerve was the most commonly injured (50%), followed by Radial nerve (40%) and Ulnar nerve (10%) (Figure 6). One fracture was complicated by absent radial pulse and median nerve palsy. It was the only open fracture in our study. There was no concomitant fracture. There were no cases of suspected child abuse in this study.

## Discussion

This study revealed some common features in trauma literature. Boys are more commonly injured compared to girls (ratio of boys: girls of 2.45:1). This probably reflects the general adventurous behaviour of boys who are more accident-prone. Mean age of presentation is around 6 years. The mean age of boys was older than the girls by 1.8 years. In the age group above 10 years old, no girls were found in our study. Non-dominant side was more susceptible to this injury as noted by most other series[5,14].

Most western literatures reported that injuries mainly occurred in the playground[14], while in our study most accidents occurred at home. This probably can partly be explained by the general lack of playground facilities in our region. On the other hand, this can also be due to the inherent lack of safety awareness or lack of supervision at home. Further assessment and investigation into the safety of our home environment would be helpful.

Most accidents occurred between 4pm to 8pm, which accounted for 48.9% of all injuries. A closer parental or guardian supervision during this time period might reduce the risk exposure of the children.

We have noticed that 16% of our patients presented more than 24 hours after the injury. These were the late presenters and not commonly encountered in western literature. The main reason for their delay was due to the initial traditional treatment. Interestingly, a recent

paper from Hong Kong[5] reported 15% of late presenters and it was also as a result of seeking traditional treatment. Public education through mass media may help to create awareness among the public so that prompt and appropriate attention is provided for this type of fracture.

The overall prevalence of nerve injury was 6.82%. The figure was comparable to those in the literature, ranging from 1.2% to 7%[4,15]. Wilkins[4] reported in his review of 61 series (7,212 patients) that radial nerve was most commonly injured.

In our study, Median nerve accounted for 50% of the nerve affected. In the literature, vascular complications at presentation have been found to be rare[4]. However, if not recognised early, it can give rise to ischaemic complication such as Volkmann ischaemic contracture. We have only one case of absent radial pulse at presentation. Ironically, this was the only open fracture, which was also found to have median nerve injury. The capillary circulation of the fingers was good despite of the absent radial pulse. The pulse returned following reduction of fracture.

## Conclusion

Supracondylar fracture of the humerus is associated with significant risk of nerve injury as well as known complication of varus malunion. Many accidents in children occurred at home, therefore we should assess the safety features in the domestic environment and improve the level of supervision. We should devote our attention to accident prevention, as this would also reduce other type of injuries in general. Parental education and awareness is paramount in reducing the group of patient that seeks traditional treatment for this type of injury. Mass media can certainly play a major role in achieving this goal.

## References


1. Landin L. Fracture patterns in children: analysis of 8,682 fractures with special reference to incidence, etiology and secular changes in a Swedish urban population. 1950-1979, Acta Orthop Scand Suppl 1983; 202: 1-109.
2. Sharrard W. Fractures and joint injuries part 1: general principles and upper limb injuries: fractures at the elbow-supracondylar fractures of the humerus. In: Sharrard W, ed. Paediatric orthopaedics and fractures. Oxford: Blackwell Scientific. 1993; 1391-406.
3. Landin L. Danielsson L. Elbow fractures in children: all epidemiological analysis of 589 cases. Acra Orthop Scand 1986; 57: 309-12.
4. Wilkins K. Fractures and dislocations in the elbow region. In: Rockwood CA Jr, Wilkins KE, King RE, eds. Fractures in children, 4th ed. Philadelphia: Lippincott, 1996; 653-904.
5. Cheng JCY, Lam TP. Supracondylar fracture of humerus in children - An epidemiological study of 403 cases. Hong Kong J Orthop Surgery 1998; 2(2): 120-26.
6. Campbell C, Waters P. Emans J. Kasser J. Millis M. Neurovascular injury and displacement in Type III supracondylar humerus fractures. J Pediatr Orthop 1995; 15: 47-52.
7. Dorman J, Squillante R. Sharf H. Acute neurovascular complications with supracondylar humerus fractures in children. J Hand Surg (Am) 1995; 20: 1-4.
8. McGraw J. Akbarnia B. Hanel D. Keppler L. Burdge R. Neurological complications resulting from supracondylar fractures of the humerus in children. J Pediatr Orthop 1986; 6: 647-50.
9. Prietto CA. A supracondylar fractures of the humerus: a comparative study of Dunlop's traction versus percutaneuos pinning. J Bone Joint Surg (Am) 1979; 17: 92-9.
10. Webb A, Sherman F. Subracondylar fractures of the humerus in children. J Pediatr Orthop 1989; 9: 315-25.

11. Williamson D, Coates C, Miller R, Cole W, Normal characteristics of the Baumann (humerocapitellar) angle: an aid in assessment of supracondylar fractures. J Pediatr Orthop 1992; 12: 639-9.

12. Cheng JCY, Shen WY. Limb fracture pattern in different paediatric age groups - A study of 3,350 children. J Orthop Trauma 1993; 7: 15-22.

13. Landin LA. Fracture patterns in children. Acta Orthop Scand 1983; 54S: 202.

14. Christine L. Farnsworth, Patricia D. Silva, Scott J. Mubarak. Etiology of Supracondylar Humerus Fractures. J Pediatr Orthop 1998; 18: 38-42.

15. Crawford C. Campbell, Peter M. Waters, John B. Emans. Neurovascular Injury and Displacement in Type III Supracondylar Humerus Fractures. J Pediatr Orthop 1995; 15: 47-52.

# The Results of Open Reduction and Pin Fixation in Displaced Supracondylar Fractures of the Humerus in Children

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**Summary**

The treatment of displaced supracondylar fracture humerus (Gartland Type III) in children continues to be a challenging problem. We did a retrospective study of such fractures treated in Hospital Muar, over a 2 years period (from January 1998 to December 1999). A total of 42 cases with displaced supracondylar fractures, treated with open reduction and internal fixation were studied. All cases were operated using a posterior triceps splitting approach and crossed kirschner wires were used to stabilize the fracture site. An excellent outcome was seen in 34 patients (81%) and a good outcome in 7 patients (17%). The incidence of complications such as pin tract infection (14%), nerve injury (2%) was very low. None of the patients had vascular complications or myossitis ossificans.

## Introduction

The supracondylar fracture of the humerus is one of the most common types of elbow fractures in children. The peak incidence is between 5 - 10 years of age. The complications of the severely displaced fractures, remain a challenging problem. The early complications are mostly neurovascular injuries. The difficulty in achieving and maintaining reduction, resulting in a cubitus varus deformity is the most frequent long term complication, with a incidence varying from 3 - 57%[1].

Various methods have been used over the years such as closed reduction and cast, traction, closed reduction with percutaneous pinning and open reduction and internal fixation. Closed techniques have been widely used previously. However, because of the swelling, the difficulty in achieving reduction and holding the reduction, the results have not been good[2,3,4]. The use of traction prolongs the hospital stay and requires intensive monitoring of the patient, and frequently the results are not satisfactory[3].

Closed reduction and percutaneous pinning is now widely used to treat this very difficult fracture. The results with this method have vastly improved with better imaging techniques. The hospital stay is short, there is no significant operative scar and the incidence of complications is low. This method is currently accepted widely as a very safe and reliable technique to manage the displaced supracondylar fracture[5,6,7,8]. However, an accurate closed reduction needs some familiarity and expertise.

In cases where closed reduction has failed (severe swelling, irreducible fractures secondary to button-holing), multiple attempts may lead to more soft-tissue damage and nerve injuries[9]. In cases with failed closed reduction, open fractures and cases with associated neurovascular complications, open reduction is indicated[1,3]. It may also be an optimal method of treatment where few such cases are seen[2], and in cases with delayed presentation[10]. Open reduction and pinning has been used by various authors with good results and minimal complications[2,4,10,11,12]. It is a safe and effective alternative to closed reduction and pinning in these situations.

## Objective

Hospital Muar is a district hospital receiving cases from Muar town, and adjacent rural areas. Frequently, cases present after few days of trauma and some cases have received traditional treatment before coming to the hospital. The treatment is also often delayed because of constraints of available operating time. In view of these problems we have been using open reduction with pinning to treat severely displaced supracondylar fractures. In all cases a posterior triceps splitting approach was used and crossed kirschner wires were used to stabilize the fracture site. This study was done to assess the results of this method of treatment and to look at the incidence of complications.

## Materials and Methods

This is retrospective study of children with displaced supracondylar fractures treated by open reduction and internal fixation in Hospital Muar, over a 2 year period from January 1998 to December 1999. A total of 49 cases were operated in this period, of which 7 did not have adequate follow-up (who did not achieve full extension of the elbow on the last visit) and were not included in this study. The remaining 42 cases were included in this study. Inclusion criteria were all children between 2 years to 12 years of age. Cases with multiple injuries and delayed presentation (more than 3 weeks of trauma) were not included in this study. None of the cases had any vascular complications on admission.

All patients had routine clinical assessment and radiographic evaluation on admission. The displacement of the distal fragment posteromedially or posterolaterally was not taken into consideration. The severity of displacement was classified as described by Gartland[13]:

Type I - Un-displaced fracture.
Type II - Displaced fracture, with some contact between fracture fragments.
Type III - Displaced fracture, with no contact between fracture fragments.

All patients had primary splintage with a plaster backslab in gentle flexion. No closed manipulation was attempted, and in all patients open reduction and pinning was done. In one patient with open fracture the surgery was done on the day of the trauma, and in other patients the surgery had been done on the 2nd - 7th day after the trauma (average 3.5 days). The patients were positioned in lateral position, and tourniquet was used in all cases, except for the patient with open fracture. A triceps splitting, posterior incision was used in all patients (the triceps was not cut or only minimally cut). The ulnar nerve was visualised in all cases. The fracture site was stabilized with 2 or 3 crossed kirschner wires and post-operatively plaster backslab was given to support the fixation. The plaster and wires were removed after 4 weeks, and active movement of the elbow started.

The follow-up was done in the orthopedic clinic and post-operative complications such as iatrogenic nerve injury, pin tract infection and myossitis ossificans were looked into. The follow-up was done till full range of movement, specially the extension of the elbow was achieved (ranging from 3 to 5 months). At the time of discharge from the clinic, the cosmetic result (loss of carrying angle as compared to the normal limb) were noted. The results of treatment were analyzed using the criterion laid down by Flynn *et al*[7], Table I and the lesser of the two measurements was adopted as the overall rating of the affected elbow.

## Results

There were 42 patients in this study, in the age group 2-12 years. Most of the cases were in the 5 - 10 years age group, with boys more commonly involved. The age and sex incidence is as shown in Figure 1 and Figure 2. Almost 81% patients were Malays, Figure 3. The left side affected in 72% patients and 28% patients had the fracture in the right elbow. The most common mode of injury was fall at home, in 43% patients and 31% patients had fall from height viz, from a tree (probably because a lot of cases came from semi-urban or rural areas). The mode of injury is shown in Figure 4.

Pre-operative nerve injury was seen in 2 patients (4%). One patient had a radial nerve injury and one patient had median nerve injury. Both patients had full recovery during the follow-up. Pin tract infection was noted in 6 patients (14%). All pin tracts healed following removal of wire's and dressings. One patient (2%) had post-operative ulnar nerve injury, which subsequently

**Table I**
**Criteria for Grading Result (Flynn *et al*)**

| Result | Cosmetic Factor: Loss of Carrying Angle (Degree) | Functional Factor: Loss of Motion (Degree) |
|---|---|---|
| Excellent | 0 - 5 | 0 - 5 |
| Good | 6 - 10 | 6 - 10 |
| Fair | 11 - 15 | 11 -15 |
| Poor | >15 | >15 |

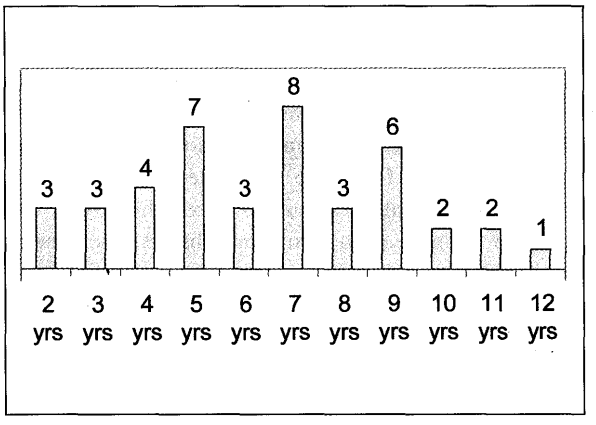


**Fig. 1: Age Distribution.**

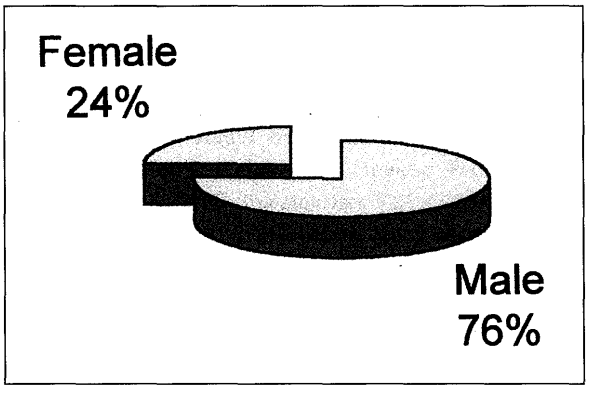


**Fig. 2: Sex Distribution.**

recovered during follow-up. In this study none of the patients had vascular injury or myossitis ossificans. The complications seen are shown in Table II.

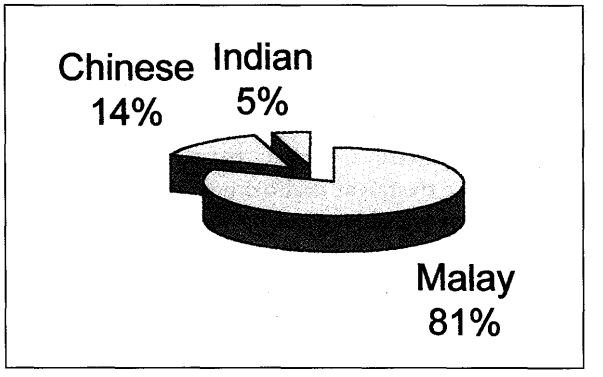


**Fig. 3: Race Distribution.**

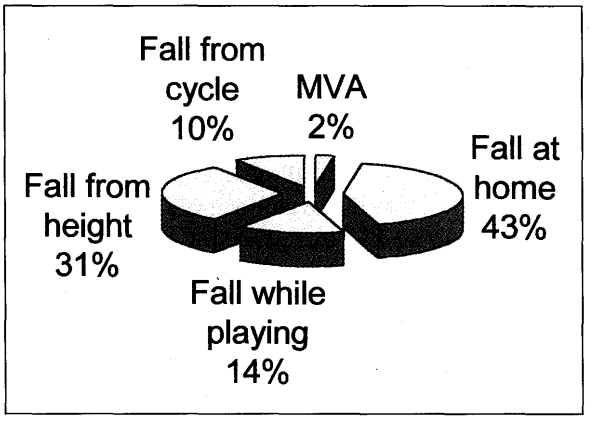


**Fig. 4: Mode of Injury.**

The result of treatment was assessed using the criterion of Flynn *et al*. The cosmetic result was excellent in 36 patients (86%), and good in 5 patients (12%). The functional result was noted to be excellent in 34 patients (81%), and good in 7 patient's (17%). Overall 81% cases had excellent result and 17% cases had good result (98% satisfactory result). The result was rated as fair in 1 patient (2%) and no poor result was seen. The results of treatment in this study are shown in Table III. Though scar was present, it was seldom conspicuous and parents never complained about it.

## Discussion

The supracondylar fracture is a very common injury in children and also a very difficult injury to treat, often

**Table II**
**Complications**

| Type of Complication | Incidence |
|---|---|
| 1. Post-operative nerve injury | 2% (1 case of ulnar nerve injury) |
| 2. Pin tract infection | 14% (6 cases) |
| 3. Pin migration | None |
| 4. Post-operative vascular injury | None |
| 5. Myossitis ossificans | None |

**Table III**
**Result of Treatment**

| Cosmetic Factor (Loss of Carrying Angle) | No. of Patients | Functional Factor (Loss of Motion) | No. of Patients |
|---|---|---|---|
| Excellent | 36 (86%) | Excellent | 34 (81%) |
| Good | 5 (12%) | Good | 7 (17%) |
| Fair | 1 (2%) | Fair | 1 (2%) |
| Poor | 0 | Poor | 0 |

**Table IV**
**Results of Open Reduction and Pinning**

| Author and Year | Excellent Result |
|---|---|
| Furrer M (1991) | 90% cases |
| Ababneh M (1998) | 55% cases |
| Yusof A (1998) | 88% cases |
| In this study | 81% cases |

associated with poor results and complications. The treatment of Type I and Type II Gartland fractures is non-controversial and usually some form of conservative treatment (plaster with or without manipulation) gives fairly good results. The treatment of the displaced Type III fracture however has been very controversial and challenging. The treatment goal is to achieve a good functional result, maintain the carrying angle of elbow with minimal neurovascular complications[3]. Prompt intervention, anatomic and stable reduction are of prime importance to achieve this goal.

Most of the recent series show that closed reduction and percutaneous pinning is a safe and effective way of treating this fracture[5,6,7,8]. The hospital stay is short and the scarring is minimal. However, expertise is needed to do an accurate closed reduction, and it may be specially difficult to do this in a swollen elbow or in a delayed case. Open reduction has been used by various authors successfully in open fractures, failed closed reduction, associated neurovascular complications[1,3] delayed presentation[10] and in a centre where few cases are seen[2]. This method is effective and associated with minimal complications[2,4,10,11,12]. An excellent outcome has been reported ranging from 55% to 90% (Table IV). In this study and excellent result was seen in 81% cases, and a good result in 17% cases (overall satisfactory result in 98% cases). Only 1 case (2%) had a fair result and none of the cases had a poor result.

In this study a posteriomedial triceps splitting approach was used to do open reduction (the triceps was not cut or cut only minimally). Medial incisions, combined lateral and medial incisions and posterior incision have been used in the past. The posterior incision is very safe and gives excellent visualization of the fracture site, thereby facilitating a more accurate reduction, specially the coronal rotation. The problem of triceps scarring and elbow stiffness has been found to be insignificant[10,14]. In this study the triceps was split in the midline and significant loss of movement was seen in only 1 case (2%). Skin scar is seldom prominent, though a medical approach has been advocated.

The technique of pin placement is also widely debated. The best results have been noted to be with the use of cross kirschner wires from the medial and lateral condyles[3,4,15] followed by the use of 2 lateral wires. In this study crossed wires were used in all the 42 cases. In 7 cases peri-operative stability was not good and an additional wire was used laterally. The result was noted to be satisfactory in 98% cases with this technique of cross wire placement.

The possibility of iatrogenic nerve injury has been a source of considerable concern. It has been seen that the incidence of such an injury increases with repeated closed reductions[9]. The incidence is also higher with pinning techniques, especially when the pins are introduced

percutaneously. The overall incidence has been noted to be 3%[4]. The ulnar nerve is most frequently injured, followed by the radial nerve. However, it has been observed that these injuries are transient and tend to recover spontaneously[16]. In this study 1 patient (2%) developed a ulnar nerve injury, which resolved spontaneously during follow-up. None of the patients had radial or median nerve injury. Pin tract infection was seen in 6 patients (14%), and all the pin tracts healed after wire removal and dressing. None of the patients had vascular injury or any myossitis ossificans.

The most common complication of supracondylar fracture is cubitus varus. The cause of this deformity has been attributed to inappropriate reduction, specially medial tilting of the distal fragment and coronal rotation[17]. Some authors believe that the varus deformity is in part due to some amount of epiphyseal growth disturbance. In this study only 1 case (2%) had significant varus deformity. Probably a longer follow up is needed to assess this problem more accurately.

## Conclusion

We conclude that open reduction and pinning is a safe and effective technique in treating the displaced supracondylar fracture, in certain situations with good cosmetic result. The posterior incision is not associated with any significant loss of elbow movement and cross pinning gives good stability.

## References


1. Ababneh M, Shannak A, Agabi S, Hadidi S. The treatment of displaced supracondylar fractures of the humerus in children. Int Orthop. 1998; 22: 263-5.
2. Mohammed S, Rymaszewski A. Supracondylar fractures of the distal humerus in children. Injury. 1995; 26(7): 487-89.
3. Pirone AM, Graham HK, Krajbich JI. Management of displaced supracondylar fractures of the humerus in children. J Bone Joint Surg. 1988; 70(A): 641-50.
4. Yusof A, Razak M, Lim A. Displaced supracondylar fracture of the humerus in children-comparative study of the result of closed and open reduction. Malaysian Medical Journal, orthopaedic supplement. 1998 Sept; 53(A): 52-8.
5. Boyd DW, Aronson DD. Supracondylar fractures of the humerus: a prospective study of percutaneous pinning. J Pediatr Orthop. 1992 Nov-Dec; 12(6) 789-94.
6. Cheng JC, Lam TP, Shen WY. Closed reduction and percutaneous pinning for Type III displaced supracondylar fractures of the humerus in children. J Orthop Trauma. 1995; 9(6): 511-5.
7. Flynn JC, Matthew JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. J Bone Joint Surg. 1974; 56(A): 263-73.
8. Mehserle WL, Meehan PL. Treatment of the displaced supracondylar fracture of the humerus (Type III) with closed reduction and pinning. J Pediatr Orthop. 1991 Nov-Dec; 11(6): 705-11.
9. The RM, Severijnen RS. Neurological complications in children with supracondylar fractures of the humerus. Eur J Surg. 1999 Mar; 165 (3): 180-2.
10. Lal GM, Bhan S. Delayed open reduction for supracondylar fractures of the humerus. Int. Ortop. 1991; 15(3): 189-91.
11. Fleuriau-Chateau P, McIntyre W, Letts M. An analysis of open reduction of irreducible supracondylar fractures of the humerus in children. Can J Surg. 1998 Apr; 41(2): 112-8.
12. Furrer M, Mark G, Ruedi T. Management of displaced supracondylar fractures of the humerus in children. Injury. 1991 Jul; 22(4): 259-62.
13. Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynae Obs. 1959; 145-54.
14. Sibly TF, Briggs PJ, Gibson MJ. Supracondylar fractures of the humerus in childhood: range of movement following the posterior approach to open reduction. Injury. 1991 Nov; 22 (6): 456-8.
15. Zionts LE, McKellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fracture of the humerus in children. J Bone Joint Surg. 1994; 76A: 253-6.
16. Piton C, Laville JM. Ulnar nerve palsy after percutaneous pinning of supracondylar fractures of the humerus in children. Rev Chir Orthop. 1993; 79(5): 415-7.
17. Wilkins KE. Fractures and dislocations of the elbow region. Fractures in children edited by Rockwood *et al*, J B Lippincot CO. Philadelphia. 1991; 6: 509-718.

# Functional Outcome of Open Reduction and Internal Fixation of Pelvic Ring Injuries

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**Summary**

Between January 1996 and August 1998, 15 patients with pelvic ring injuries were treated by open reduction and internal fixation. Fractures types included Tile Al (7%), B1 (33%), C1 (53%) and C3 (7%). The patients were observed for an average of 1 year (range: 5 to 21 months). Thirteen patients (87%) who were operated within 3 weeks after injury had their pelvic disruption healed. One patient with Tile Cl and non-union of the fracture dislocation of sacroiliac joint was operated 11 months after injury and developed implant failure and non-union of the fracture dislocation of sacroiliac joint. Another patient with Tile Cl injury with transforamina sacral fracture was fixed anteriorly only and developed non-union of the sacral fracture and redisplacement of pelvic disruption. Both of them had a poor functional outcome. A 40 points pelvic outcome grading scale (Cole et al 1996) based on physical examination, pain, radiographic analysis and activity/work status was used. Six patients (40%) (1 Tile Al, 5 Tile B1) had an excellent functional outcome. Seven patients (47%) (6 Tile Cl, 1 Tile C3) had a good functional outcome.

*Key Words:* Open reduction, Internal fixation, Pelvic ring injuries

## Introduction

Acute pelvic fractures resulting from high energy trauma is associated with multiple injuries and potentially lethal with the mortality rate of 10% to 20% for the unstable pelvic fracture. In the case of open fracture, the mortality rate can be as high as 50%[1]. A thorough understanding of the anatomic and biomechanical basis of acute pelvic fractures is the key to logical decision making. The need for surgical stabilization of the pelvic ring injury is determined by the combination of instability of the pelvic ring injury and the deformity present[2]. Treatment of unstable posterior pelvic ring injuries has evolved several times. Treatment began with bed rest augmented by traction or pelvic sling, followed by external fixation (with or without traction)[3,4,5]. External fixation controls the anterior pelvis fairly well, but yield poor control of unstable posterior injuries[5]. Most recently, open reduction and internal fixation has become the method of choice for stabilization of the pelvis[1,2,,3,4,5,6,7]. This study presents the early experience of open reduction and internal fixation of the pelvic ring injuries in our hospital.

## Objective

1. To evaluate the functional outcome of open reduction and internal fixation of Tile's B and Tile's C pelvic ring injuries.
2. To evaluate the influence of reduction of sacroiliac joint on the functional outcome of open reduction and internal fixation of Tile's C pelvic ring injuries.

## Materials and Methods

Fifteen patients with pelvic ring fractures treated by open reduction and internal fixation in Hospital UKM between January 1996 till August 1998 were studied. The average follow-up period was 1 year (range: 5 to 21 months).

Eleven patients had their pelvic ring injuries treated operatively by the same surgeon and four other surgeons operated four patients respectively. The data were obtained from the patients' record, initial radiographs, follow-up radiographs, a patient based questionnaire, and a follow-up physical examination. The functional outcome was assessed by using a modified protocol designed by Cole *et al.*[8] (Appendix A).

The preoperative and postoperative displacement of symphysis pubis diasthesis, and sacroiliac joint displacement were measured on the anteroposterior radiographs of pelvis. In terms of anatomical reduction, satisfactory position after fracture fixation was defined as symphysis pubis diasthesis of 1cm. or less and sacroiliac joint displacement (horizontal and vertical) less or equal to 0.5cm.

The pfannenstial or ilioinguinal approach was used for open reduction of anterior pelvic ring injuries. The posterior injuries were approached via incision over the iliac crest or 2 posterior vertical incisions along the posterior superior iliac spine, which was done for one patient in this series.

### Postoperative protocol

Postoperative weight bearing status was based on the stability of the anterior and posterior pelvic ring fixation, the quality of the patient's bone and the presence of associated injuries. If the anterior ring was stabilized with plate and the patient had good bone quality posteriorly that allowed excellent purchase of fractures or dislocated bone fragments, then the patient was allowed to bear weight as tolerated immediately postoperatively. Patients with Tile C injuries in this study were not allowed weight bearing for 3 months.

### Follow-up

Follow-up evaluation included physical examination, analysis of plain radiographs, determination of work status, and completion of the modified Cole's outcome assessment scale form.

The functional outcome assessment included:
1. Pain secondary to physical activity,
2. Subjective pain,
3. Ability to resume previous work, household, or recreational activities,
4. Physical examination, and
5. Pelvic radiographs assessment.

The physical examination assessed gait, Trendelenburg gait, range of motion, bodily pain, anterior or posterior pelvic tenderness, sharp sensation, deep tendon reflexes, muscle strength, and the presence of urinary or sexual dysfunction or postoperative complications. Work status and results of physical and radiographic examinations were used to design a 40 point pelvic outcome scale as originally designed by Cole *et al.*[8] (Appendix A).

## Results

There were 10 males (67%) and 5 females (33%) with an average age of 24 years (range: 17 - 49 years). There were 8 Malay (54%), 5 Indian (33%) and 2 Chinese (13%) patients whom sustained the injuries through motor-vehicle accidents.

The injuries were classified using the Tile's classification of pelvic ring injuries. One patient (7%) with Tile Al, 5 with B2 (33%), 8 with Cl (53%) and 1 with C3 (7%).

The associated injuries included 10 lower and 8 upper extremity injuries, 2 head and neck injuries (parietal skull fracture and cerebral concussion), 1 rib fracture, 1 perineal tear with rectal wall injury ended up with emergency laparotomy and colostomy, and 2 urethral tear and 1 kidney contusion (see Table I). All the patients were admitted directly from the accident scene.

The anterior injuries included a symphyseal diasthesis in 13, pubic rami fracture in 3 and both in 3 patients (Table II). Then posterior injuries included the sacroiliac joint fracture dislocation in 9, LS transverse process fractures in 3, iliac wing fractures in 2, and sacral fracture in 1 patient (Table II).

Eleven consecutive patients with pelvic ring injuries were treated operatively by one surgeon at Hospital Kuala Lumpur and Hospital Universiti Kebangsaan Malaysia, and 4 patients by four other surgeons respectively. The patients were follow up for an average of 1 year after injury (range 5 - 21 months).

**Table I**
**Pattern of Musculoskeletal Injuries Based on Tile's Classification**

| | A1 | B1 | C1 |
|---|---|---|---|
| Fracture humerus | 0 | 1 | 2 |
| Radius fracture | 0 | 1 | 1 |
| Scapular fracture | 0 | 0 | 1 |
| Metacarpal fracture | 0 | 1 | 1 |
| Scaphoid fracture | 0 | 0 | 1 |
| Fracture femoral neck | 0 | 2 | 0 |
| Fracture femoral shaft | 0 | 2 | 3 |
| Fracture tibia | 0 | 1 | 0 |
| Metatarsal fracture | 0 | 1 | 0 |
| Degloving injury of thigh | 1 | 0 | 0 |

**Table II**
**Pattern of Pelvic Ring Injuries**

| Pattern of Injuries | No. of Patients |
|---|---|
| Symp. Pubis diasthesis | 13 |
| Pubic rami fracture | 3 |
| Pubis symp & rami fracture | 3 |
| SI joint fracture dislocation/ SI joint dislocation | 8 |
| L5 transverse process fracture | 3 |
| Iliac wing fracture | 2 |
| Acetabulum fracture | 1 |
| Sacral fracture | 1 |

Four patients were treated initially with external fixation with skeletal traction including 3 Tile's C1 and 1 Tile's C3 injuries. One patient was treated with a C-clamp during the resuscitative phase (see Table III).

Fourteen patients underwent definitive fracture fixation less than 3 weeks after injury (range 9 - 17 days). Six patients with Tile's Cl injury and 1 patient with Tile C3 injury had internal fixation (plating) across the symphysis pubis and sacroiliac joint. Four patients with Tile B 1 injury were treated with plating across of the symphysis pubis and had excellent functional outcome. One patient with Tile B1 injury was treated with

**Table III**
**Initial Treatment of Pelvic Ring Injury**

| Initial Treatment | No. of Patients |
|---|---|
| External fixator | 2 (1B1, 1C1) |
| External fixator & traction | 4 (3C1, 1C3) |
| Skeletal traction | 1 (C1) |
| C-clamp | 1 (C1) |
| None | 4 (3C1, 1A1) |

**Table IV**
**Complications of Open Reduction and Internal Fixation of Pelvic Ring Injuries**

| Complications | No. of patients |
|---|---|
| Lower limb shortening | 3 (3C1) |
| Loosening of implant | 3 (3C1) |
| Implant failure | 1 (C1) |
| Screw in hip joint | 1 (C1) |
| Heterotopic ossification | 2 (B1, C1) |

external fixation initially which managed to reduce the symphysis diastasis from 4cm to 2.5cm, and plating of the symphysis pubis further reduce the diastasis to 1 cm. The external fixator was kept for 4 weeks, and this patient also had an excellent functional outcome.

One patient with Tile' Cl injury was treated with external fixation for 3 months and ended up with non-union of the fracture dislocation of the sacroiliac joint. Open reduction

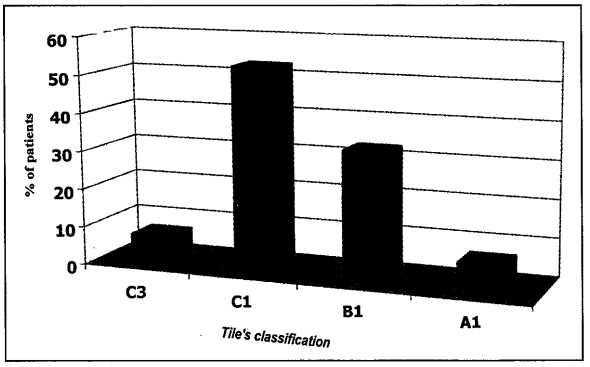


**Fig. 1: Distribution of pelvic ring injury based on Tile's classification.**

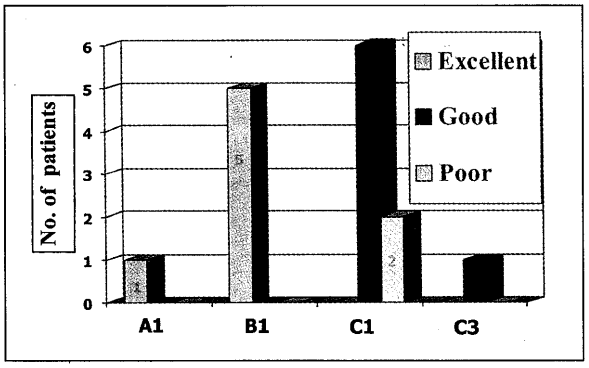


**Fig. 2: Functional outcome of open reduction and internal fixation of pelvic ring injuries.**

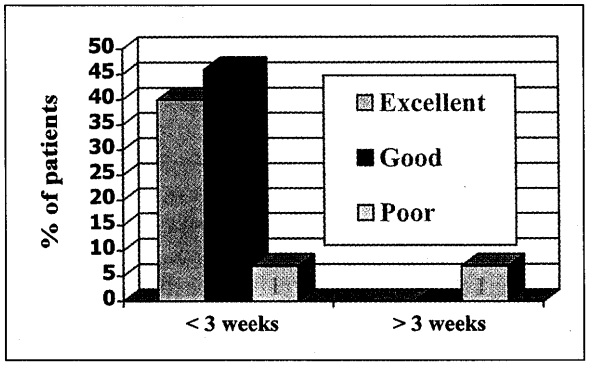


**Fig. 3: Distribution of functional outcome according to duration after injury.**

and internal fixation with bone grafting was performed for this particular case 11 months after the injury and ended up with failure of implant with broken screws and loosening of screws and redisplacement of the sacroiliac joint, eventually led to non-union. The functional outcome for this patient is poor. She was not keen for bone grafting and replating. This case illustrated a poor functional outcome of late open reduction and internal fixation of pelvic ring injury (Table IV).

Another patient with Tile Cl injury with transforamina sacral fracture and rectal wall tear had an emergency laporotomy for colostomy. His pelvic ring injury was treated by anterior plating of the symphysis pubis diastasis through the laparotomy incision. This patient had failure of the fixation with loosening and marked displacement of the sacroiliac joint and non-union of the sacral fracture. He also had urethral stricture and left foot drop secondary to the lumbosaral plexus injury. This case illustrated a poor outcome unstable posterior pelvic ring injury treated with only plating of the symphysis pubis. (Figure 1)

The duration of operation and the estimated blood loss for internal fixation of the pelvic injury could not be isolated in most of the cases. The average length of postoperative hospital stay was 9 days for all the patients (range 4 - 21 days). The median length of hospital stay was 6 days for all patients.

In terms of anatomical reduction, satisfactory position after fracture fixation was defined as symphysis pubis diasthesis of 1cm or less and sacroiliac joint displacement (horizontal and vertical) less or equal to 0.5cm. Preoperative and postoperative displacements were evaluated with anteroposterior radiographs of pelvis. The average preoperative displacement of symphysis pubis was 4mm (range 2.5 - 8cm). The preoperative sacroiliac joint displacement was 2.2cm (range 0.5 - 7.5cm). The average preoperative vertical shear was 1.5cm (range 1 - 2cm). Out of the 8 patients with Cl injury, satisfactory reduction of the sacroiliac joint was achieved in 1 patient only, and for the symphysis pubis in 4 patients. The patient with satisfactory reduction had good functional outcome. Five patients with Cl injury also had good functional outcome despite unsatisfactory reduction. These results showed that anatomical reduction might not be necessary for good functional outcome even though statistical analysis could not be carried out because of the small number of patient. All the 5 patients with Tile Bl injury had satisfactory reduction and they all had excellent functional outcome.

In this study, good functional outcome was obtained in Tile's C pelvic ring injuries treated with open reduction and internal fixation of both anterior and posterior lesions within 3 weeks of injury (Figure 2).

## Complications

There were no intra-operative complication, deep vein thrombosis or iatrogenic nerve injury noted in this

series. There were 3 patients with loosening of screws, one patient with broken screws, one patient with grade I heterotrophic ossification, one patient with the screw in the hip joint causing chronic hip pain. Lower limb shortening was found in 3 patients with Cl injury after open reduction and internal fixation (range 1 - 2.5cm). There was one patient with Cl injury with sacral fracture non-union and marked sacroiliac joint dislocation had lumbosacral plexus injury ended up with foot drop, sensory deficit of L5, Sl and S2 dermatomes which the patient sustained from the initial injury. This particular patient also had infected screw which was subsequently removed.

## Discussion

Non-operative treatment of unstable pelvic ring disruption requires prolonged immobility and yields poor results[2,5,6,9,10]. External fixation is used in the acute phase after injury to add to the bony stability during transport, decrease the pelvic volume and allow patients to avoid recumbancy. However, external fixator of the pelvis cannot adequately maintain the alignment of the posterior injuries, is not as strong biomechanically as internal fixation, and risks pin tract infection[11]. Internal fixation of the pelvis is significantly stronger than external fixation. Recent authors have recommended internal fixation of the unstable pelvic ring disruption[2,7,12].

Kellam[3] defined an acceptable reduction to be less than 1cm posteriorly and less than 2cm anteriorly. Karahaju[13] graded their reduction only by posterior displacement as measured on anteroposterior film; with excellent being <0.5cm, good 0.5 - 1cm and poor >1cm. Samba *et al.*[14] found that initial combined anterior and posterior displacement of greater than 1 cm leads to a high rate of severe low back pain. Tournetta[15] critically analyzed preoperative and postoperative anteroposterior, 40° caudal and 40° cephalad views of 107 patients with unstable pelvic ring injuries to assess the reduction and the ability to maintain them. The reductions were graded based on the largest displacement measured on the 3 views. The reductions were obtained within 4mm in 67% and within 1 cm in 95% of cases. In cases done within 3 weeks of injury, 70% were reduced to within 4mm. Leg length discrepancy was also decreased to less than 1cm in 102 of the 107 patients.

In this study, the reductions were graded by maximal displacement measured on the anteroposteroior view of the pelvis. Satisfactory position of the reduction was defined as symphysis pubis diasthesis of less or equal to 0.5cm and sacroiliac joint dislocation less or equal to 1 cm. Using the criteria, all the five patients with Tile B1 injury achieved excellent fixation position, but only 1 out of 8 patients with Tile Cl injury had achieved the satisfactory fixation position. It is important to note that the radiological criteria is not the sole determinant of the functional outcome used in this study. The functional outcome are good for the patient with Tile C3 injury, good for 6 out of 8 patients with Tile Cl injury, and excellent for the 5 patients with Tile Bl and 1 patient with Tile Al injury. Comparative studies should be carried out to compare the functional outcome of the pelvis injuries with and without anatomical reduction. This means a bigger number of patients are needed to enable statistical analysis.

Several authors have voiced concerns about infection in the open reduction and internal fixation of pelvic injuries[4,11]. Kellam[16] reported a 25% rate of infection. Goldstein[17] had an 18% infection rate. Other authors have reported much lower infection rate[5,18]. In this study, there was one out of 15 patient developed this complication i.e. 7% infection rate. This patient had plating of the symphysis pubis diasthesis following a colostomy for an intra-abdominal injury at the same sitting, contributing to the infected implant in this patient. The plate was removed and the patient recovered well. It is thought that open reduction and internal fixation of the pelvic ring need not be considered as a high-risk procedure. However, care must be taken to recognize severe soft tissue injury and treat it appropriately. Matta[6] routinely perform an incision, drainage, and debridement of close subcutaneous degloving injuries. Following that, the wound is left open, packed daily, and allowed to closed secondarily.

The patient with broken screw and loss of reduction and subsequent nonunion of the sacroiliac joint dislocation in this study highlighted the poor outcome of late internal fixation i.e. more than 3 weeks after injury. Open reduction in unstable pelvic injury need to perform as soon as possible to gain better outcome as evidenced by the good to excellent functional outcome of the Tile Cl injuries in this study treated within 3 weeks after the injury.

In this study, one patient with Tile Cl pelvic ring injury with transforaminal sacral fracture was only fixed anteriorly, eventually ended up with poor outcome (Figure 3). This case highlighting the need to fix anteriorly and posteriorly for Tile C injury in order to get better functional outcome. Severe neurologic compromise has been associated with vertically unstable injuries, particularly if there is a transforaminal sacral fracture[16,18,19]. This is well illustrated by this case as well.

**Outcome of rotationally unstable pelvic injuries treated by internal fixation:**

Tornetta *et al.*[20] observed 29 patients with unstable rotationally injuries treated operatively for 3 years and found 96% had no pain or pain only on strenuous activity, ambulated without assistance or limitation, and returned to work. Open reduction and internal fixation of rotationally unstable pelvic fractures results in a high functional success rate. Our study yielded the same conclusion.

Pohlemman[21] reported that open reduction and internal fixation of pelvic injuries results in a higher percentage of anatomic reduction. Using 4-hole dynamic plate fixation, Pohlemann[21] reported 73 anatomic reductions (93%) and 5 reduction within 1cm in rotationally unstable injuries. Twenty of 28 patients available for follow-up at 2.2 years did not complain of pain. Two (7%) had pain on strenuous exertion, and 1 (3.5%) had moderate pain. 21% had mild sensory deficit and none had sexual disturbance. In our study, there were 5 patients with rotational unstable pelvic injury (Tile Bl) whom 4 to 6 holes 4.5 reconstruction plate or DCP plate were used to fix the symphysis pubis. These patients had satisfactory reduction with the symphysis pubis diasthesis of 1cm or less, and all of them had excellent functional outcome.

Most surgeons fix the anterior ring with plates and screws[22,23]. Single (2,4 and 6 hole) and double plating techniques for the symphysis have been described. Lange and Hansen[22] reviewed 6 patients treated with 4 - holes compression plates and found that acceptable reduction (average, 1.2cm) were obtained in all cases. Two of the 4 -holes plates were loose at follow-up as compared with none of the 2-holes plates. It was concluded that 2-holes plates are preferred. However, one of the 4-hole plates was in a patient who had a completely unstable posterior injury that was not fixed and the other 4-hole plate was in a patient who had an open fracture. Later Webb *et al.*[23] reported excellent results in 5 patients with rotationally unstable injuries treated with a 2-hole plate. There were no losses of reduction or plate loosening in any of the cases. However, the average time to full weight bearing was 57 days. To allow early weight bearing, a longer plate is preferred.

**Outcome after internal fixation of unstable posterior pelvic ring injuries:**

The long-term outcome of operatively treated displaced posterior ring injuries is to a large degree unknown. In the larger series where bed rest, traction, or pelvic slings were used as the treatment, high rates of posterior pain, impaired gait, pelvic obliquity, and inability to return to gainful employment was reported[2,3,10,14,18].

Slatis and Huittinen[1] studied 113 patients with posterior unstable pelvic ring injury treated with recumbancy and a light pelvic sling for 6 weeks. Sixty-five patients were observed for 1 to 7 years. Major complaints included pelvic obliquity and impaired gait in 21 patients (32%), lumbosacral nerve deficit in 31 (48%), and disabling low back pain in 11 (17%).

Tile[2] reported a 60% incidence of pain for vertically unstable injuries treated with bed rest, traction, and external fixation. He thought that the pain was related to mal-reduction of the sacroiliac joint. Kellam[3] reported results in patients treated with external fixation and found that greater than 2cm displacement resulted in an 80% incidence of pain requiring analgesia as opposed to 0% with an acceptable reduction. Browner *et al.*[18] treated 15 patients with emergency external fixation and delayed internal fixation. Twelve of them were observed for 1 to 4 years. 50% went back to work. 33% had significant posterior pelvic pain. There was no anatomical reduction achieved in-patients with pure sacroiliac joint dislocation. The difficulty of late reduction of the posterior complex was also reported by Matta and Tornetta[5] and Matta and Saucedo[6].

Simpsom *et al.*[24] reviewed 16 patients with unstable sacroiliac dislocation treated with open reduction and internal fixation via anterior approach and plating. This

technique yielded excellent reduction, but long term follow-up of patients with respect to function and pain were not reported. Ward *et al.*[12] reported 12 patients with vertically unstable fracture treated by open reduction augmented by internal or external fixation of the anterior injury. Nine patients walked without difficulty and only 2 had significant posterior pain. Ward felt that an accurate reduction was paramount in obtaining good functional results.

Tornetta *et al.*[15] reported 48 unstable posterior pelvic injuries all treated with open reduction and internal fixation. There was no non-union in the series. Two - third of the patients returned to their previous jobs without restriction and an additional 16% did not return because of associated injuries. Sixty-three percents had no pain or pain only with strenuous activity. 63% of the patients ambulated normally and an additional 25% did not ambulate normally because of associated injuries. Neurologic injury was found in 35% of patients in this study and adequate reduction did not positively influence neurologic injury. Reduction to within 10mm seems to be adequate for functional results[15].

In this study, there were 9 patients with unstable posterior pelvic injury (8 Tile Cl, 1 Tile C3) treated with open reduction and internal fixation. Six out of eight patients with Tile Cl injuries and 1 patient with Tile C3 injury had good functional outcome. Five patients of Tile Cl injury were fixed posteriorly through anterior extrapelvic approach. Only one patient with Tile Cl injury had posterior fixation through posterior approach with a bridging plate placed across the sacroiliac joint bilaterally. Out of the 8 patients with Cl injury, satisfactory reduction of the sacroiliac joint was achieved in 1 patient only. The patient with satisfactory reduction had good functional outcome. Five patients with Cl injury also had good functional outcome despite unsatisfactory reduction. This result is comparable with the series of Tornetta[15]. However, arthritis may in fact occur in these patients with longer follow-up. Therefore, every effort should be made to obtain an anatomical reduction of all posteriorly unstable pelvic ring disruptions. These results showed that anatomical reduction might not be necessary for good functional outcome even though statistical analysis could not be carried out because of the small number of patient.

One patient with Tile Cl injury was treated with internal fixation late, i.e. 11 months after the injury and had poor outcome. The poor outcome of late open reduction and internal fixation was also reported by Browner[18], Matta and Tornetta[6] and Matta and Saucedo[5].

One patient with Tile Cl injury with transforaminal sacral fracture was fixed anteriorly only with single plate and resulted in poor outcome. This emphasizes the importance of solid posterior fixation to ensure good outcome. The injury of nerve roots involves left L5, Sl and S2 of this particular patient has poor prognosis in view of the wide displaced non-union transforamina sacral fracture with marked vertical displacement of the sacroiliac joint. Matta and Saucedo[5] observed that the course of the nerve injury is not affected by a satisfactory reduction. They thought that the ultimate prognosis of the nervous injury is determined at the time of the nervous injury. This finding was confirmed by Tornetta and Matta[15] in which only 1 patient had complete neurological recovery and several partial recovery. Neurological injury was found to be more common among patients with sacral fracture and pure sacroiliac dislocation than fracture-islocation[15].

The results of this study and other series[15,20] show that a significant percentage of patients with severe posterior pelvic ring disruption can expect good return to function and gainful employment. The presence of neurologic and associated injuries can have profoundly deleterious effects on the outcome of the patients with pelvic ring injuries.

## Conclusions

From this study, it is concluded that:

1. Open reduction and internal fixation of Tile's B pelvic ring injuries have excellent functional outcome.
2. Good functional outcome can be achieved by treating Tile's C pelvic ring injuries with open reduction and internal fixation of both the anterior and posterior lesions within 3 weeks of injury.
3. Anatomical reduction of the sacroiliac joint of Tile's C pelvic ring injuries might not be necessary for good functional outcome. However, longer follow-up and bigger number of patients are needed for statistical analysis.

## Appendix A
## Pelvic Outcome Scale (Cole *et al* 1996)

| Category | Description | Points |
|---|---|---|
| Functional pain | **Pain secondary to physical activity** | |
| | * None | 5 |
| | * Pain only with strenous activity | 4 |
| | * Mild pain with stair climbing, lifting, mowing, or other moderated strenous activities | 3 |
| | * Moderate pain with start up of activities and intermittent radicular pain | 2 |
| | * Pain with sitting or standing longer than 1 hour, requires frequent position changes | 1 |
| | * Chronic severe pain regardless of activity | 0 |
| Subjective pain | **Average of resting and ambulation scores on a scale of 1 (no pain) to (severe pain)** | |
| | * 1 - 2 points | 4 |
| | * 3 - 4 points | 3 |
| | * 5 - 6 points | 2 |
| | * 7 -8 points | 1 |
| | * 9 - 10 points | 0 |
| Narcotic use | **Narcotic use > 12 weeks postoperatively** | |
| | * No | 1 |
| | * Yes | 0 |
| Activity status | **Ability to resume previous work, household, or recreational activities** | |
| | * Without limitation | 10 |
| | * With some discomfort | 8 |
| | * With limitations such as tires more easily or cannot lift as much as before injury | 6 |
| | * With marked limitations requiring change in work status to part time, sedentary, or with restriction; requires assistance with household activities or avoids strenous recreational activities | 4 |
| | * Unable to resume any previous work, household, or recreational activities; cannot drive and requires assistance with stairs or with shopping | 2 |
| | * Unable to resume any previous work, household or recreational activities and requires assistance with activities of daily living | 0 |

| | | |
|---|---|---|
| Physical examination | **Gait** | |
| | * Normal gait | 4 |
| | * Antagic gait or limp | 3 |
| | * Requires assistive device (cane) | 2 |
| | * Requires assistive device (walker; occasionally uses wheelchair) | 1 |
| | * Nonambulatory | 0 |
| | **Trendelenberg** | |
| | * Negative | 1 |
| | * Positive | 0 |
| | **Tenderness** | |
| | * No sacral or pubic tenderness | 2 |
| | * Sacral or pubic tenderness | 1 |
| | * Sacral and public tenderness | 0 |
| | **Lower extremity muscle group strength flexion/extension** | |
| | * Bilateral thigh flexion and extension=5/5 | 1 |
| | * Thigh flexion or extension <5/5 | 0 |
| **Category** | **Description** | **Points** |
| | **Abduction/adduction** | |
| | * Bilateral thigh abduction and adduction=5/5 | 1 |
| | * Thigh abduction or adduction <5/5 | 0 |
| | **Range of motion** | |
| | * Normal hip and trunk range of motion | 1 |
| | * Trunk flexion <90°, hip flexion <90°, or >20° difference in hip internal or external rotation when compared with contralateral side | 0 |
| Pelvic radiograph (AP) | **Posterior (normal sacroiliac joint space = 4mm)** | |
| | * Displacement ≤ 0.5cm without sacroiliac joint reactive changes | 6 |
| | * Displacement ≤ 0.5cm with sacroiliac joint reactive changes | 5 |
| | * Displacement > 0.5cm and ≤ 1.0cm | 4 |
| | * Displacement > 1.0 cm | 2 |
| | * Nonunion | 0 |
| | **Anterior (normal pubis symphysis space = 0.5cm)** | |
| | * Displacement ≤ 0.5cm | 4 |
| | * Displacement >0.5cm and ≤ 1.0cm | 3 |
| | * Displacement > 1.0cm and ≤2.0 cm | 2 |
| | * Displacement > 2.0cm | 1 |

## References


1. Tile M: Fractures of the pelvis and acetabulum. Baltimo, Williams and Wilkins, 1996.
2. Tile M: Pelvic ring fractures: Should they be fixed? J Bone Joint Surg 1988; 70B: 1-12.
3. Kellam J: The role of external fixation of pelvic disruptions. Clin Ortho 1989; 241: 66-82.
4. Kellam J, McMurray R, Paley D, *et al*: The unstable pelvic fracture operative treatment. Orthop Clin North Am 1987; 18: 25-41.
5. Matta JM, Sauceda T: Internal fixation of pelvic ring fracture. Clin Ortho 1989; 242: 83-97.
6. Matta JM, Tornetta III P: Internal fixation of unstable pelvic ring injuries. Clin Ortho 1996; 329:129-40.
7. Tile M: Acute pelvic fractures: Causation and classification. J Am Acad Orthop Surg May/June 1996; 4(3): 143-51.
8. Cole JD, Blum DA, Ansel LJ: Outcome after fixation of unstable posterior pelvic ring injuries. Clin Ortho 1996; 329: 160-79.
9. Holdsworth F: Dislocation and fracture dislocation of the pelvis. J Bone Joint Surg 1948; 30B: 461-66.
10. Slatis P, Huittinen VM: Double vertical fractures of the pelvis: A report on 163 patients. Act Chir Scand 1972; 138: 799-807.
11. Failinger M, Mcganity P: Current concepts review: Unstable fractures of the pelvic ring. J Bone Joint Surg 1992; 74A: 781-91.
12. Ward E, Tomasin J, Vander Griend R: Open reduction and internal fixation of vertical shear pelvic fractures. J Trauma 1987; 27: 291-95.
13. Karaharju EO, Slatis PAR: External fixation of double vertical pelvic fractures with a trapezoid compression frame. Injury 1978; 142-49.
14. Semba R, Yasukawa K, Gustilo R: Critical analysis of results of 53 Malgaigne fractures of the pelvis. J Trauma 1983; 23: 535.
15. Tornetta P, Matta JM: Outcome of operatively treated unstable posterior pelvic ring disruptions. Clin Orthop 1996; 329: 186-83.
16. Patterson FP, Morton KS: Neurological complications of fractures and dislocations of the pelvis. J Trauma 1973; 12: 1013-23.
17. Goldstein A, Philips T, Sclafani S, *et al*: Early open reduction and internal fixation of the disrupted pelvic ring. J Trauma 1986; 26: 325-33.
18. Browner B, Cole D, Graham M, *et al*: Delayed posterior internal fixation of unstable pelvic fractures. J Trauma 1987; 27: 998-1006.
19. Majeed SA: Grading the outcome of pelvic fractures. J Bone Joint Surg 1989; 71B: 304-6.
20. Tornetta P, Dickson K, Matta JM: Outcome of rotationally unstable pelvic ring injuries treated operatively. Clin Ortho 1996; 329: 147-51.
21. Pohlemann T, Bosch U, Gansslen A, *et al*: The Hanover experience in the management of pelvic fractures. Clin Orthop 1994; 305: 69-80.
22. Lange RH, Hansen ST: Pelvic ring disruptions with symphysis pubis diastasis. Clin Ortho 1985; 201: 130-37.
23. Webb LX, Gristina AG, Wilson JR, *et al*: Two -hole plate fixation for traumatic symphysis pubis diastasis. J Trauma 1988; 28: 813-17.
24. Simpson L, Waddle J, Leighton R *et al*: Anterior approach and stabilization of the disrupted sacroiliac joint. J Trauma 1987; 27: 1332-39.

# Clinical Experience with Reamed Locked Nails for Close and Open Comminuted Tibial Diaphyseal Fractures : A Review of 50 Consecutive Cases

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## Summary

We present the results of our experience in treating comminuted tibial shaft fractures with reamed interlocking intramedullary nail from September 1993 to December 1995. In this retrospective study, there were fifty patients with an average follow-up of 14.3 months (range six to twenty-eight months). Ninety-eight percent of the fractures were due to motor-vehicle accident with majority of the patients being motorcyclist (96%). Thirty-eight fractures were closed and twelve were open (Gustilo grade I - 8; grade II - 4); 44% of them had additional fractures or other injuries. According to Winquist-Hansen classification of diaphyseal fracture comminution, there were 24% type I; 18% type II; 26% type III and 32% type IV. The union rate was 98%. There were 6 infections, 2 superficial and 4 deep. All these infections arose from closed fractures, which was possibly due to the long operative time. No patients with open fractures, which underwent delayed nailing, had infection. One of the patient had severe deep infection which required early nail removal before union. Anterior knee pain following nailing occurred in 6% of the patients. The average hospital stay after operation was 3.4 days. Ninety-four percent of the patients had excellent to good functional outcome after nailing. The mean time to regain full range of movement of knee and ankle was 8.4 weeks. Patients were allowed full weight bearing in the average time of 10.7 weeks and the mean time to return to work was 24.7 weeks.

*Key Words:* Reamed locked nail, Comminuted tibial diaphyseal fracture

## Introduction

Tibial shaft fracture is a common injury largely due to its superficial location, and the subcutaneous characteristics of its anteromedial aspect easily cause open fracture. The treatment of comminuted diaphyseal tibial fractures is difficult and challenging. Various methods of treatment have been used ranging from the use of plaster cast[1,2,3,4] functional braces[5,6] external fixation[7,8] and internal fixation with plate[9,10,11,12] and intramedullary nail[13,14] Puno *et al.*[15] has listed the major predictive factors that determine the poor outcome of the tibial shaft fractures. This includes the amount of initial displacement or comminution, the extent of soft-tissue disruption and the presence of sepsis.

Intramedullary devices have been used to stabilise tibial fractures for many years. Intramedullary nails for tibial fractures may be divided into two categories: unreamed and reamed. Reamed nailing for lower limb fractures is a well-established technique. Interlocking nailing for long bones fractures of the lower limb has greatly

increased the scope of the technique of closed intramedullary nailing. Interlocking nails widens the surgical indications of nailing, allowing it to be used for comminuted fractures, on fractures too proximal or too distal to be operated on without interlocking and on aseptic pseudarthrosis. Interlocking increases axial, angular and rotational stability, thereby making it easier to maintain alignment and length. Its main advantages are the reduction of postoperative infection rates[16] and the decreased incidence of nonunion[17]. Reamed nailing is associated with a significant lower time to union as compared to unreamed nailing[13].

The use of interlocking nail in the treatment of unstable comminuted tibial shaft fracture in Universiti Kebangsaan Malaysia, Orthopaedic Unit was introduced in the late 1993. Before this the treatment of this fractures comprised of calcaneal traction for few weeks followed by casting or bracing. Less severe fractures were treated with plate osteosynthesis. The incidence of malunion and restricted movement of the knee and ankle were unacceptable. Infection following plating of the tibia was high.

The study was a retrospective study on a series of patients with comminuted tibial diaphyseal fractures treated with reamed intramedullary interlocking nail at the Universiti Kebangsaan Malaysia Kuala Lumpur from September 1993 to December 1995. Various orthopaedic surgeons and registrars performed the operations and the results of the treatment were documented.

The study was undertaken with the following objectives:

1. To determine the percentage of union of comminuted tibial diaphyseal fractures treated with reamed intramedullary interlocking nail.
2. To analyse the functional outcome of comminuted tibial diaphyseal fractures treated with reamed intramedullary interlocking nail.
3. To determine the complications encountered following interlocking nail of comminuted tibial diaphyseal fracture.

## Materials and Methods

This was a retrospective study performed by Department of Orthopaedic and Traumatology, Faculty of Medicine, University Kebangsaan Malaysia at the Kuala Lumpur Hospital. There were 50 consecutive acute tibial fractures in 50 patients who were treated with tibial interlocking nail from September 1993 to June 1996. The cases selected for this studies are those with comminuted unstable diaphyseal tibial fractures which were treated with a reamed intramedullary interlocking nail. Tibial fractures, which failed conservative treatment, were also included. There are three systems of reamed tibial interlocking nail used in these studies. They include Gross-Kempf nail, Russel Taylor nail and Biomet nail. Basically the designs of the nail are almost the same. The following exclusion criteria disallowed a patient from the study: 1) previous tibial internal fixation, 2) fractures above the tibial tubercle, 3) tibias with an open physis, and 4) comminuted fractures of the proximal or distal region of the tibia that would render the locking devices unstable.

Clinical particulars of the patients, mechanism of injury, associated injuries and operative procedure were obtained from previous records. Radiographs of the fractured tibia, pre-, postoperative and subsequent follow-up were evaluated. Patients were then called up for further clinical and functional assessment. The soft tissue injury for closed fractures tibia were classified according to Tscherne classification: grade 0 - no soft tissue injury; grade 1 - superficial abrasion or contusion caused by fragment pressure from within; grade 2 - deep contaminated contusion associated with a localized skin or muscle contusion from direct trauma and impending compartment syndrome is included; grade 3 - extensive contused or crushed skin and possibly severe muscle damage. Kuala Lumpur Hospital is a national referral centre and because of limited operating time, interlocking nailing is being done as an elective procedure. Most of the injured limb were provisionally managed by calcaneal traction and elevation on Bohler Braun frame prior to the operation.

All open fractures were treated acutely with standard wound-management proctocol. All open fractures were classified according to the criteria of Gustilo and

Anderson: Based on the radiographic findings, all fractures of the tibial comminution were classified according to the system of Winquist *et al.* (1986): type I - only a small piece of bone broken away with less than 25% of the width of the bone; type II - larger butterfly fragment present of up to 50% of the width of the bone; type III - very large butterfly segment, greater than 50% of the width of the bone; type IV - comminution of a complete bone segment and denotes lack of inherent rotational and axial stability and type V - comminution with segmental bone loss. All the patients were given a regime of 3 doses of prophylactic antibiotic which consist of intravenous Cefuroxime 1.5gm at induction and 750mg at 6 hours and 12 hours postoperative or intravenous Claforan or Cefobid 1.0gm at induction and 6 hours and 12 hours post-operation.

Postoperatively immediate care was to monitor the compartment. Most of the patients were allowed to mobilize the knee and ankle as early as possible and progressive weight bearing when deemed appropriate. Most of the patients were not allowed to put weight on the operated limb until they are told to do so. Patients were called for follow-up by tracing their address from previous record. On each visit, clinical assessments were made and radiographs of the affected tibia were obtained. The functional outcome of the limb, complications and bony union were evaluated. Delayed unions were defined as those fractures with no evidence of healing at 6 months postoperatively. Non-unions were defined as those fractures with no progression of healing at 9 months post-operatively[18].

**Table I**
**Associated Injuries**

| Associated Injuries | Number |
|---|---|
| Fracture Clavicle | 1 |
| Fracture Radius Ulna | 5 |
| Fracture Phalanx Hand | 3 |
| Dislocation Elbow | 1 |
| Fracture Acetabulum | 1 |
| Dislocation Hip | 1 |
| Fracture Femur | 5 |
| Fracture Contralateral Tibia Fibula | 4 |
| Multiple Wound | 8 |
| Total | 29 |

**Table II**
**Degree of Tibial Shaft Fracture Comminution**

| Winquist Classification | Close | | Open | |
|---|---|---|---|---|
| | No. | % | No. | % |
| I | 8 | 21.1 | 4 | 33.3 |
| II | 6 | 15.8 | 3 | 25.0 |
| III | 12 | 31.6 | 1 | 8.3 |
| IV | 12 | 31.6 | 4 | 33.3 |
| Total | 38 | | 12 | |

## Results

Fifty tibial fractures in 50 patients treated with intramedullary tibial interlocking nail were followed up for an average of 14.3 months (range six to twenty-eight months) from September, 1993 to December, 1995. These include nineteen (38%) Malays, eighteen (36%) Chinese, six (12%) Indians, five (10%) immigrants and two (4%) from other races. The majority of the fractures occurred as a result of motor vehicle accident, 98%, with one patient (immigrant) fell from a height in the construction site. Ninety-six percent of the vehicle involve were motorcycle. Thirty-five (70%) of the injured patients were motorcyclist, 5 (10%) pillion rider, 7 (14%) pedestrian and one each from a lorry driver, a car passenger and a construction worker. There are twenty-nine associated fractures or other injuries in these series (Table I).

There were 48 (96%) male and 2 (4%) female with an average age of 29 years (range 17 to 80 years). There were 33 right-side fractures and 17 left-side fractures. Thirty-eight (76%) fractures were closed and 12 (24%) were open. Based on the classification of Tscherne, the soft tissue injury attained in the closed fractures were thirty (78.9%) of grade 0, 6 (15.8%) of grade I and 2 (5.3%) of grade II. Of the open fractures, there were 8 (66.7%) grade I, and 4 (33.3%) grade II open fractures. All of the fractures were classified according to the diaphyseal classification of Winquist[16] (Table II). In the closed fractures, 8 were type I, 6 were type II,12 were

**Table III**
**Type of Locking**

| | No. of Proximal Screws | No. of Distal Screws | No. of Patients |
|---|---|---|---|
| Static | 2 | 2 | 4 |
| | 1 | 1 | 31 |
| | 1 | 2 | 5 |
| | 2 | 1 | 4 |
| Dynamize | 2 | 0 | 4 |
| | 0 | 2 | 2 |

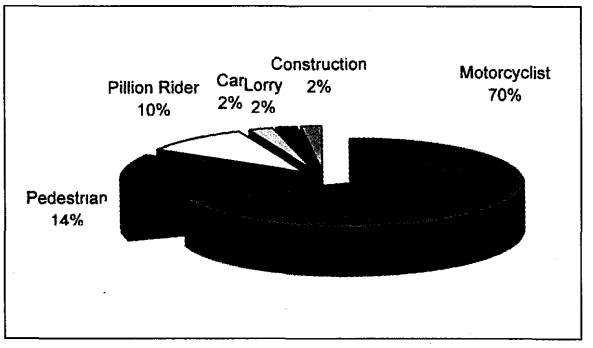


**Fig. 1: Mechanism of Injury.**

**Table IV**
**Functional Results Following Tibial Interlocking Nail**

| | | No. | % |
|---|---|---|---|
| Excellent | Full knee and ankle motion<br>No muscle atrophy<br>Normal radiographic alignment | 31 | 62 |
| Good | Slight loss of knee or ankle motion<br>Less than 2cm of muscle atrophy<br>Angular deformity less than $5^0$ | 16 | 32 |
| Fair | Moderate ($25^0$) loss of knee or ankle motion<br>More than 2cm muscle atrophy<br>Angular deformities $5^0$ - $10^0$ | 2 | 4 |
| Poor | Marked loss of knee or ankle motion<br>Marked muscle atrophy<br>Angular deformities greater than $10^0$ | 1 | 2 |

**Table V**
**The Complication in Interlocking Nailing of the Tibia**

| | Complication | No. of Patients |
|---|---|---|
| Intraoperative | Small nail | 1 |
| | Iatrogenic fracture | 2 |
| | Missed locking screws | 2 |
| Postoperative | Impending compartment syndrome | 1 |
| | Infection - Superficial | 2 |
| | - Deep | 4 |
| | Anterior knee pain | 3 |
| | Bent locking screw | 1 |

type III and 12 were type IV. In the open fractures, 4 were Winquist type I, 3 type II, 1 were type III and 4 were type IV. Six (12%) of the fractures involve upper third tibia below the tibial tuberosity, thirty-one (62%) at middle third and 13 (26%) occurred at lower third. Three of the patients had their ipsilateral fibula intact. Preliminary calcaneal traction was done in forty-five (90%) patients and the other five were immobilized temporarily on a backslab prior to definite treatment.

Definitive treatment of the fractured tibia with reamed intramedullary interlocking nail was performed within five days post injury in 4 (8%) patients, within three weeks in 38 patients (76%) and after three weeks in 8 patients (16%) (Fig. 4). There were several surgeons and registrar who performed the operation and the duration taken to do the procedure was: within one hour - 13 patients; within one and half hours - 19 patients; within two hours - 10 patients; within two and half hours - 3 patients; within three hours - 3 patients; within three and half hours - one patient; and within four hours- one patients. 44 patients were treated with a static locked nail (88%): 31 tibia were locked with one screw on each side; 4 with two screws on each side; 5 with one screw proximally and 2 screws distally and 4 tibia were locked with two screws proximal and one screw distally. Dynamic locking was used in the remaining 12%. Four patients had proximal locking and two patient had distal locking (Table III). Closed intramedullary nailing

**Table VI**
**The Rate of Infection in Interlocking Nail Tibia**

| Type of # | Classification | | Superficial Infection | | Deep Infection | |
|---|---|---|---|---|---|---|
| | | | No. | % | No. | % |
| Closed | Tscherne | 0 | 0 | | 2 | 5 |
| | | 1 | 1 | 5 | 2 | 5 |
| | | 2 | 1 | 5 | 0 | |
| | | 3 | 0 | | 0 | |
| Open | Gustilo | 1 | 0 | | 0 | |
| | | 2 | 0 | | 0 | |

was performed in 92% of the cases. In only four patients (8%) was the fracture site opened to facilitate nailing. The type of interlocking nail used was Gross-Kempf nail in 7; Russel Taylor in 26; and Biomet in 17. Gross-Kempf nail was used in the early series. The average stay in hospital after interlocking was 3.4 days.

All fractures were reviewed until union occurred. The overall union rate was 98%. One patient had severe deep infection following nailing which required early implant removal before bone healing. The functional results of the limbs were assessed on clinical examination and radiographic appearance on each follow-up based on the grading by Klemm and Borner (1986) (Table IV). An excellent result was defined as full knee and ankle motion, no muscular atrophy and anatomic alignment of the fracture radiographically. To be graded good there had to be only slight loss of knee or ankle motion, less than 2cm of muscular atrophy and angulatory deformities radiographically of less than five degrees. A fair result meant that there was at least 25 degree loss of knee or ankle motion, more than 2 cm of calf atrophy, and angulation in any plane between 5 degrees and 10 degrees. A poor result is when there was marked loss of knee or ankle motion, marked muscle atrophy and angular deformities greater than 10 degrees. Excellent or good results were obtained in 93% of these patients. Four percent of the patients were judged fair and one patient (2%) was deemed to have a poor result or failure.

Partial weight bearing are allowed on the patients on the average of fifty days after operation (7 days to 3 months) depending on the degree of comminution and stability of fixation. The average time for full weight bearing is seventy-five days (range from 45 days to 5 months). Patients regained their full range of movement of knee and ankle in the average of fifty-eight days (seven days to 6 months). One patient had markedly reduced movement of knee and ankle with wasting of quadricep and hamstring muscles because of prolonged stay on bed because of the management of his associated open grade IIIA of ipsilateral femur. Three patients had shortening of 0.5 to 1.0cm and one patient had shortening of 2.0 cm. This patient had an ipsilateral fracture of femur which was treated with simple intramedulary nail. There are three patients who had wasting of calf muscle which is less than 1.0cm. The average time to return to normal activities or work is 173 days (6 months).

Intraoperative complications developed in six patients (12%) following tibial interlocking nail (Table V). In one patient who had type IV comminution, the implant was considered unstable, which required a Sarmiento 's cast. The fracture healed in this patient. One patient suspected to develop compartment syndrome following reaming and nailling but there was no neurological symptom. The limb was elevated on Bohler Braun frame with strict observation. The swelling reduced the next day. Iatrogenic diaphyseal shaft fracture occured in one patient following nail insertion. However the nail managed to purchase distally and fracture healed without deformity. Another patient had proximal comminution following insertion of nail. This nail was removed because of severe infection. One screw was out, each from proximal and distal locking on two respective patients but the healing was uneventful.

Two patients developed superficial infection (abscess) at the entry site. Incision and drainage was done and specimen grew beta-Haemolytic Streptococcus (group A) in one patient and the other grew Staphylococcus aureus. He was also given a course of intravenous cloxacillin in ward and follow by oral antibiotic. The wound healed well and the fracture united. One patient had pin tract infection from the previous calcaneal pin, which was debrided and healed. Four patients (10%) had deep infections following nailing (Table VI). All four were closed fractures with type IV comminution and required more than two hours of operation. These patients had frequent debridement with antibiotic coverage according to culture and sensitivity for at least

six weeks and the implant was removed when fracture healing has occurred. The implants were removed nine to ten months after the operation. One of the patient had no discharge ten months later and the other two was still on treatment when this studies was written. One patient had an early removal of the implant (before healing) because of profuse purulent discharge inspite of frequent debridement and prolonged antibiotics. This is the same patient who had proximal comminution following nail insertion. The organism isolated is methicillin-resistant Staphylococcus aureus and was sensitive to fucidic acid and rifampicin. Similar organisms were isolated on subsequent culture after debridement. The tibia underwent osteolysis with persistent purulent discharge and the implant was exposed and loose. It was removed four months later with extensive debridement of avascular bone and devitalised soft tissues. Papineu graft was then incorporated over the bone defect a week later.

Three patients (6%) had anterior knee pain following nailing which became worst on kneeling during pray. They contribute the pain to the entry site of the nail One patient had the distal screw bend at five months post operation which wa removed. The fracture healed well. Two patients had a distraction of the fracture after nailing. No evidence of union was noted at three months. The distal screw was then removed and patients were allowed partial weight bearing (dynamization). The fracture healed uneventfully.

## Discussion

Analysis of our data revealed that the commonest cause of tibial diaphyseal fractures in this series is high-energy trauma following motor vehicle accidents (98%). Only one patient sustained fracture following a fall from a height at construction site. This does not really represent the true incidence of tibial shaft fractures because we only analysed those fractures that was treated operatively with interlocking tibial nail. In the epidemiology study by Court-Brown and McBirnie[19], they advocated that motor vehicle accidents are the commonest cause of tibial diaphyseal fractures with the motorcyclist being the major victims. The second commonest is sport injuries but in our series there is no sport-related tibial fractures who were treated with locking nail because most of them sustained simple fractures which can be treated by other method. Majority of our patients are young, active male. There are only two female. More than 90% of the injured patients were motorcyclist which involved in a motor-vehicle accident and sustained severe comminution shaft fracture of Winquist type II and above (96%). Twenty-two patients (44%) sustained other injuries following this high-energy trauma. Only open fractures of Gustilo grade I and II were treated with locking nail. Grade III open fractures were better stabilised with external fixator because of the severe soft tissue injuries.

Since this is a retrospective studies, it was difficult to determine the mean union time for the fractures following reamed locked intramedullary tibial nailing because the patients are not sequentially follow-up. However, the information that was gained from the clinical records and radiographic findings, noted that 49 out of 50 patients (98%) which was evaluated showed clinical and radiological union by the end of their follow-up. One patient had a severe deep infection with no sign of union that required nail removal at four months. There was no bone grafting required in this series, even for severe diaphyseal comminution fractures (Winquist type III, IV and IV). There was no non-union.

Thirty-eight (76%) of the tibial shaft fractures were fixed with interlocking nail within 5 to 21 days. There are 8 fractures, which were fixed with nail after three weeks.

These were open fractures, which required soft tissue healing prior to reaming and nail insertion. The nailing was done after soft tissue swelling had subsided and also in our set-up it depends on the availability of the operating time. According to Court-Brown *et al.*[20] the proper timing for intramedullary nailing of the tibia has not been clearly established, even for closed fractures. In the multiple injured patients, acute reamed tibial nailing is particularly applicable, and it has been used safely within the initial 24 hours after injury[21]. However, Bone and Johnson[22] and Donald and Seligson[23] have recommended that it is better to delay nailing for three to five days in patients with isolated closed tibial fractures. This delay allows for the acute swelling to subside and decreases the haematoma at the fracture site and this will reduce the development of compartment syndrome after reaming and nailing. Immediate open nailing of Gustilo grade III open fractures with reamed nails has a high rate of infection and is contraindicated[24].

Closed nailing was performed in 92% of the patient and only four required open nailing because of difficulty in reduction. Three fractures were closed fractures and the other was open. The healing process for all the fractures was uneventful. Chapman[24], documented that closed intramedullary nailing is superior to open intramedullary nailing, particularly in the presence of an open fracture. In his review of 1499 closed intramedullary nailing of lower limbs long bones, he found that the infection rate averages 0.4% and the rate of nonunion was 1%. In compare to 1950 long bone fractures treated by open intramedullary nailing, the deep infection rate averaged 3.2%, which is four times the rate in closed nailing. The infection problem is worse in open nailing of open fractures, where the average infection rate was 17.7% in his series. Open nailing showed a nonunion rate of 2.1%, which is ten times that in closed nailing.

Eighty-eight percent of the patients had static interlocking with 31 was locked with one screw both proximal and distal to the fracture. Four patients were locked with two screws, proximal and distal. Four patients were primarily dynamized distally and two were dynamized proximal. Primary dynamization were performed for fractures with less comminution (Winquist-Hansen I or II). All fractures healed uneventfully except for the patient who had deep infection, which required early removal of nail.

Two screws create a more rigid construct and are more resistant to fatigue failure. However, this may result in more delayed union or nonunion, as their rigidity prevents the autodynamization that occurs when one screw is used[25]. Lindholm *et al.*[26] advocated that some movement at a fracture site is believed to induce healing by callus formation. Several studies using external fixator which can be modified, to control the amount of movement and force to promote fracture healing. Kenwright *et al.*[27], using a Dynabrace fixator (Richards) with the application of cyclic movements within two weeks from injury gave a 20% improvement in healing rates. De Bastiani *et al.*[7] recommended unlocking the Orthofix fixator at four to six weeks and noted an average healing time of 15.5 weeks for closed tibial fractures. The effects of dynamisation on movement at fracture site can be divided into two different process: in terms of cyclic movement and of progressive movement or closure[28]. Cyclic movement is produced by early weight bearing with the fixator column locked (insitu screw). Progressive movement occurs after unlocking the column (screw remove), and is often associated with a reduction in cyclic movements. Richardson *et al.*[28] postulated that the relatively large cyclic movements may well act as a stimulus to the growth of callus in the early weeks, while increased stability and compression of callus (progressive closure or movement) may be more appropriate stimuli in the later phase of callus maturation.

Locking intramedullary nail of the tibia allows early mobilization of the patients. Only one patient required extra external support (Sarmiento cast) after nailing. Otherwise patients were encouraged to move their knee and ankle once there is no more pain. Excellent and good results of 93% were obtained in this study. This patients had near normal range of movement of the knees and ankles, less than two cm. of muscle wasting and the fracture healed with no varus or valgus angulation or rotational malalignment greater than 5 degrees or shortening of greater than 1cm. The mean time to attained full range of movement of the knee and ankle is 8.4 weeks. This constitutes 92.5% of the patients, which is comparable to 89.6% of the patients in six weeks in Court-Brown[20] series.

The average time for hospitalization after operation is 3.4 days. They were discharged after complete antibiotic and physiotherapy treatment. The actual time of stay in the hospital after injury were not able to assess because most of the cases were operated as elective procedure. The time to allow patients to weight bear is taken cautiously. This depend on the degree of fracture comminution and stability of fixation. Seventy percent patients had severe comminution diaphyseal fractures (Winquist type III to V). Immediate weight bearing was allowed on twelve patients after operation and by the average time of 7.1 weeks, all patients were on weight bearing with crutches (partial weight bearing). One patient with Winquist type IV, had a bent distal screw following early weight bearing and the screw was removed when union occurred. The mean time for full weight bearing without crutches was 10.7 weeks. The increased mobility provided by nailing facilitates return to full activities and to work. The average time taken for a patient to return to work in this series was 24.8 weeks (6 months). They were back to work only when clinical and radiological

union was attained. In comparison to 14.3 weeks in Court-Brown[20] series, the returning to full activities is allowed even before clinical union is observed.

The infection rate in our series was 4% superficial infection and 8% deep infection. This rate is high in comparison with others series. There was no infection in our open tibial fractures (Gustilo type I and II) who had undergone delayed nailing. We didn't do primary nailing for open tibial shaft fractures because of the inavailability of the instruments in the casualty department and at the same time the turnover of patients in the casualty was high. So most of open fractures were debrided initially, put on calcaneal traction and covered with antibiotics for at least two weeks. Delayed nailing was attempted when the wound healed after secondary suturing or skin grafting.

Three patients had anterior knee pain following nailing of the tibia. This pain was aggravated with kneeling. It is a troublesome problem in our community because kneeling is required in daily activities such as praying and certain occupation. Orfaly *et al.*[29] had found that sixty-one of the 107 patients (56%) developed anterior knee pain in the area of nail insertion. When a paratendinous insertion had been used 33 of 65 fractures (51%) were associated with subsequent knee pain. When nail insertion was through the patella tendon 28 of 36 knees developed pain. He documented that the use of a patellar-tendon-splitting approach for nail insertion was associated with a much higher risk of subsequent anterior knee pain and advocated that a paratendinous approach helps to reduce this symptoms. This probably explained the low incidence of anterior knee pain (5%) in this series as all of our patients had a paratendinous approach for the nail insertion. Hardy[30] had documented that the pain may be corresponded to the shortening of the patella tendon, which is known to occur after surgery to the knee or neuroma formation in the scar. Court-Brown[20] had found that the anterior knee pain is usually abolished by removing the nail although relief took several months to occur in some of his cases. However, Orfaly *et al.*[29] had noted that the response to nail removal was unpredictable. Only 45% of his patients had complete relief after nail extraction. In our patients with anterior knee pain following nailing, they were given analgesia and physiotherapy to relief the pain.

Iatrogenic fracture of the tibia occurred in two patients during nail insertion. One had a crack fracture of the shaft, which was not displaced. The other had a proximal comminution, which displaced but the nail was able to push through the fracture and locked both proximal and distal. This proximal comminution can be avoided according to Court-Brown *et al.*[20] by flexing the knee to at least 90 degrees. There are no bend or broken nail in our series. However there was one patient who had a bent distal screws. This patient had open fracture type I with Winquist comminution type IV. He had one locked screw on each side of the fracture and was on early full weight bearing (a month post-nailing). Kneifel and Buckley[25] did a study to compare one versus two distal locking screws in tibial fractures treated with interlocking nail. Fifty-nine percent of his patients had a screw failure with one distal screw as compared to two distal screws (5%). They found that screw failure occurred more often in heavier patients and usually between six and twelve weeks. Others factors that contribute to screw failure are numbers of screw used, statically versus dynamically locked nails and the fracture pattern and degree of comminution. Proximal screw failure was seen in 17% of his patients and this failure occurred more often with two distal screws. This is believed to be caused by a single screw acting as the weakest point in the nail construct. The high incidence of screw failure is due to early full weight bearing (6 weeks post-operation). Fracture healing did well inspite of screw failure and this complication was only important when hardware removal was considered.

## Conclusion

This study showed that reamed intramedullary interlocking nail is efficacious in the treatment of closed unstable, comminuted tibial diaphyseal fractures. Delayed nailing (at least three weeks after injury) is a safe technique for open grade I and II. The nail allows healing of these fractures with 98% union encountered in the series. This is comparable with results of others studies. Nailing allowed shorter hospitalisation with early regain of function and return to work. The complications following this procedure were low in this study.

## References


1. Ellis H. The speed of healing after fracture of the tibial shaft. 3. Bone Joint Surg. 1958; 40B: 42-6.
2. Haines JF, Williams EA, Hargadon ES, Davies DRA. Is conservative treatment of displaced tibial shaft fractures justified? 3. Bone Joint Surg. 1984; 66B: 84-88.
3. Kay L, Hansen BA, Raaschou HO. Fractures of the tibial shaft conservatively treated. Injury 1986; 17: 5-11.
4. Oni OOA, Hui A, Gregg P3. The healing of closed tibial shaft fractures: the natural history of union with closed treatment. J. Bone Joint Surg. 1988; 70B: 786-90.
5. Austin RT. The Sarmiento tibial cast: a prospective study of 145 fractures. Injury 1981; 13: 10-22.
6. Digby JM, Holloway GMN, Webb 3K. A study of function after tibial cast bracing. Injury 1982-83; 14: 432-9.
7. De Bastiani G, Aldegheri R, Brivio LR. The treatment of fractures with a dynamic axial fixator. 3. Bone Joint Surg. 1984; 66B: 538-45.
8. Evans G, McLaren M, Shearer JR. External fixation of fractures of the tibia: clinical experience of a new device. Injury 1988; 19: 73-6.
9. Batten RL, Donaldson U, Aldridge MJ. Experience with the AO method in the treatment of 142 cases of fresh fracture of the tibial shaft treated in the UK. Injury 1978; 10; 108-14.
10. Christensen J, Greitf J, Rosendahl S. Fractures of the shaft of the tibia treated with AO-compression osteosynthesis. Injury 1982; 13: 307-14.
11. Ruedi T, Webb 3K, Allgower M. Experience with the dynamic compression plate (DCP) in 418 recent fractures of the tibial shaft. Injury 1976; 7: 252-7.
12. Thunold 3, Varhaug JE, Bjerkeset T. Tibial shaft fractures treated by rigid internal fixation : the early results in a 4-year series. Injury 1975; 7: 125-33.
13. Court-Brown CM, Will E, Christie 3, McQueen MM. Reamed or unreamed nailing for closed tibial fractures: a prospective study in Tscherne Cl fractures. 3. Bone Join Surg. 1996; 78B: 580-3.
14. Klemm KW, Borner M. Interlocking nailing of complex fractures of the femur and tibia. Clin. Orthop. 1986; 212, 89-100.
15. Puno RM, Teynor JT, Nagano 3, Gustilo RB. Critical analysis of results of treatment of 201 tibial fractures. Clin. Orthop. 1986; 212: 113-21.
16. Winquist RA, Hansen ST, Clawson DK. Closed intramedullary nailling. 3. Bone Joint Surg. 1986; 66A: 877.
17. Hausen ST, Winquist RA. Closed intramedullary nailing of the femur. Kuntsher technique with reaming. Clin. Orthop. 1979; 138: 56.
18. Johnson EE, Simpson LA, Helfet DL. Delayed intramedullary nailing after failed external fixation of the tibia. Clin. Orthop. 1990; 253: 251.
19. Court-Brown CM, McBirnie 3. The epidemiology of tibial fractures. 3. Bone Joint Surg. 1995; 77B; 417-21.
20. Court-Brown CM, Christie 3, McQueen MM. Closed intramedullary tibial nailing: Its use in closed and type I open fractures. J. Bone Joint Surg. 1990; 72B: 605-11.
21. Browner BD. Pitfalls, errors and complications in the used of locking Kuntscher nails. Clin. Orthop. 1986; 212: 192.
22. Bone LB, Johnson KD. Treatment of tibial fractures by reaming and intramedullary nailing. J. Bone Joint Surg. 1986; 68A: 877-87.
23. Donald G, Seligson G. Treatment of tibial shaft fractures by percutaneous Kuntscher nailing: Technical difficulties and a review of 50 consecutive cases. Clin. Orthop. 1983; 178: 64.
24. Chapman MW. The role of intramedullry fixation in open fractures. Clin. Orthop. 1986; 212: 26-33.
25. Kneifel T, Buckley R. A comparison of one versus two distal locking screws in tibial fractures treated with tibial nails: a prospective randomized clinical trial. Injury 1996; 27: 271-73.
26. Lindholm RV, Lindholm TS, Toikkanen S, Leino R. Effect of forced inter-fragment movements on the healing of tibial fractures in rats. Acta. Orthop. Scand. 1970; 40: 721-8.
27. Kenwright J, Richardson JB, Cunningham JL. Axial movement and tibial fractures: a controlled randomised trial of treatment. J. Bone Joint Surg. 1991; 73B; 654-9.
28. Richardson JB, Gardner TN, Hardy JRW, Evans M, Kuiper JH, Kenwright 3. Dynamisation of tibial fractures. 3. Bone Joint Surg. 1995; 77B: 412-6.
29. Orfaly R, Keating JF, O'Brien P3. Knee pain after tibial nailing: Does the entry point matter? (Brief reports) J. Bone Joint Surg. 1995; 77B: 976-77.
30. Hardy JRW. Knee pain after tibial nailing. (Correspondence) 3. Bone Joint Surg. 1996; 78B: 510.

TRAUMA

# Proximal Third Femoral Shaft Fractures in Children: Prevention of Angular Deformities Using Bilateral Thomas Splints

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**Summary**

This is a prospective study to look at the outcome of unilateral proximal third femoral shaft fractures in children treated with a bilateral Thomas splint in the Department of Orthopaedic Surgery Universiti Kebangsaan Malaysia between the period of January 1996 and June 1998. Eighteen children aged between 2 years and 12 years old with unilateral proximal third fractures of the femoral shaft were treated using a bilateral Thomas splint. Angular deformities were measured using a goniometer metric scale before and after Thomas splints. The percentage of varus tilt corrected ranged from 17% to 72% with an average correction of 29% from the initial deformity and the difference was statistically significant ($p<0.05$). The percentage of posterior tilt corrected ranged from 19% to 60% with the average correction of 20% from the initial deformity. The difference was statistically significant ($p<0.05$). From this study, we conclude that bilateral Thomas splints can give a better correction of angular deformity for proximal third femoral shaft fractures in children below twelve years of age.

*Key Words:* Proximal third femoral shaft fracture, Children, Angular deformity and Bilateral Thomas splints

## Introduction

Fractures of the femur were first treated by closed minipulation and immobilization in a single hip spica by Harvey Cushing in 1898 at the Johns Hopkins Hospital[1]. The traditional method of treatment for fracture of the femoral shaft in a child has been to use traction in hospital for the four to six weeks until the fracture has healed[2].

Other methods of treatment with satisfactory results have been obtained with Bryant's method, longitudinal skin traction, Russel traction, 90 - 90 skeletal traction, immediate or subsequent hip spica, double spica cast, and cast bracing[3,4,5,6].

The treatment of choice for femoral shaft fracture in children at the Universiti Kebangsaan Malaysia is a sliding longitudinal skin traction combined with a Thomas splint, followed by applying a spica cast after about 2 weeks when the fracture is sticky. The spica cast will be removed when solid union has occured.

Due to the effect of muscle pull (the iliopsoas, abductors and short external rotators) which are attached on the proximal fragment, proximal third fractures require a position of flexion, abduction and external rotation. This position can be achieved from a sliding skin traction combined with a Thomas splint applied to the affected leg.

We realized that young children, tend to align their body in the line of traction; as a consequence the optimal position will not be maintained. In order to prevent this, we applied another Thomas splint over the normal leg without traction, to maintaining both limbs in abduction.

A full-length anteroposterior and lateral radiograph were taken before and after bilateral Thomas splints were applied and the change in angulation was analyzed. Once there is evidence of good callus formation, usually after an average of 10 to 14 days, a single hip spica cast was applied, another radiograph was taken and the patient can be discharged if the alignment was satisfactory. Further assessment will be continued during their follow up at the clinic as an outpatient.

The aims of the study are:

1. to analyzed the degree of angular deformity (varus-valgus / anterior-posterior) before and after bilateral Thomas splints.
2. to identify possible treatment-related complications that may occur by using bilateral Thomas splints.
3 to assess the degree of deformities during the final follow up (at an average of one year) such as angular deformity, limb length discrepancy, femoral torsion deformity and stiffness if any.

## Materials and Methods

This study is a prospective descriptive analysis of children below 12 years old, admitted to the paediatric orthopaedic unit, UKM from January 1996 to June 1998. All children below 12 years old were included in the analysis if they sustained fracture of the proximal third of the femoral shaft.

They received initial treatment with unilateral longitudinal traction using Thomas splint (n=18). Mean age was 6 years 6 months. There were 13 male and 5 female. None of the children had underlying bone disease or chronic diseases. 13 patients were involved in motor-vehicle accidents and 5 patients had a fall. The following were analysed; sex, age at injury, type of fracture, associated injuries, mechanism of injury and duration of unilateral and bilateral splinting.

All the fractures involved the proximal third of the femoral shaft, and the major direction of tilt of the distal fragment was varus in 16, in valgus in 2, anterior in 4 and posterior in 14.

All patients had been initially treated with longitudinal traction using Thomas splints whereby fifteen patients used skin traction and three patients used low tibial pins for a few days (mean, 4 days) followed by application of another Thomas splint. The average duration for patients on unilateral splint was 4 days while a bilateral splint was 14 days.

Clinical disability and abnormality of alignment were assessed and serial full-length AP and lateral radiographs were taken in each patient. Any shortening and angulation caused by the actual fracture was measured from the routine AP and lateral radiograph using a goniometer and metric ruler before and after bilateral Thomas splints were applied. The differences in the degree of angulation (varus-valgus and anterior-posterior angulation) before and after bilateral Thomas splints were recorded for analysis.

When there was evidence of callus formation and the fracture was sticky, unilateral hip spica cast was applied. The patients were discharged a day after application of the cast, but associated injuries can prolonged their hospital stay.

Associated injuries included one closed head injury, two long bone fractures (tibia and fibula), one pelvic fracture, one fracture of the clavicle, one skull fracture, and one degloving injury of the right thigh with skin loss.

Radiographs were obtained on each visit to the orthopaedic clinic until union occurred. Once union had occurred, the spica was removed and patient was referred to physiotherapy for active and passive exercises of the affected limb. At subsequent visits or final follow up (average 7 months) any limb length discrepancy, measured in supine, position were recorded, hip and knee range of movement were assessed and recorded, and the gait was analyzed clinically.

Rotational deformity was assessed clinically during follow up. The patient examined in prone position with hip extended. No patient had a difference in rotation of more than 15 degrees between the two sides.

## Results

Eighteen proximal third femoral shaft fractures in children aged between 2 and 11 years 8 months were treated initially with longitudinal traction using a Thomass splint (15 on skin traction and 3 skeletal traction) followed by application of another Thomas splint to the opposite limb.

There were 13 males and 5 females; 10 cases involved the right femur and 8 involved the left femur. There were 9 transverse, 3 oblique, 1 spiral and 5 comminuted fractures. All were closed fractures. Thirteen patients were involved in a motor vehicle accident. They were hit by a car or were passengers in a vehicle. Five had a falls.

The average period a patient was on unilateral traction was 4 days, while on bilateral Thomas splint was another 14 days. The average total duration of splinting was 18 days. The average hospital stay was 20 days. The average time spent in the spica cast was 52 days.

Associated injuries includes fractured the tibia (2), fibula fracture (1), head injury (1), skull fracture (1), fracture clavicle (2), degloving injury of the right thigh with skin loss (1) and fracture pelvis (1).

All the fractures involved the proximal third of the shaft, and the major direction of tilt of the distal fragment was varus in 16, valgus in 2, anterior in 4, and posterior in 14.

The amount of varus angulation on unilateral splints and bilateral splints and the percentage correction achieved are shown in Table I.

The amount of valgus angulation on unilateral splints and bilateral splints and the percentage correction achieved are shown in Table II.

The amount of posterior angulation on unilateral splints and bilateral splints and the percentage correction achieved are shown in Table III.

The amount of anterior angulation on unilateral splints and bilateral splints and the percentage correction achieved are shown in Table IV.

The average percentages of correction of angular deformity after bilateral Thomas splints are shown in Table V. On average we found that varus tilt of the distal fragment had corrected by 29%, valgus tilt 0%, anterior tilt by 13% and posterior tilt by 20%.

In 5 femurs with varus angulation, there had been no discernible change in angulation at the fracture angle. This could be due to the varus deformity that had already been corrected by the unilateral splint to an acceptable degree or the original varus angulation was minimal that further correction using bilateral Thomas splints was not very significant. Most of the patients under this category had original varus angulation between 5 to 10 degrees.

In this study of eighteen children who had had a closed proximal third fracture of the femoral shaft and were treated with bilateral Thomas splint, all fractures healed without significant sequelae. No complication involving limitation of function was recorded at final follow-up. The ranges of motion of the hip and the knees were full and symmetrical. There was no significant rotational deformity recorded, except for two patients who had slight rotational deformities, which was less than 10 degrees. A limb-length discrepancy found at final follow-up (averange 1 year) was between 1 - 1.5cm.

## Discussion

Since as early as the 18th century, traction has been used for management of femoral fractures in children. In 1861, Buck introduced simple horizontal traction. Vertical overhead traction with the hip flexed 90 degrees and the knee straight was introduced by Bryant in 1873, but this often resulted in vascular insufficiency, and it is now rarely used for treatment of femoral fractures, except occasionally in infants younger than 2 years of age and weighing less than 20 pounds. Modified Bryant's traction, in which the knee is flexed 45 degrees, increases the safety of overhead skin traction.

**Table I**
**Varus Angulation**

| Patients Age (yr) | Unilateral Splint (degrees) | Bilateral Splint (degrees) | Difference (degrees) | Percentage of Correction (%) |
|---|---|---|---|---|
| A (3 yrs) | 27 | 12 | 15 | 55 |
| B (6 yrs) | 10 | 10 | 0 | 0 |
| D (6 yrs) | 12 | 10 | 2 | 17 |
| E (9 yrs) | 18 | 5 | 13 | 72 |
| F (9 yrs) | 10 | 10 | 0 | 0 |
| H (6 yrs) | 30 | 20 | 10 | 33 |
| I (2 yrs) | 10 | 5 | 5 | 50 |
| J (2 yrs) | 30 | 30 | 0 | 0 |
| K (11 yrs) | 15 | 10 | 5 | 33 |
| L (3 yrs) | 5 | 5 | 0 | 0 |
| M (3 yrs) | 10 | 10 | 0 | 0 |
| N (11 yrs) | 10 | 5 | 5 | 50 |
| O (6 yrs) | 10 | 5 | 5 | 50 |
| P (2 yrs) | 42 | 30 | 12 | 28 |
| Q (8 yrs) | 20 | 15 | 5 | 25 |
| R (7 yrs) | 20 | 10 | 10 | 50 |

**Table II**
**Valgus Angulation**

| Patients Age (yr) | Unilateral Splint (degrees) | Bilateral Splint (degrees) | Difference (degrees) | Percentage of Correction (%) |
|---|---|---|---|---|
| C (7 yrs) | 10 | 10 | 0 | 0 |
| G (9 yrs) | 10 | 10 | 0 | 0 |

**Table III**
**Anterior Angulation**

| Patients Age (yr) | Unilateral Splint (degrees) | Bilateral Splint (degrees) | Difference (degrees) | Percentage of Correction (%) |
|---|---|---|---|---|
| F (9 yrs) | 10 | 5 | 5 | 50 |
| H (6 yrs) | 5 | 5 | 0 | 0 |
| I (2 yrs) | 5 | 5 | 0 | 0 |
| N (11 yrs) | 5 | 5 | 0 | 0 |

**Table IV**
**Posterior Angulation**

| Patients Age (yr) | Unilateral Splint (degrees) | Bilateral Splint (degrees) | Difference (degrees) | Percentage of Correction (%) |
|---|---|---|---|---|
| A (3 yrs) | 36 | 25 | 11 | 30 |
| B (6 yrs) | 10 | 10 | 0 | 0 |
| C (7 yrs) | 15 | 15 | 0 | 0 |
| D (6 yrs) | 15 | 15 | 0 | 0 |
| E (9 yrs) | 16 | 12 | 4 | 25 |
| G (9 yrs) | 5 | 5 | 0 | 0 |
| J (2 yrs) | 20 | 10 | 10 | 50 |
| K (11 yrs) | 10 | 5 | 5 | 50 |
| L (3 yrs) | 5 | 5 | 0 | 0 |
| M (3 yrs) | 10 | 10 | 0 | 0 |
| O (6 yrs) | 10 | 4 | 6 | 60 |
| P (2 yrs) | 37 | 30 | 7 | 19 |
| Q (8 yrs) | 16 | 10 | 6 | 38 |
| R (7 yrs) | 5 | 5 | 0 | 0 |

**Table V**
**The Average Correction of Angular Deformity After Bilateral Splints**

| Angular Deformity | Average Percentage of Correction |
|---|---|
| Varus (16) | 29% |
| Valgus (2) | 0% |
| Anterior (4) | 13% |
| Posterior (14) | 20% |

**Table VI**
**Paired Samples Test**

| Variables | T | P |
|---|---|---|
| Varus-Valgus Angulation | 3.346 | 0.004 |
| Anterior-Posterior Angulation | 4.001 | 0.001 |

*p<0.05*

When the femoral fracture is just distal to the trochanters, the muscle inserted into the proximal fragment, particularly the iliopsoas and the glutei, pull it into a position of flexion, external rotation and abduction. Therefore, in order to obtain correct alignment of the fracture fragments, continuous traction must be so arranged as to bring the distal fragment up to and in line with the proximal fragment.

This corresponded to our data in which 16 patients had varus tilt and 14 patients had posterior tilt. The largest angulation that we recorded was from a 2 years old child, a pedestrian who was hit by a car and sustained a simple transverse proximal third femoral shaft fracture. She presented with 42 degrees varus tilt and 37 degrees posterior tilt.

On average, varus tilt had corrected by 29% and posterior tilt by 20% after bilateral Thomas splint. This was statistically proven by paired samples test in which the differences of correction was significant (TableVI) ($p < 0.05$).

We do not believe, however, that rotation played a significant role. We did not measure rotation at fracture union, but found that the radiological angular deformity at fracture union was always maximal in one plane; either varus, valgus, anterior or posterior tilt. Hagglund *et al*[8]

has shown that at initial union after treatment by skin traction, rotational deformity never exceeded 20 degrees.

In view of the fact that normal persons show significant differences in rotation between left and right, the question arises whether exact correction of rotational deformities is really necessary.

Our patients were all treated by longitudinal skin or skeletal traction followed by bilateral Thomas splint and unilateral hip spica at union. Our clinical findings at follow up of a difference of rotation between the two sides of less than 15 degrees is within the normal physiological range[7].

However, rotational deformities of over 20 degrees are usually clinically obvious by the abnormally rotated position of the knee and foot during walking. Owing to the abnormal position of the joints and forced compensatory mechanism, fatigue and pain may occur[1].

## Conclusion

On average, varus tilt had corrected by 29%, posterior tilt by 20%, anterior tilt by 13%. At final follow up (1 Year), the average residual angular deformities in varus was 10 degrees, in posterior was 8 degrees. Only two patients had limited external rotation of 30 degrees. Average limb length discrepancy measured during final follow up was 0.6cm. Our study showed that bilateral Thomas splints give better correction of angular deformities then unilateral splint for proximal third femoral shaft fractures in children below twelve years of age.

## References


1. Dameron, T.B. and Thomson, H.A.: Femoral shaft fractures in children. Treatment by closed reduction and double spica cast immobilization. J Bone and Joint Surg. 1959; 41: A, (7): 1201-12.
2. Shapiro F.: Fractures of the femoral shaft in children: the overgrowth phenomenon. Acta Orthop Scand 1981; 52: 649-55.
3. Griffin, P.P.: Fractures of the femoral diaphysis in children. Orthop. Clin. North America, 1976; 7: 633-38.
4. Sugi, M. and Cole, W. G.: Early plaster treatment for fractures of the femoral shaft in childhood. J Bone and Joint Surg. 1987; 69: B, (5), and 743-45.
5. Scott, John; Wardlaw, Dauglas; and McLauchlan, James.: Cast bracing of femoral shaft fractures in children: A prelimanary report. J. Pediatr. Orthop. 1981; 1: 199-201.
6. Spinner, Morton; Frenndlich, B. D. and Miller I. J.: Double-spica technique for primary treatment of fractures of the shaft of the femur in children. Clin. Orthop. 1967; 53: 109-14.
7. Brower, K.J. Molenaar, J.C. Van Linge, B: Rotational deformities after femoral shaft fractures in childhood: a retropective studies 27 - 32 years after the accident. Acta Orthop Scand. 1981; 52: 81-89.
8. Hagglund, G. Hansson, L. I. Norman, O.: Correction by growth of rotational deformity after femoral fracture in children. Acta Orthop Scand. 1983; 54: 858-61.

# Total Hip Arthroplasty in Malaysia - The Universiti Kebangsaan Malaysia and Hospital Kuala Lumpur Experience

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## Summary

The results of 109 primary total hip arthroplasties in 92 patients performed in Hospital Kuala Lumpur from January 1987 to December 1996 were reviewed after a mean follow-up of 30.8 months. There were 22 males and 70 females with the average age of 49.9 years (range 19 to 94 years). Chinese females comprised the largest group of patients (52.2%). Avascular necrosis was the most common diagnosis (33.1%) followed by hip dysplasia and primary osteoarthritis (17.4%). The procedure was performed more on the right hip (64.2%) compared to the left (35.8%). All patients received prophylactic antibiotics but none were given deep vein thrombosis prophylaxis. The Charnley prosthesis was most commonly used and the majority of the arthroplasties were cemented (60.5%). About 80% of the THA were performed via the lateral approach. The functional hip score improved from an average of 8.9 to 15.0 with 66.3% of the patients categorized as good and excellent results. There were 16 patients (17.4%) with poor outcome. The most common complications encountered were dislocation (10.1%), aseptic loosening (9.2%) and periprosthetic fracture (5.5%). Other complications were deep infection (1.8%), deep vein thrombosis (0.9%), trochanteric osteotomy complications (1.8%), superficial infection (7.3%), urinary tract infection (5.5%), pressure sore (3.7%) and respiratory complication (1.8%). Fifteen hips (13.8%) required revision. The causes for revision were aseptic loosening, dislocation and infection. Technical anomalies were recognized as one of the factors contributing to poor results. Five-year survival rate was 87.3%. Better results can be expected with increasing experience and technical skulls.

*Key Words:* Total hip arthroplasty (THR), Primary and Revision

## Introduction

The history of total hip arthroplasty (THA) dated back to 1938 when it was performed in the Middlesex Hospital, London and reported in 1958[1]. However, it was not until the 1960s when significant progress was made. The late Sir John Charnley, who is widely regarded as the father of the modern hip replacement surgery, made invaluable contributions which include the use of acrylic cement for fixation of the components, the introduction of the body-exhaust system and laminar airflow to reduce infection rate. He developed the concept of low-friction arthroplasty and reported his results in 1972[2].

Over the years, THA became a commonly performed procedure in the developed countries. Different types of prostheses, techniques of fixation and surgical approaches have been used. The literature on hip replacement surgery is enormous. With the availability

of long-term results, more problems have been identified and some of them remain unresolved, particularly the problem of wear and loosening despite continuous efforts to improve on the characteristics of prosthetic material, design and methods of fixation.

In Malaysia, it is believed that the first THA was performed in the University Hospital in 1969[3]. For the past three decades, this surgery has been performed with increasing frequency and in the process, more experience and skill have been acquired. The Joint Replacement Unit (JRU) of the Orthopaedic Department (Kementerian Kesihatan Malaysia) was established in 1993 in Hospital Kuala Lumpur handling all the total replacement of the hip and knee. Functioning under the same roof, the Orthopaedic Department of Universiti Kebangsaan Malaysia has also been active in joint replacement surgery. A study was conducted to review retrospectively the results and complications of the primary THA that were performed in Hospital Kuala Lumpur by these two departments over a period of 10 years from January 1987 to December 1996.

## Materials and Methods

From January 1987 to December 1996, a total of 162 primary total hip arthroplasties in 142 patients (20 bilateral cases) were performed in the Hospital Kuala Lumpur by both the Orthopaedic Department of Universiti Kebangsaan Malaysia (UKM) and the Orthopaedic Department of Kementerian Kesihatan Malaysia (KKM). Out of these, the records of 114 patients (133 hips) were available from the Record Department. Twenty-two patients (24 hips) were excluded due to incomplete records of insufficient duration of follow-up (less than 12 months). There were thus 92 patients with 109 hips left for this study including 17 bilateral case. This figures represented 67.3% the 162 primary THA that were performed during the ten years period. The number of primary THA performed over these ten years is depicted in Figure 1.

There were 22 (23.9%) male and 70 (76.1%) female patients. More than half of the patients was Chinese (52.2%). Malays (28.3%), Indians (15.2%) and other races (4.3%) followed this. Chinese females comprised the largest group (45.6%). The age of the patients

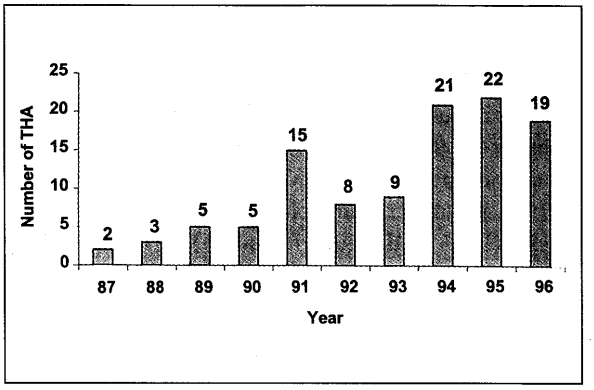


**Fig. 1: Number of THA according to year.**

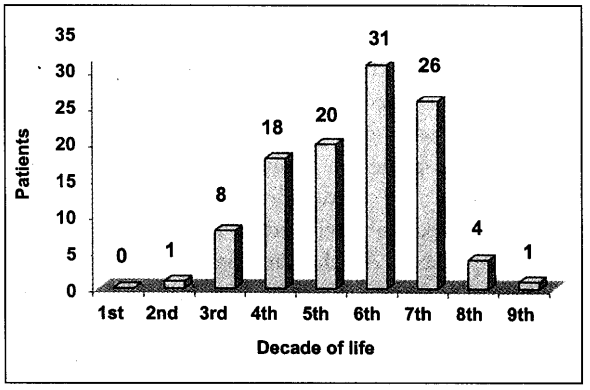


**Fig. 2: Distribution of patients according to decade of life.**

ranged from 19 to 84 years (average 49.9 years). Of the 109 THA performed, 43.1% were in-patients below 50 years old and 56.9% in those 50 years and above. Surgery was performed for more patients who were in their sixth decade of life (Figure 2).

Seventy (64.2%) THA were performed for the right hip and 39 (35.8%) for the left. The diagnoses of the hips that underwent THA were reviewed by taking into account the clinical features, radiological and intra-operative findings. Degenerative hips with no obvious causative factors were considered as primary osteoarthritis even if other features of primary osteoarthritis such as Heberden's nodes, Bouchard's

nodes and polyarticular involvement were absent. The most common diagnosis was avascular necrosis of the head of femur (33.1%) followed by hip dysplasia and primary osteoarthritis (17.4% respectively), rheumatoid arthritis (13.8%), failed hemiarthroplasty (5.5%), post-traumatic osteoarthritis (4.6%), ankylosing spondylitis (3.7%), juvenile rheumatoid arthritis (1.8%), Perthes disease (1.8%) and pseudarthrosis (0.9%) (Table I).

Of the 36 hips that were diagnosed as avascular necrosis, 17 were steroid induced, 16 were post-traumatic, one occurred after irradiation and the other two were idiopathic avascular necrosis (Figure 3). The duration of follow-up ranged from 12 to 120 months (mean 30.8 months).

All the patients had prophylactic antibiotics given prior to the surgery and continued post-operatively for 3 doses to 5 days. Among the antibiotics used were cefuroxime, cefoperazone, ceftazidime, ceftriaxone and cloxacillin in combination with gentamycin. One patient who was allergic to the penicillin group of antibiotics was given erythromycin. All were administered intravenously. None of the patient reviewed in this study was given DVT prophylaxis. All the surgeries were performed in the general operating theatre in Hospital Kuala Lumpur without body-exhaust system, laminar airflow or ultraclean air system. All surgeries were performed by specialists and assisted by postgraduate orthopaedic trainee and medical officers.

**Table I**
**Distribution According to Diagnosis**

| Diagnosis | Number of Hips | Percentage |
|---|---|---|
| Avascular necrosis | 36 | 33.1 |
| Hip dysplasia | 19 | 17.4 |
| Primary osteoarthritis | 19 | 17.4 |
| Rheumatoid arthritis | 15 | 13.8 |
| Failed hemiarthroplasty | 6 | 5.5 |
| Post-traumatic osteoarthritis | 5 | 4.6 |
| Ankylosing spondylitis | 4 | 3.7 |
| Perthes disease | 2 | 1.8 |
| Juvenile rheumatoid arthritis | 2 | 1.8 |
| Pseudarthrosis of proximal femur | 1 | 0.9 |
| Total | 109 | 100 |

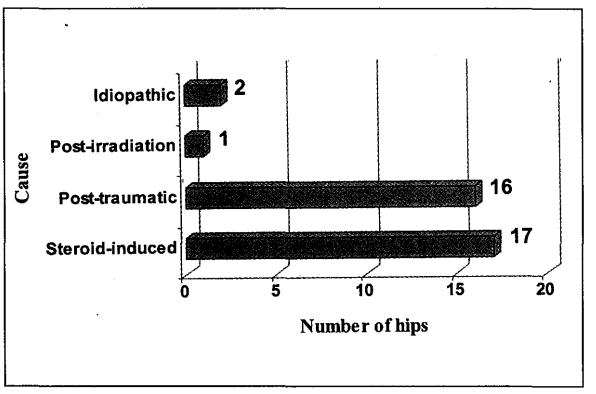


**Fig. 3: Causes of AVN.**

The lateral approach was the most commonly used surgical approach (80.8%). This included the direct lateral, Hardinge, Modified London Hospital and McFarland-Osborne approaches. Transtrochanteric approach was used in 7.3% of the cases. Six cases (5.5%) were operated using the posterior approach including four, which were due to failed hemiarthroplasty.

Cemented THA were performed in 66 hips (60.5%) while cementless THA in 32 hips (29.4%). Cementless acetacular cup with cemented femoral components (hybrid) were performed in 11 hips (10.1%). The Charnley prosthesis was most commonly used (52 hips) followed by PCA and Exeter Hip System (31 and 14 hips respectively). Bone graft was required in 6 cases, all of which were for acetabular deficiency. Blood loss was recorded in 89 cases and this ranged from 400 to 2000 mls (average 839mls). Suction drain was inserted in all cases and in the majority of cases (106 hips), it was removed within 48 hours. In the remaining 3 hips, the drain was removed within 36 hours. The duration of surgery ranged from 120 to 360 minutes (average = 190.9 minutes).

The average hospital stay was 18.4 days (range = 7 to 79 days). The longest stay was registered by a patient who had bilateral hip arthroplasty done 4 weeks apart during which she was not discharged from the hospital. Mobilization of the patients started at an average of 4.3 days after the surgery (range 2 to 51 days). The patient who was mobilized 51 days after the surgery had recurrent dislocation for which he underwent closed

**Table II**
**D'Aubigne and Postel Functional Hip Scoring System**

| Score | Pain | Mobility | Ability to Walk |
|---|---|---|---|
| 0 | Intense and permanent | Ankylosed in bad position | None |
| 1 | Severe even at night | No movement; slight deformity | Only with crutches |
| 2 | Severe when walking; prevents any activity | Flexion < 40° | Only with cane |
| 3 | Tolerable with limited activity | Flexion 40 to 60° | With one cane; < 1 hour; very difficult without cane |
| 4 | Mild with walking; disappears with rest | Flexion 60 to 80° | A long time with cane; short time without cane and limp |
| 5 | Mild and inconsistent; normal activity | Flexion 80 to 90°; abduction at least 15° | Without cane but with slight limp |
| 6 | No pain | Flexion 90°; abduction to 30° | Normal |

**Table III**
**D'Aubigne and Postel Functional Grading of the Hip**

| If Mobility Score = 5 or 6 | |
|---|---|
| **Pain + Walking Ability** | **Functional Grading** |
| 11 - 12 | Excellent |
| 10 | Good |
| 9 | Medium |
| 8 | Fair |
| 7 and less | Poor |

*If Mobility Score - 4, the result is classed one grade lower*
*If Mobility Score - 3 or less. The result is classed two grades lower*

reduction twice and was put on traction for 6 weeks after the second attempt. Generally, in uncomplicated cases, patients who had cemented hip arthroplasty were started weight bearing on the third post-operative day. In the uncemented group and in those who required bone grafting, weight bearing was allowed only after 6 weeks.

Functional results of the hips were assessed with the scoring system described by D'Aubigne and Postel[4] and compared between the pre-operative period and on the last follow-up (Table II and III).

The complications of the THA were recorded and analyzed. This included superficial and deep infection, DVT, pulmonary embolism, dislocation, periprosthetic fracture, greater trochanter complications and others.

Superficial infection is defined as infection that occurs superficial to the deep fascia and this includes wound inflammation, wound discharge and superficial abscess. Deep infections are those that involve the deep fascia and beyond. Deep vein thrombosis and pulmonary embolism were considered to be present if they were diagnosed clinically or by investigations such as Doppler ultrasonography, venogram and ventilation-perfusion scan. However, these investigations were not routinely performed.

Dislocation was classified as immediate if occurs within the first 3 weeks, early if occurs between 3 weeks to 3 months and dislocations after 3 months are classified as late[11]. Classification of periprosthetic fracture as described by Johansson *et al*[5] was used:

| | |
|---|---|
| Type I | Fracture proximal to the tip of the prosthesis with the stem remaining in the canal. These are stable fractures. |
| Type II | Fracture line extended from proximal and to beyond the tip of the stem with the stem dislodged from the canal. These are unstable fractures. |
| Type III | Fractures entirely distal to the prosthesis. |

The post-operative and follow-up radiographs were scrutinized for loosening of the components. Radiolucency around the femoral and acetabular components were recorded according to the zones described by Gruen *et al*[6] and DeLee and Charley[7] respectively. The diagnosis of loosening of the femoral components was made based on the criteria described by Harris *et al*[8]. Definite loosening was defined as the presence of femoral component subsidence, the appearance of new radiolucent line that was not present at the immediate post-operative radiographs and the presence of stem or cement fracture. Loosening of the acetabular component was diagnosed when there was a migration of the cup or a continuous radiolucent line of more than 2mm width[9]. The time when loosening occurred after the surgery was recorded.

Survivorship analysis was done using the method described by Kaplan-Meier[10]. Revision or recommendation for revision was used a end-point.

## Results

### Functional Results

The functional results based on the D'Aubigne and Postel Functional Hip Score improved from a mean of 8.9 pre-operatively to 15.0 on the last follow-up. Pain improved from an average of 2.4 to 5.2, mobility improved from 3.5 to 5.1 and the average score for ability to walk increased from 3.0 to 4.7.

Excellent and good results were achieved in 66.3% of the patients. The outcomes of 16 patients (17.4%) were rated as poor (Figure 4).

In the 16 patients with poor results, two had infected hip where one of them had a Girdlestone procedure done and the other one was awaiting revision.

Four patients had poor general condition due to their primary diseases. One was an end-stage renal failure patient, two were suffering from rheumatoid arthritis with multiple joint involvement and the fourth one was suffering from systemic lupus erythematosus.

Four patients had aseptic loosening of either one or both components. One of them was associated with an acetabular component which was too anteverted. Two

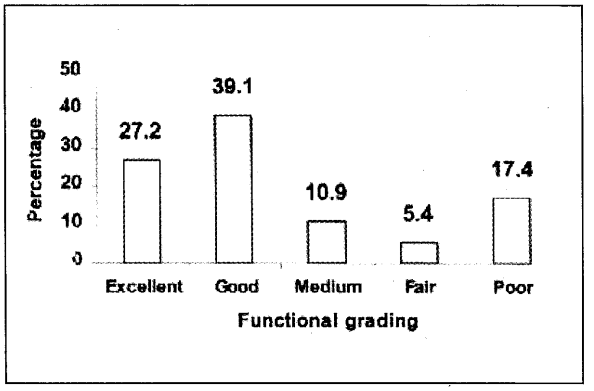


**Fig. 4: Functional results of total hip arthroplasty.**

had their revision surgery done and another two were waiting for revision. All of them had hip pain and only able to walk with aid.

Two had persistent hip pain and limp probably due to greater trochanter non-union. One of them had the primary surgery done via the transtrochanteric approach complicated by non-union of the greater trochanter. She refused further surgery. In the second patient, the greater trochanter was fractured during surgery and wiring was done but resulted in non-union. This was an elderly man (86 years old) and was treated conservatively.

One patient had recurrent dislocation post-operatively secondary to the retroverted femoral component. Closed reduction was done twice with success. She however had hip pain and very limited hip motion. She was wheelchair-bound until her last follow-up 30 months after the surgery.

There were three patients with persistent thigh pain. One of them had generalized osteoporosis. In the other two patients, the thigh pain could not be explained (Table IV).

### Complications

Forty-one THA had one or more complications giving an overall complication rate of 37.6%. This included superficial and deep infection, dislocation, greater trochanter non-union, deep vein thrombosis, periprosthetic fracture, aseptic loosening, pressure sore, atelectasis and urinary tract infection (Table V).

**Table IV**
**Causes of Poor Functional Results**

| Cause | Patients |
|---|---|
| Disabling Primary Disease | 4 |
| Aseptic Loosening | 4 |
| Infection | 2 |
| Greater Trochanter Non-Union | 2 |
| Recurrent Dislocation | 1 |
| Persistent nigh pain | 3 |
| Total | 16 |

**Table V**
**Complications of Total Hip Arthroplasty**

| Complication | Hips | Percentage |
|---|---|---|
| Deep Vein Trombosis | 1 | 0.9 |
| Pulmonary Embolism | 0 | 0 |
| Superficial Infection | 8 | 7.3 |
| Deep Infection | 2 | 1.8 |
| Dislocation | 11 | 10.1 |
| Periprosthetic Fracture | 6 | 5.5 |
| Aseptic Loosening - Acetabular | 7 | 6.4 |
| Aseptic Loosening - Femoral | 6 | 5.5 |
| Trochanteric Osteotomy Complications | 2 | 1.8 |
| Neurovascular Complications | 0 | 0 |
| Pressure Sore | 4 | 3.7 |
| Urinary Tract Infection | 6 | 5.5 |
| Atelectasis | 2 | 1.8 |

### Deep Vein Thrombosis

There was one case (0.9%) with deep vein thrombosis which was diagnosed clinically and treated with intravenous heparin and warfarin. One patient developed difficulty in breathing two days after surgery. Electrocardiogram, venogram and ventilation-perfusion scans were normal. She did not received any treatment for DVT and was well two days after onset of symptoms. Her symptom was thought to be due to ischaemic heart disease rather than pulmonary embolism. There were therefore no documented cases of pulmonary embolism.

### Infection

Deep infection rate was 1.8% (2 hips) and superficial infection occurred in 8 cases (7.3%). One of the patients had persistent hip pain and was unable to weight bear two months after hip replacement surgery. Radiograph showed loosened acetabular cup and the erythrocyte sedimentation rate was raised. She underwent debridement and the prosthesis was removed. Intra-operative swab culture however, did not grow any organism but the diagnosis was made based on the operative findings where there were necrotic tissues and pus in the hip joint. She was awaiting revision surgery.

The second patient had deep infection which was associated with recurrent dislocation and loosening of both the acetabular and femoral components with poor bone stock. The infecting organism was ***staphylococcus aureus***. A girdlestone procedure was performed. All the patients with superficial infection responded to intravenous antibiotics.

### Dislocation

Eleven hips (10.1%) had prosthetic dislocation and 5 of them were recurrent dislocation. All except one were posterior dislocation. Dysplastic hip was the diagnosis in four (36.4%) of them. Ten were immediate dislocations and one was a late dislocation following a fall 8 months after the surgery.

Seven cases of dislocation were associated with technical difficulties during surgery and malposition of prosthetic components. The only case of anterior dislocation occurred in a 60-year-old patient with primary osteoarthritis of the hip. Closed reduction was attempted once but unsuccessful. Open reduction was performed but the hip was unstable after reduction. He was put on hip spica for 6 weeks but dislocation recurred and was later diagnosed to have deep infection. Girdlestone procedure was performed for this patient.

The femoral head size was 22mm in five out of eight (45.5%) of the dislocated hips. The rest (54.5%) were either 26 or 28mm heads.

Only one of these hips was operated using the posterior approach. In this particular case, there was history of previous hip surgery for acetabular fracture. The femoral

component was also noted to be too antevertedly placed. There was no previous hip surgery in the other ten cases.

Closed reduction was attempted in 8 hips. The success rate for closed reduction was 37.5% (3 hips). Two were successful after the first attempt and in another hip, reduction was achieved after the second closed reduction. In 5 hips, closed reduction failed requiring either open reduction or revision. Three patients underwent revision without prior closed reduction since there was clear evidence malposition of the components. All together, 72.7% of the dislocated hips (8 hips) required surgery.

### Periprosthetic Fracture

Periprosthetic fracture occurred in 6 hips (5.5%). One was a post-operative fracture of the femur just distal to the tip of the prosthesis after a fall (Type III). This occurred 5 years after surgery. The fracture was reduced and fixed with Dall-Miles cables and plating.

Five of the fractures were intra-operative and iatrogenic in nature and all of them were of Type I fracture. In two of them, the greater trochanters was fractured during surgery and were fixed with wires. One was united but the other one had non-union with hip pain and limp. He was treated conservatively. One patient had periprosthetic fracture during bilateral THA. On the right side, the lesser trochanter was fractured but later healed without fixation. On the left side, the proximal femur was fractured during reaming and was fixed with cerclage wire. Another patient had fracture of the proximal femur during surgery, which healed with wire fixation.

### Aseptic Loosening

There were 12 hips (11.0%) with aseptic loosening of the components. In nine hips, loosening involved only one of the components and another three, both the femoral and acetabular components were loosened. Apart from these, there were two acetabular cups, which showed evidence of radiolucencies but were not progressive and did not fulfill the criteria of loosening. All together, eight femoral stems and seven acetabular cups were loosened.

Four hips had acetabular loosening alone. These were asymptomatic and required revision. Five hips had femoral stem loosening and three of them were definite loosening and required revision. The other two were classified as possible loosening.

Three hips had loosening of both the femoral and acetabular components. All of them required revision. There were therefore, seven (6.4%) acetabular loosening and six (5.5%) definite femoral loosening in 10 hips (9.2%).

Of the six definite femoral loosening, three (50.0%) were cement less while six out of seven (85.7%) of the loosened acetabular cups were cement less. Two of the acetabular and one of the femoral component loosening were associated with dislocation of the prosthesis.

The mean time for femoral component loosening was 52.5 months (range 1 to 108 months) after the surgery. Half of the loosened femoral component occurred before 5 years. The acetabular cup was loosened after a mean of 46 months after the surgery (range 1 to 108 months). Four out of seven cups (57.1%) loosened before 5 years.

### Trochanteric Osteotomy Complications

Two hips (1.8%) had greater-trochanter non-union complicating trochanteric osteotomy. One was asymtommatic and the other one had pain but refused further surgery.

### Neurovascular Complications

No neurovascular complication was documented in this study.

### Other Complications

There were 4 patients (3.7%) who developed pressure sore. All of them recovered with proper treatment. Two patients (1.8%) had atelectasis who responded to chest physiotherapy. Urinary tract infection occurred in 6 patients (5.5%). All responded to antibiotics therapy.

### Revision

There were 15 hips (13.8%) that required revision surgery including 3 hips, which were in the waiting list (Table VI). Seven acetabular and six femoral components in 10 hips needed revision for aseptic loosening. The average time of 12 cases that underwent revision was 36.2 months from the primary hip replacement.

**Table VI**
**Reasons for Revision Surgery**

| Reason | Hips |
|---|---|
| Aseptic loosening of acetabular component only | 4 |
| Aseptic loosening of femoral component only | 3 |
| Aseptic loosening of both components | 3 |
| Dislocation | 3 |
| Infection | 2 |
| Total | 15 |

In three hips, revision was performed primarily for dislocation. Two out of the three had both the acetabular and femoral component revised. In the other hip, only the acetabular cup which was too anteverted was revised.

Two hips needed revision for infection. One of them had her prosthesis removed and was waiting for revision surgery. A girdlestone procedure was performed for the other patient.

### Survivorship Analysis

Using revision or recommendation for revision as the end-point, the survival rate at 5 years was 87.3% (Figure 5).

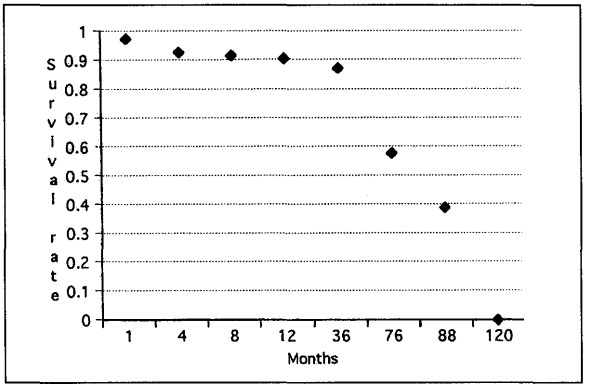


**Fig. 5: Survival curve.**

## Discussion

The average age of the patients in this study was 49.9 years and this was similar to those reported by Museru *et al*[11] and Kim and Kim[9] where the average age were 48.4. In the series by Kwok and Chiu[12] and Matsui *et al*[13], the mean age were 49 years and 50 years respectively. More patients required THA during their sixth decade of life. They were thus younger than those reported in the Western literature where more THA were performed for patients who were in their seventh decade of life[2,14].

Chinese comprised more than half of the patients (52.2%) and 76.1% of the patients were females. Chinese females comprised the largest group (45.6%). This could be partly due to the epidemiology of the primary diseases. In Malaysia, Chinese females had the highest prevalence of systemic lupus erythematosus compared to other ethnic groups[15]. In a survey on rheumatoid arthritis among Taiwan population, Chou *et al*[16] found that this disease affected more females than males. A study on the admission into General Hospital Kuala Lumpur for hip fractures, Lee *et al*[17] reported that out of 191 cases of fracture neck of femur, 55% of them were Chinese and 70% of them were female and Chinese females comprised 39% of the 191 patients. The incidence of primary osteoarthritis in regards to gender and ethnic distribution among Malaysian population is however, unknown.

There is a difference in the diagnoses encountered among the patients who underwent THA in the Western compared to the Asian population. In the Western countries, primary osteoarthritis was the most common diagnosis where it was diagnosed in 42% to 70% of the patients[2,18]. A different pattern was seen in the Asian population where more patients had avascular necrosis of the femoral head compared to primary osteoarthritis. It comprised 40% to 50% of the diagnosis[9,11]. Das De *et al*[19] reported that primary osteoarthritis is rare in Asians since only one out of sixty cadaveric hips that were examined showed unexplained degenerative changes. Therefore it is not surprising that avascular necrosis was the commonest diagnosis (33.1%) in this study. The majority of the avascular femoral head was steroid-induced and post-traumatic.

Over 80% of the primary THA done were via the lateral approach and the Charnley hip system was the most commonly used (52 hips). Almost two-thirds of the THA were cemented. The average hospital stay was 18.4 days. In uncomplicated cases, the patients were usually

discharged after removal of suture at 14th post-operative day. Those with complications generally stayed longer than 2 weeks and this explains the average hospital stay of more than 2 weeks. In most cases, mobilization started within a week after the surgery, usually on the third and fourth day post-operatively. Again, there were several cases with complications that were mobilized late. One of these patient who had recurrent dislocation was mobilized only after 51 days.

The functional results of primary THA have been generally encouraging with good and excellent results in more than 80% of the patients[20,21,22]. Matsui *et al*[13] and Kwok and Chiu[12] reported 100% of good and excellent results while Kim and Kim[9] experienced a slightly lower rate of 91%. In this study, the good and excellent results were achieved in only 66.3% of the patients based on the D'Aubigne and Postel Functional Hip Score. Although D'Aubigne and Postel Functional Hip Score had been shown to be more pessimistic compared to other hips scores[23], this figure is still low compared to the results of Matsui *et al*[13] where the same functional hip score was used. These authors reported 100% of good and excellent results. Pain improved from an average of 1.2 to 5.8, mobility improved from 3.6 to 5.6 and walking ability from 3.0 to 5.5 after 2 years. In our study, pain improved from 2.7 to 4.9 mobility from 3.4 to 5.3 and walking ability from 2.8 to 4.8. Thus, greater improvement was achieved in all the 3 criteria assessed in Matsui's series.

Sixteen (17.4%) of the patients in this study had poor results. In two of these patients, there was malposition of the component leading to loosening in one and recurrent dislocation in another. One patient had symptommatic non-union following iatrogenic fracture of the greater trochanter and two patients had periprosthetic infection. Thus, in theory, there were at least five patients in whom the poor results can be potentially avoided with improved technique and better preventive measures against infection.

The incidence of DVT was 0.9% and no pulmonary embolism was encountered. Kim and Kim[9] reported a DVT rate of about 10% without prophylaxis. Dhillon *et al*[24] who used routine post-operative venogram detected evidence of DVT in 64.3% of the patients who underwent hip replacement. In this study, DVT prophylaxis was not given to any patients. Venogram and Doppler ultrasound were not routinely performed. Therefore, the true incidence of DVT could be higher. The high incidence of DVT reported by Dhillon *et al*[24] have an important bearing on the role of DVT prophylaxis in terms of medico legal aspect which we may need to reconsider.

The infection rate in this study (1.8%) is comparable with those reported in the literature which were generally below 2%[14,11,21]. All the patients in this study were given prophylactic antibiotics for variable duration. The body-exhaust system, laminar and ultraclean airflow were not available in the operating theatre in Hospital Kuala Lumpur. These features need to be incorporated into our local setting in order to lower the infection rate.

The incidence of dislocation was rather high at 10.1% (11 hips) with almost half of them having 2 or more episodes of dislocations. About two-third were associated with technical errors. The posterior approach and the 22mm femoral head size did not seem to be associated with dislocation. However, it was observed that in 4 cases, the diagnosis was dysplastic hip. In other words, 4 out of 10 (40%) of the cases with dysplastic hip in this study had dislocation. This seems to agree with the suggestion that hip dysplasia is a risk factor for dislocation[25]. The success rate of closed reduction was low (37.5%) compared to the 81% success rate reported by Joshi *et al*[26]. This is understandable since the majority of them had malpositioned components which usually require revision.

There were 6 hips (5.5%) with periprosthetic fracture. One was a post-operative fracture following a fall. The rest were intra-operative fractures and iatrogenic in nature and is thus avoidable. All the intra-operative fractures were identified and dealt with appropriately during the surgery while the patient with post-operative fracture underwent internal fixation. Most of them healed and did not seem to affect the functional outcome. As pointed out by Mont and Maar[27], periprosthetic fractures if recognized early and treated intra-operatively will have good prognosis. In this study, only one who had an intra-operative fracture of the greater trochanter, which resulted in non-union and pain. He had a poor functional result.

The rate of aseptic loosening was 6.4% for the acetabular component and 5.5% for the femoral component. About half of these occurred within 5 years from the primary surgery. The mean follow-up in this study was 30.8 months and the incidence of aseptic loosening is known to increase with time. Therefore, with longer follow-up, the loosening rate is expected to be higher.

The rate of femoral loosening was comparable with those reported by Kim and Kim[9] (6%) and Salvati *et al*[28] (7.6%) but higher compared to Owen *et al*[18] (1.8%) and Mohler *et al*[29] (2%). Although about half of the loosened femoral stems were cementless stems and the other half were cemented, it should be remembered that there were only a total of 32 cementless femoral stems performed in this study while the rest were cemented. Therefore, 9.4% (6 out of 32) of the cementless stems loosened compared to 3.7% in the cemented stems. This is in agreement with the more severe problem of loosening in cementless stems[30].

A similar situation was observed in the acetabular component where 6 out of the total of 43 (14.0%) cementless cups performed in this study had loosening. In contrast, only one out of the 66 (1.5%) cemented cups was loosened. Studies have shown that the cementless cups tend to fare better than the cemented ones[31,32] and the rate of loosening for cementless cups were reported to be 2% to 3%[18,29]. The reason for the high loosening rate of the cementless cups in this study is however, unknown.

There were 2 non-union of the greater trochanter following trochanteric osteotomy giving an overall rate of 1.8%. However, in this study the transtrochanteric approach was only used in 8 cases. In other words, 25% of the trochanter that were osteotomised failed to unite. This is an alarming rate compared to the 2.7% non-union reported by Charnley and Cupic[33] where trochanteric osteotomy was routinely performed. Nevertheless, it is difficult to conclude on this matter since the number of trochanteric osteotomy done in this study was very small.

No neurovascular complications were encountered in this study. The incidence of neural injury after THA was reported to range from 0% to 3%[34]. With the aid of the electrophysiological assessment, this rate was reported to be as high as 70%[35]. It is possible that some of the neural injury were not diagnosed since in most of the follow-up notes, there was no mention on the neurological assessment.

The revision rate in this study was 13.8% (15 hips) which is comparable with those experience by Ranawat *et al*[20] and Owen *et al*[18] (11.6% and 13.3% respectively). The average time for revision was 36.2 months after the primary surgery. Aseptic loosening of either one or both of the components was responsible for two-thirds of the revisions. This is a common finding where failure of the component remains the main cause for revision[9,36,22].

The survival rate of THA in this study at 5 years was 87.3%. Owen *et al*[18] reported a survival rate of 91% at 6 years for the cementless Porous-Coated Anatomic prosthesis. In a study of Charnley prosthesis with long-term follow-up, the survival rate at 20 years was 89.3%[36]. Compared to these studies, our survival rate was low and is expected to decline further with time. However, it should be remembered that the average follow-up duration in this study was only 30.8 months and only a small number of the patients had been followed-up for 5 years or more. Therefore the survival rate estimated from the survival curve beyond this period might not be accurate.

## Conclusion

This study was based on 92 patients (109 hips) who underwent primary total hip arthroplasty in Hospital Kuala Lumpur from January 1987 to December 1996. However, it may not reflect the true picture since these 109 hips only represented 67.3% of the total primary hip arthroplasties performed during the same period. In addition, the mean follow-up duration of 30.8 months was relatively short. Since the number of cases that were performed using the cementless and hybrid technique was small, no attempt was made to compare the results and complications between them and the cemented THA.

The patients who required THA here differ from those in the Western countries in terms of age group and diagnosis. The patients in this study were younger and avascular necrosis was the commonest diagnosis instead of primary osteoarthritis. The Charnley prosthesis was

most commonly used and cemented THA were performed more frequently compared to cementless and hybrid THA. The lateral approach was the preferred approach for this surgery. Prophylactic antibiotics were a standard feature but not DVT prophylaxis.

The functional results of these 109 THA was somewhat inferior than those reported in the literatures. Dislocation, aseptic loosening and periprosthetic fracture were the commonest complications encountered. Further analysis revealed that aseptic loosening, dislocation and infection were the main causes for revision. There were also several cases where technical errors was the contributory factor leading to poor outcome. The 5-years survival rate was 87.3% and this too, is low compared to those reported in the literature. With increasing experience and technical skills, it is hoped that these results can be improved.

## References


1. Wiles, P.W.: The surgery of the osteoarthritic hip. Br. J. Surg., 1958; 45: 488-97.
2. Charnley J. The long term results of low-friction arthroplasty of the hip performed as a primary intervention. J Bone Joint Surg 1972; 54B: 61-76.
3. Balasubramaniam P. Medicine in Malaysia : Orthopaedic Surgery. Med J Mal. (Suppl. A) 1995; 50: 75-578.
4. D'Aubigne RM, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. J Bone Joint Surg 1954; 36A: 451-75.
5. Johansson, J.E.; McBroom, R; Barrington, T.W.; Hunter, G.A.: Fracture of the ipsilateral femur in patients with total hip replacement. J. Bone Joint Surg., 1981; 63A: 1435-42.
6. Gruen TA, McNeice GM, Amstutz HC. Modes of failure of cemented stem-type femoral components. A radiographic analysis of loosening. Clin Orthop 1979; 141: 17-27.
7. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop 1976; 121: 20-32.
8. Harris WH,; McCarthy, J.C.; O'Neill, D.A.: Femoral component loosening using contemporary techniques of femoral cement fixation. J. Bone Joint Surg., 1982; 64A: 1063-67.
9. Kim, Y.H.; Kim, V.E.M.: Uncemented porous-coated anatomic total hip replacement. Results at six years in a consecutive series. J. Bone Joint Surg., 1993; 75B: 6-14.
10. Kaplan, E.L; Meier, P.: Nonparametric estimations from incomplete observations. J. Am. Stat. Assoc., 1958; 53: 457.
11. Museru, L.M.; Tay, B.K.; Balachandran, N.: Isoelastic cementless THR. Preliminary results with 24 replacements. Sing. Med. J., 1998; 29: 361-66.
12. Kwok, H.Y.; Chiu, P.K.Y.: Hydroxyapatite coated THR: Early results in Hong Kong. J. Bone Joint Surg., 1998; 80B (Suppl. 11): 133.
13. Matsui, M.; Nakata., K.; Masuhara, K.; Ohzono, K., Sugano, N.; Ochi, T.: The metal-cancellous cementless Lubeck total hip atrhroplasty. Five to nine-year results. J. Bone Joint Surg., 1998; 80B: 404-10.
14. Eftekhar NS, Stinchfield FE. Experience with low-friction arthroplasty. A statistical review of early results and complications. Clin Orthop 1973; 95: 60-8.
15. Wang, F.; Wang, C.L.; Tan, C.T.; Manivasagar, M.: Systemic lupus eryhtematosus in Malaysia: A study of 539 patients and comparison of prevalence and disease expression in different racial and gender groups. Lupus, 1997; 6: 248-53.
16. Chou CT, Pei L, Chang DM *et al.* Prevalence of rheumatic diseases in Taiwan: A population study of urban, suburban and rural differences. J Rheumatol 1994; 21: 302-06.
17. Lee, C.M.; Sidbu, J.S.; Pan, K.L.: Hip fracture incidence in Malaysia 1981-1989. Acta Orthop. Scand., 1993; 64: 178-80.

18. Owen, T.D.; Moran, C.G.; Smith, S.R.; Pinder, I.M.: Results of uncemented porous-coated anatomic total hip replacement. J. Bone Joint Surg., 1994; 76B: 258-62.

19. Das De S, Bose K, Balasubramaniam P, Goh JCH, Teng B. Surface morphology of Asian cadaveric hips. J Bone Joint Surg 1985; 67B: 225-28.

20. Ranawat, C.S.; Atkinson, R.E.; Salvati, E.A.; Wilson, P.D.: Conventional total hip arthroplasty for degenerative joint disease in patients between the ages of forty and sixty years. J. Bone Joint Surg., 1984; 66A: 745-52.

21. Smith, S.E.; Harris, W.H.: Total hip arthroplasty performed with insertion of the femoral component with cement and the acetabular component without cement. Ten to thirteen-year results. J. Bone Joint Surg., 1997; 79A: 1827-33.

22. Thomas, B. J.; Salvati, E.A.; Small, R.D.: The CAD hip arthroplasty. five to ten-year follow-up. J. Bone Joint Surg., 1986; 68A: 640-46.

23. Bryant MJ, Kernohan AG, Nixon JR, Mollan RAB. A statistical analysis of hip score. J Bone Joint Surg 1993; 75B : 705-09.

24. Dhillon KS, Askander A, Doraisamy S. Post-operative deep-vein thrombosis in Asian patients is not a rarity. A prospective study of 88 patients with no prophylaxis. J Bone Joint Surg 1996; 78B: 427-30.

25. Morrey, B.F.: Difficult complications after hip joint replacement. Dislocation. Clin. Orthop., 1997; 344: 179-87.

26. Joshi, A; Lee, C.M.; Markocie, L.; Vlatis, G.; Murphy, J.C.: Prognosis of dislocation after total hip arthroplasty. J. Arthroplasty, 1998; 13: 17-21.

27. Mont, M.A.; Maar, D.C.: Fractures of the ipsilateral femur after hip arthroplasty: A statistical analysis of outcome based on 487 patients. J. Arthroplasty, 1994; 9: 511-19.

28. Salvati, E.A.; Wilson, P.D.; Jolley, M.N.; Vakili, F; Aglietti, P.; Brown, G.C.: A ten-year follow-up study of our first one hundred consecutive Charnley total hip replacement. J. Bone Joint Surg., 1981; 63A: 753-67.

29. Mohler, C.G.; Kull, L.R.; Martell, J.M.; Rosenberg, A.G.; Galante, J.O.: Total hip replacement with insertion of an acetabular component without cement and a femoral component with cement. Four to seven-year results. J. Bone Joint Surg., 1995; 77A: 86-96.

30. Xenos, J.S.; Hopkinson, W.J.; Callaghan, J.J.; Heekin, R.D.; Savory, C.G.: Osteolysis following uncemented total hip replacement. Clin. Orthop., 1995; 317: 29-36.

31. Ballard WT, Callaghan JJ, Sullivan PM. Total hip arthroplasty in patients under 50 using contemporary cement techniques. J Bone Joint Surg 1995; 77A : 585-89.

32. Kavanagh, B.F.; Fitzgerald, R.H.J.: Multiple revisions for failed total hip arthroplasty not associated with infection. J. Bone Joint Surg., 1987; 69A: 1144-49.

33. Charnley J, Cupic Z. The nine and ten-year results of the low-friction arthroplasty of the hip. Clin Orthop 1973; 95: 9-25.

34. Wasielewski, R.C.; Crossett, L.S.; Rubash, H.E.: Neural and vascular injury in total hip arthroplasty. Orthop. Clin. North. Am., 1992; 23: 219-35.

35. Weber, E.R.; Daube, J.R.; Coventry, M.B.: Peripheral neuropathies associated with total hip arthroplasty. J. Bone Joint Surg., 1976; 58A: 66-69.

36. Neumann, L.; Freund, K.G.; Sorenson, K.H.: Long-term results of Charnley total hip replacement. Review of 92 patients at 15 to 20 years. J. Bone Joint Surg., 1994; 76B: 245-51.

# Limb Reconstruction Surgery with External Fixators - University Hospital Experience

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**Summary**

We are describing 21 limb reconstruction procedures performed in 18 patients with the use of external fixators from 1996 to 1998. The average age of patients was 21, ranging from 1 to 50 years old. Indications for surgery included short limb, non-union, pseudoarthrosis and bone or soft tissue deformities. Average length obtained for cases of limb lengthening was 6 cm. All the seven clubfoot deformities in five children were fully corrected. Equinus deformity recurred in one foot and was treated with supramalleolar osteotomy. Out of the seven cases with infected nonunion and bone loss, three failed to achieve union and required additional bone grafting procedures. One patient with unilateral external fixator for the correction of tibia shortening developed valgus deformity.

*Key Words:* Bone lengthening, Club foot, Non-union, External fixator

## Introduction

Deformity of a limb or discrepancy in limb length can be congenital, developmental or acquired in origin. Congenital abnormalities present early in life and may be difficult to treat in a single stage operation due to the deficiency of surrounding soft tissues. In some cases of chronic osteomyelitis, eradication of infection may not be possible unless a significant amount of infected bone is removed. Recent advances in free tissue transfer have enabled composite structures to be brought to the deficient areas but this may be associated with considerable donor site morbidity. Expertise in micro-vascular reconstruction is also required.

Anderson[1] introduced the use of external fixator for bone lengthening in 1952. However, its use was limited due to prolonged hospitalization, bulky construct of fixator frame and unpredictable new bone formation. In 1968, Wagner[2] developed a method of bone lengthening with his unilateral external fixator. All soft tissues that may impede elongation were released, including the periosteum. Most cases required plate fixation and bone grafting for consolidation. Duration before weight bearing may be up to 2 or 3 years and he did not recommend any lengthening more than 7cm. De Bastiani[3] with his unilateral external fixator employed principles of delay and slower rate of distraction. Angular or rotational deformity has to be corrected acutely before initiation of lengthening. Monticelli and Spinelli[4] first described lengthening of immature bone by gradual distraction across the physeal plate called chondrodiastasis.

Ilizarov[5] from Kurgan, Siberia used circular frame external fixator that is more stable and versatile to correct not only bone deficiency, but also non-union and chronic osteomyelitis. He described corticotomy, a technique of cutting bone cortex without interruption of periosteum and endosteal vasculature. He also employed gradual distraction of 0.25mm every 6 hours for the distraction of the corticotomy site. In 1981, this technique was introduced to Italy and from there to the rest of the world. For the past 10 years, there has been a large number of publications reporting favorable outcome in the treatment of difficult limb deformities including fibular hemimelia, congenital tibial pseudoarthrosis,

resistant non-union and massive bone loss[6,7,8,9,10] with different types of external fixator. More recently, soft tissue distraction for the correction of congenital deformity especially congenital talipes equinovarus (CTEV) has also been found to be very successful[11].

In this center, external fixators has been used for bone lengthening since 1970. However, biological basis of bone formation has been defined more clearly and better understood recently[12,13,14,15]. With the availability of newer generation of uniplanar as well as circular frame external fixators we were able to expand the indications of surgery. We would like to report our experience of 21 consecutive procedures performed in 18 patients between 1996 and 1998 using this method of treatment.

## Materials and Methods

From March 1996 to December 1998, we treated 18 patients with deformities of upper and lower limbs. Seven congenital talipes equinovarus (CTEV) in 5 children was treated with Ilizarov circular frame external fixator. Average age of these patients for CTEV correction was four and half years (ranges from one to eight years old ). All of them had recurrent deformity with one or more previous soft tissue corrective procedures. 14 procedures for the remaining 13 patients were for deformities that required a combination of both bone and soft tissue correction. Average age for this group of patients was 28 years ( ranges from 5 to 50 years old). Four patients in this group had failure of previous surgery and were given the option of limb amputation. Particulars of patients and types of procedures are summarized in Table I.

The patients were admitted 1 to 2 days prior to surgery, and pre-operative planning with fitting of the pre-constructed frame was made in the ward. During the operation, image intensifier was used for positioning of wires or half-pins, assess the alignment of bone segments and also to confirm complete corticotomy. After operation, we advised alternate day dressing of the wire or pin sites for the first two weeks. Patients were allowed to return home after an average of eight days post op (ranges from 2 to 31 days). They came for review in one or two weeks for removal of stitches and initiation of gradual correction. Distraction would start on 7th post-op day in children and 14th post-op day in adults. No admission was required for this purpose. Patients/Parents were shown which nut to turn, and the directions were marked on the frame. Follow up is arranged in a special clinic at first 2 weekly and later monthly. Patients were advised to telephone or return to clinic of one of the authors if they experienced any difficulty. Patients were taught to dress pin tracts at home.

## Results

There is no well-accepted method to evaluate the overall outcome of patients undergoing limb reconstruction procedures. The final functional outcome heavily depends on the initial problem or underlying pathology. One can compare the initial aim or expectation of the procedures with the final result. Another way is to assess the rate of complications of procedures. Even so, the relevance of these unexpected adverse events to the overall evaluation is also not standardized. It can be reflected by the wide variation in surgical complication rates as reported in literature. Wagner[2] reported 45%, De Bastiani[3] 14%, and Dahl[16] as high as 182%.

Complete correction was achieved in all the 7 clubfoot deformities (Figure 1). The average duration on the external fixator frame was 96 days (ranges from 70 to 146 days). In children, sequential of both feet was performed. The average duration of follow up in this group was 16 months. 1 foot has developed stiff equinus deformity and was subsequently corrected by supramalleolar osteotomy. Another child developed residual but flexible forefoot adduction that do not affect walking or wearing of shoes. For the remaining 14 procedures, 9 were performed for infected non-union with bone loss, 4 for limb lengthening and 1 for correction of angular deformity with shortening. Duration of frame application for this group of patients varied from 62 to 617 days (average 120 days) Amount of bone lengthened were from 3cm to 12cm (average of 6cm). Percentage of bone lengthened (new bone segment compared to original bone length) in these patients varied from 8% to 50% (average 22%). The longest length of new bone gained was 12cm (Figure 2). This patient who had an infected non-union of right femur was also a known case of mitral valve stenosis with history of heart failure. He was able to return to

**Table I**
**Patient Particulars and Results of Treatment**

| No | Sex | Age | Diagnosis | Structure | Indication | Fxt Fix | Days On Frame | New Bone | Percentage | Outcome |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 1 | Arthrogryposis with bilateral CTEV | Foot ( R ) | cstd | Ilizarov | 146 | NA | NA | Excellent |
| 2 | M | 2 | Arthrogryposis with bilateral CTEV | Foot ( L ) | cstd | Ilizarov | 71 | NA | NA | Excellent |
| | | | Arthrogryposis with bilateral CTEV | Foot ( R ) | cstd | Ilizarov | 73 | NA | NA | Excellent |
| 3 | M | 3 | Seckel's syndrome with bilateral CTEV | Foot ( L ) | cstd | Ilizarov | 132 | NA | NA | Good. Flexible forefoot adduction |
| 4 | M | 5 | Osteochondroma with shortening | Ulnar ( R ) | I | Wagner | 97 | 3cm | 25% | Excellent |
| 5 | F | 7 | Arhtrrogryposis with bilateral CTEV | Foot ( R ) | cstd | Ilizarov | 99 | NA | NA | Excellent |
| | | | Arhtrogryposis with bilateral CTEV | Foot ( L ) | cstd | Ilizarov | 70 | NA | NA | Poor. Require supramalleolar osteotomy |
| 6 | M | 8 | Bilateral CTEV | Foot ( R ) | cstd | Iliazov | 80 | NA | NA | Excellent |
| 7 | F | 10 | Fibula hemimelia | Tibia ( L ) | I | Orthofix | 225 | 5cm | 17% | Fair. Valgus deviation |
| 8 | M | 15 | Multiple exostosis with shortening | Ulnar ( L ) | I | Orthofix | 91 | 4cm | 20% | Good |
| | | | Multiple exostosis with shortening | Ulnar ( R ) | I | Orthofix | 62 | 4cm | 20% | Poor. Delay consolidation require bone grafting |
| 9 | M | 17 | Blount's disease | Tibia ( L ) | cbd | Iliazarov | 121 | NA | NA | Excellent |
| 10 | M | 21 | Infected non union with bone loss | Tibia ( L ) | bt | Maxx | 223 | 6cm | 18% | Poor, require bone grafting for union |
| 11 | F | 22 | Open fracture with bone loss | Tibia ( R ) | bt | Ilizarov | 169 | 3cm | 9% | Excellent |
| 12 | M | 25 | Infected non union with large sequestrum | Tibia ( L ) | bt | Ilizarov | 186 | 4cm | 10% | Poor, require bone grafting for union |
| 13 | M | 37 | Infected non union with bone loss. Mitraal stenosis | Femur ( R ) | bt | Ilizarov | 516 | 12cm | 50% | Excellent |
| 14 | M | 38 | Infected non union with bone loss | Tibia ( R ) | bu | Ilizarov | 105 | NA | NA | Poor, premature frame removal |
| 15 | M | 42 | Infected non union. Diabetic | Hunerus ( R ) | bu | Ilizarov | 124 | NA | NA | Excellent |
| 16 | M | 43 | Infected femur / tibia fracture with osteomyelitis | Left knee | bt | Ilizarov | 328 | 9cm | 26% | Excellent |
| 17 | M | 44 | Non union with bone loss | Knee ( L ) | bt | Ilizarov | 134 | 3cm | 8% | Fair |
| 18 | M | 50 | Infected non union with bone loss. DM and HPT | Tibia ( L ) | bt | Ilizarov | 152 | 4cm | 10% | Excellent |

*cstd : correction of sodt tissue deformity*
*cbd : correction of bony deformity*
*I : lengthening*
*bt : bone transport*
*bu : bone union*
*NA : not applicable*

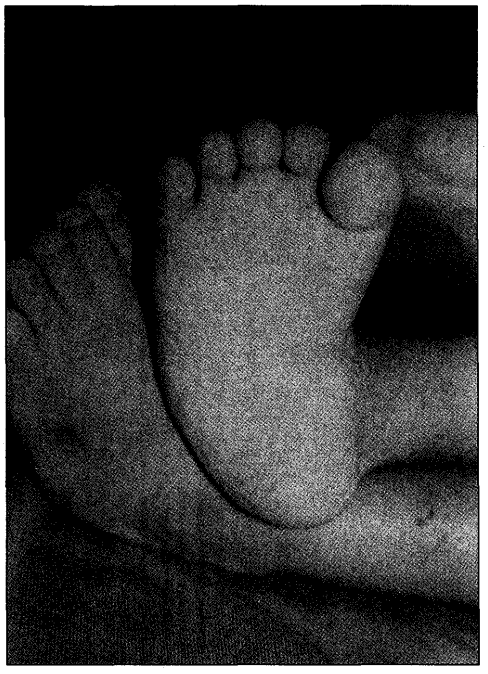

**Fig. 1a: Bilateral club foot deformities in a 3 year old boy.**

**Fig. 1b: Child tolerating the external fixator well.**

**Fig. 1c: Result of correction.**

work as a factory manager during the period of consolidation with the ring fixator on. He is now walking without any support. Another patient had a bone transport procedure for bone loss around the knee (Figure 3). Elective bone grafting was performed on docking of femur and tibia and stable fusion was achieved with 10cm of new bone in the femur. In three patients union were not achieved at the end of bone transport procedure. Two of the patients had bone transport through densely scarred and previously infected fracture site. Both of them gained full correction in length with no active wound infection during the whole process. The third patient insisted for premature removal of the frame. He was also not compliant on follow up weight bear too early. All of them subsequently achieved union with bone grafting and either POP casting or internal fixation.

We taught our patients to do own dressings at home. We did not encounter any major complications such as ring sequestrum or fulminant infection that would required extensive debridement. No limb ended up in amputation. 4 wires required premature removal due to loosening.

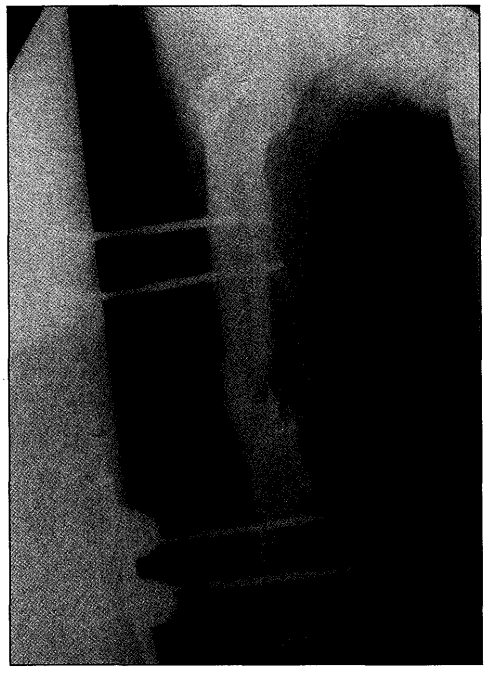

**Fig. 2a: Infected non-union of femur shaft with external fixator.**

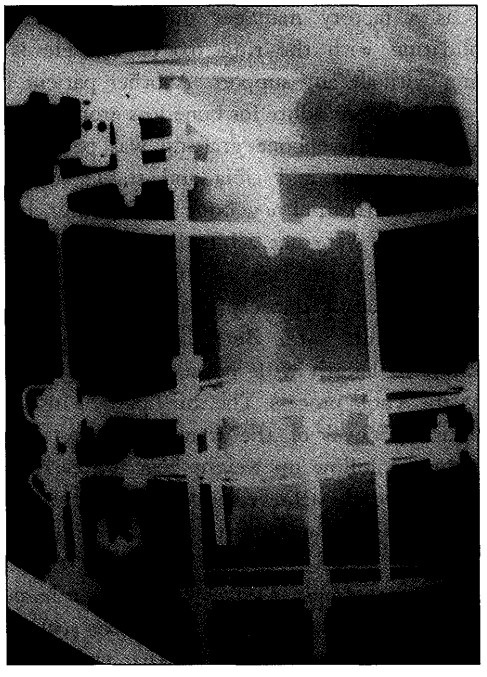

**Fig. 2b: Bone resection, acute docking and early distraction of proximal corticotomy.**

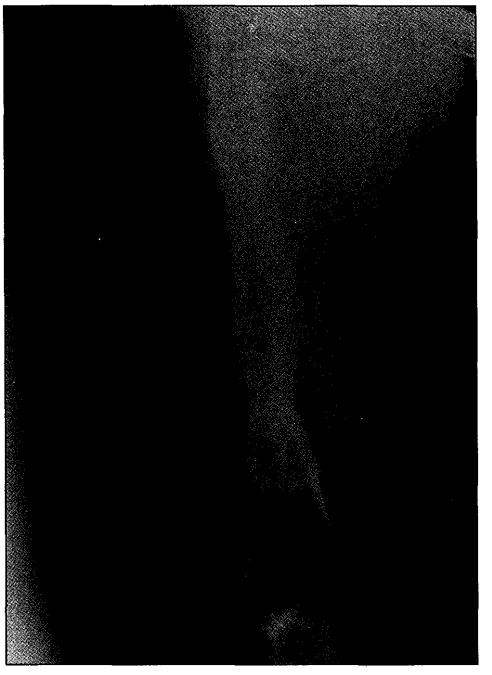

**Fig. 2c: Early new born formation.**

One of the patients developed significant angular deviation from the initial planned axis of lengthening. She was a 10-year-old girl with tibial shortening of 5cm due to fibular hemimelia (Figure 4). During process of lengthening with Orthofix external fixator, she developed 30 degrees of valgus deviation of upper tibia but achieved full correction of the tibial length.

## Discussion

Results of limb deformity correction has improved significantly over the past few decades. Better understanding of the biology of bone and soft tissue healing[12,13,14,15] together with improvements in the technology and design of implants and instruments both contributes to this development. Mark Dahl[16] developed a classification for severity for limb deformities. Factors that are associated with high risk of complications include lengthening of more than 15% in length, congenital deformities, cases with multiple previous surgery and presence of active infection. With the use of external fixator, one can perform gradual correction of a deformity in various planes. It also allows modification

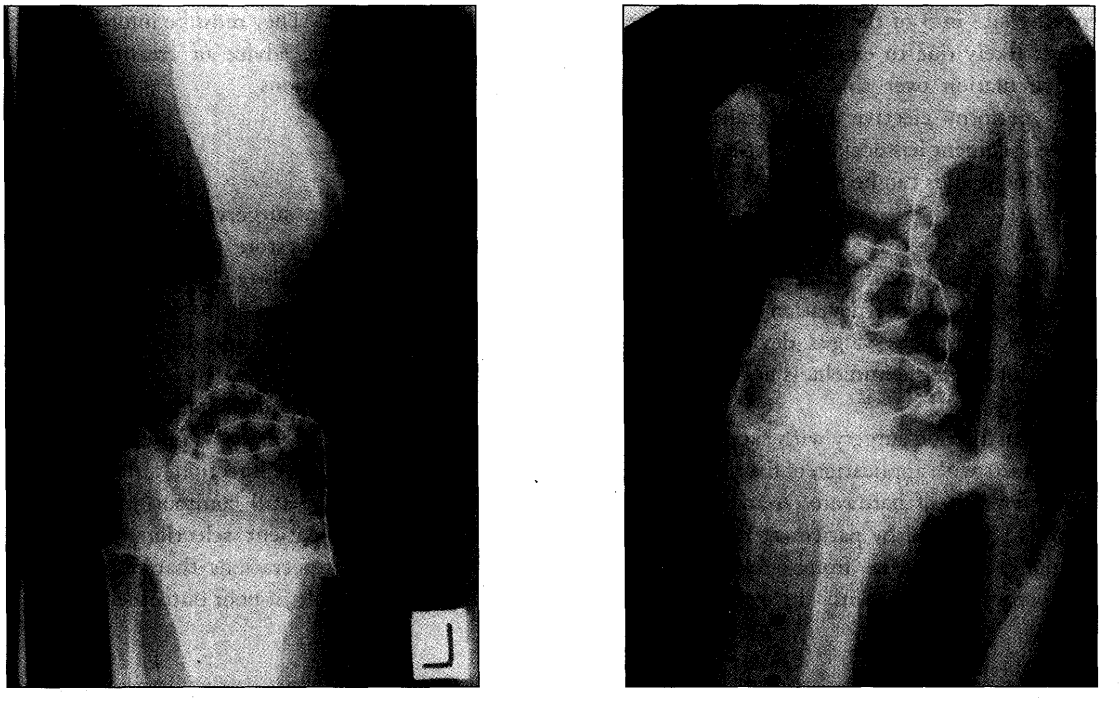

**Fig. 3a & 3b: Bone loss around the knee resulting from infected internal fixation of open tibial and femoral fractures. Debrided and gentamycin beads inserted.**

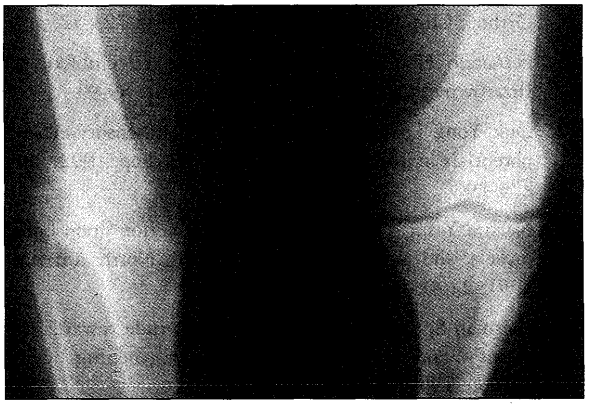

**Fig. 3c: Standing radiograph of both knees after femoral bone transport with elective bone grafting upon docking.**

of frame configuration to accommodate unexpected problems encountered during the procedure.

We managed to correct all the CTEV deformities. The external fixator basically stretch the tight and contracted soft tissue and cause minimal injury to the bone, joint surface and neurovascular structures. With conventional treatment, all the foot deformities would have required bony correction that may retard the subsequent growth of the foot. The average length of new bone formation was 6cm, and the percentage of bone length was 22%. This amount of lengthening was generally difficult to achieve with other procedures, like vascularised bone transfer.

Pin tract infection is still the commonest problem. Avoiding penetration of muscle bellies can minimize this problem. Properly placed wires and more liberal use of half-pins can help to achieve this aim. We also belief that once the tract is matured in about 2 weeks, regular dressings were not required. Failure of union at

the docking site in 3 of the bone transport procedures were most likely due to extensive tissue scarring and lack of circulation over this region. Many surgeons routinely perform elective bone grafting once the transported segment has docked. Alternatively, primary docking of bone ends can be performed if the gap is not excessive[17].

Uniplanar external fixator is mechanically less stable than ring fixators. Varus deviation of femur in long lengthenings as well as valgus deviation of tibia in corrections for fibular hemimelia is not uncommon.

In limb reconstruction surgery with external fixator, the procedure starts with application of fixator and complete only after removal of hardware. A major part of the procedure is performed by patient at home. More than half of our patients were from outstation, therefore effective communication with the patients or family members is essential. They must be informed about how to seek clarification, advice or treatment in case of unexpected complications.

## Conclusion

Limb reconstruction surgery with external fixations allows a surgeon to restore the function of deformed extremities and to salvage limbs that are grossly abnormal. It can be used to treat many problems irrespective of their etiology and the indications are still expanding. However, the procedure involves prolonged period of gradual frame adjustment and is associated with many potentially serious complications. Pin tract infection, failure of union and loss of correction are still common and require close attention. Careful patient selection is important to avoid unrealistic expectations that may lead to poor compliance and result in poor outcome.

## References


1. Anderson W.V. Leg lengthening. J. Bone Joint Surg. 1952; 34B: 150.
2. Wagner H. Lengthening of the femur. Clin. Orthop. 1978; 136: 125-42.
3. De Bastiani *et al.* Limb Lengthening by Callus Distraction Pediatr. Orthop. 1987; 7 (2): 129-34.
4. G. Monticelli, Renato Spinelli. Distraction Epiphysiolysis as a method of limb lengthening Clin. Orthop. 1979; 154: 254-61.
5. Ilizarov G.A. Clinical application of the tension-stress effect of limb Clin. Orthop. 1990; 250: 8-25.
6. Catagni M *et al.* Management of fibular hemimelia using the Ilizarov Orthop. Clin. North America 1991; 22(4): 715-22.
7. Catagni M *et al.* Distraction osteogenesis in the treatment of stiff hypertrophic nonunions using the Ilizarov apparatus. Clin. Orthop. 1994; 301: 159-63.
8. Dror Paley, Maurizio Catagni. Ilizarov Treatment of tibia nonunions with bone loss Clin. Orthop. 1989; 241: 146-65.
9. Dror Paley *et al.* Treatment of congenital pseudoarthrosis of the tibia using the Ilizarov technique Clin. Orthop. 1991; 280: 81-93.
10. Tracy Watson J. High energy fractures of the tibia plateau. Orthop. Clin. North America. 1994; 25(4): 723-52.
11. Fernando H. Correction of the neglected clubfoot by Ilizarov method. Clin. Orthop. 1994; 301: 89-93.
12. Duk Yong Lee *et al.* Changes in somatosensory-evoked potentials in limb lengthening. Clin. Orthop. 1992; 285: 273-79.
13. Natsuo Yasui *et al.* The effect of distraction upon bone, muscle, and periosteum. Orthop. Clin. North America. 1991; 22(4): 563-67.
14. Sherman S, Steven M. The present attitude towards the biology and technology of limb lengthening. Clin. Orthop. 1991; 264: 76-83.
15. Vladimir Schwartsman, Roman schwartsman, Corticotomy. Clin. Orthop. 1992; 280: 37-47.
16. Mark Dahl *et al.* Complications of limb lengthening. Clin. Orthop. 1994; 301: 10-18.
17. Stuart Green. Skeletal Defects. Clin. Orthop. 1994; 301: 111-17.

CASE REPORT

# *Candida Albicans* Infection of a Prosthetic Knee Replacement: A Case Report

**B Badrul, MD, MS Ortho, G Ruslan, MD, MS Ortho, AM**

**Summary**

We report a 64 year old man who developed *Candida albicans* infection following total knee arthroplasty. A two-stage exchange arthroplasty was performed after an initial swab culture grew *Acinobacter sp.* A scanty growth of yeast was also found from the tissue culture. Intravenous cefuroxime was instituted for six weeks followed by reimplantation four months after the removal. Three weeks after that revision, the prosthesis became infected and a culture of knee aspirate established the diagnosis of *Candida albicans* infection. Treatment consisted of thorough debridement of the involved joint and oral fluconazole for a year. Infection was never totally resolved and a secondary infection with methicillin resistant staphylococcus aureus then developed. Excision arthroplasty was done at two and a half years after the initial infection. At five years follow-up the infection was quiescent and he had a range of movement of 30° to 70°. Knee brace was used to control the valgus-varus stability.

*Key Words:* *Candida albicans*, Prosthetic infection, Exchange arthroplasty, Excision arthroplasty

## Introduction

The use of prosthetic arthroplasty for the treatment of degenerative joint diseases has increased dramatically during the last two decade. The incidence of prosthetic joint infection has decreased over the years to 1.0 to 2.0% with the use of prophylactic antibiotic[1]. While bacteria is the most common organism found in infected prosthesis, fungal infections are exceedingly rare with only 20 reported cases in the English literature[2,3]. We report an additional case of prosthetic fungal arthritis due to *Candida albicans*.

## Case Report

A 59 year old Chinese man underwent a right total knee replacement in September 1992 for severe osteoarthritis. Prior to the operation, he was treated with nonsteroidal anti-inflammatory agents and he also took traditional Chinese medicine. Post-operatively the knee had become swollen and painful. The joint was aspirated on several occasions but the effusion re-accumulated after each procedure. Prolonged antibiotic was instituted. However no further information was available as he was treated in another hospital.

The patient presented to our clinic in February 1994 with symptoms and signs of a chronic infection of the right knee. The right knee was grossly swollen, tender and warm with skin redness overlying the anteromedial aspect. There was no sinus discharge and the patient was afebrile. Peripheral white blood cell (WBC) count was 8,100/dl and his erythrocyte sedimentation rate (ESR) was 95mm/h. Radiography evaluation revealed radiolucent area underneath the cemented tibial prosthesis.

The knee was debrided and the prosthesis was removed in March 1994. Tissue culture grew *Acinobacter sp.* and scanty growth of yeast. Histopathological examination revealed synovial granulation tissue with chronic

inflammation but no sign of tuberculous infection. Intravenous cefuroxime was instituted for six weeks. The swelling had reduced and ESR decreased to 40mm/h. A repeat joint aspiration was performed in early May 1994 and there was no growth after seven days of incubation. The second stage of an exchange arthroplasty was performed on 18th May 1994. However three weeks after reimplantation, the prosthesis became infected and ESR was 120mm/h. Joint aspiration yielded serosanguinous fluid and a fungal culture was positive for *Candida albicans* only. Intravenous fluconazole 50mg daily was commenced for two weeks and then continued orally for a further six weeks. The infection subsided but never totally resolved. Therefore the antifungal drug was continued for a year.

The patient did well until September 1996, when he developed recurrence of sepsis, this time due to methicillin-resistant *Staphylococcus aureus* (MRSA). X-ray showed osteolysis and loosening. The prosthesis was removed and followed with intravenous fucidic acid. We used a cement spacer to occupy the gap and a cross-knee external fixator to immobilise the knee. In October 1996, the cement spacer and external fixator were completely removed. All cultures taken intraoperatively were negative.

At five years follow up, the patient was well and infection was controlled. ESR was 22mm/h and WBC count was 6,500/dl. Patient was mobilizing with a walking stick and the range of movement of his right knee was $30^0$ to $70^0$. He requires a knee brace to overcome valgus-varus instability. No further attempt at reimplantation of a prosthesis has been made as the patient was happy with his current condition.

## Discussion

Candida arthritis is uncommon. Candidia prosthetic joint infection is even rarer; only 20 cases have been reported. Wada reporting 18 of them[2,3]. This case report is the twenty-first. A summary of these 21 cases is presented in Table I. Candida is the classic opportunistic pathogen, causing infections in the host who may be compromised by antibiotic therapy, corticosteroids, malnutrition, diabetic mellitus, cancer chemotherapy or AIDS. *Candida albicans* is a normal human and animal commensal. Therefore the source of the disseminated and deeply seated candidiasis is endogenous, via the blood stream, from the gastrointestinal tract or from the skin. In this case report, the disseminated infection was promoted by prolonged antibiotics (which could act by inhibiting bacterial competition or by their effect on phagoctes) as well as steroid.

Clinical presentation includes joint pain, swelling and effusion. Frequently the diagnosis is not made until the infection became chronic. An indolent infection may become apparent only weeks or months later. Development of infection after joint replacement is likely to cause loosening of the prosthesis. Thus, radiograph of the prosthetic candidal infection will show osteolysis. White blood cell count is usually normal but erythrocyte sedimentation rate is markedly raised. Persistent swelling of the joint with dark-red or blood stained fluid should be carefully investigated for fungal infection[4]. The diagnosis is always be confirmed by tissue biopsy and culture.

In most cases reported previously, amphotericin B was the cornerstone of therapy for prosthetic candidal infection. Amphotericin B is an antibiotic that has nephrotoxicity as a major side effect. Since the introduction of antifungal azoles in the last decade, fluconazole, which unlike amphotericin B can be given orally have been increasingly used as therapy for the systemic mycoses[5]. The availability of flucanozale in both oral and intravenous forms and the relative lack of toxicity, were the factors that encouraged us to believe that fluconazole was the most attractive to amphotericin B in our patient.

Operative debridement and antifungal therapy are the mainstays of treatment, provided it is detected early. The debridement includes the excision of all infected and the necrotic tissue and the removal of cement and the prosthesis if it is not well fixed. Wada *et al* (1998) reported a case which was successfully treated by debridement and continuous irrigation combined with oral antifungal medication without removal of prosthesis. Selmon *et al* (1998) employed a one-stage exchange arthroplasty using cement impregnated with amphotericin B and no history of recurrence. Oral itraconazole was also given for 8 weeks. In retrospect, revision arthroplasty should not have been carried out with ESR more than 40mm/hr and untreated yeast infection.

**Table I**
**Summary of Cases with Fungal Prosthetic Infection**

| Year Reported | Reference | Organism Isolated | Affected Joint | Antifungal Treatment | Surgical Treatment | Reference |
|---|---|---|---|---|---|---|
| 1979 | Wada *et al* | *Candida parapsilosis* | Knee | Amphotericin B, 5-flucytosine | Removal and Arthrodesis | No |
| 1983 | Wada *et al* | *Candida parapsilosis* | Shoulder | Amphotericin B, ketoconazole | Removal | Not Reported |
| 1983 | Wada *et al* | *Candida tropicalis* | Knee | Amphotericin B | Removal | No |
| 1983 | Wada *et al* | *Torulopsis glabrata* | Hip | Amphotericin B | Removal | No |
| 1984 | Wada *et al* | *Candida parapsilosis* | Hip | Amphotericin B, 5-flucytosine | Removal | No |
| 1986 | Lim *et al* | *Candida albicans* | Shoulder | Amphotericin B | Removal | No |
| 1988 | Wada *et al* | *Candida albicans* | Knee | Amphotericin B, 5-flucytosine ketoconazole | Removal and arthrodesis | No No |
| 1988 | Wada *et al* | *Candida albicans* | Knee | Amphotericin B, ketoconazole | Removal and arthrodesis | Not Reported |
| 1988 | Wada *et al* | *Candida albicans* | Knee | Amphotericin B | Removal and arthrodesis | Yes |
| 1988 | Wada *et al* | *Candida tropicalis* | Hip | Amphotericin B | Removal | No |
| 1988 | Wada *et al* | *Candida tropicalis* | Knee | Amphotericin B, ketoconazole | Removal | Yes |
| 1989 | Wada *et al* | *Candida albicans* | Hip | Amphotericin B | Removal | No |
| 1989 | Wada *et al* | *Candida albicans* | Knee | Amphotericin B | Removal | No |
| 1989 | Wada *et al* | *Candida albicans* | Hip | Amphotericin B | Removal | No |
| 1989 | Wada *et al* | *Candida tropicalis* | Hip | Amphotericin B, ketoconazole | Debridement and removal | No |
| 1990 | Wada *et al* | *Candida albicans* | Hip | Amphotericin B | Removal | No |
| 1990 | Wada *et al* | *Candida albicans* | Hip | Amphotericin B | Removal | No |
| 1993 | Wada *et al* | *Candida parapsilosis* | Knee | Amphotericin B, ketoconazole fluconazole | No surgical treatment | Amputation |
| 1998 | Wada *et al* | *Candida parapsilosis* | Knee | Fluconazole | Debridement and continuous irrigation | No |
| 1998 | Selmon *et al* | *Candida glabrata* | Knee | Itraconazole | 1-stage exchange arthroplasty and amphotericin B impregnated bone cement | Not Reported |
| 1999 | Present case | *Candida albicans* | Knee | Fluconazole | Debridement and resection arthroplasty (following failed exchange arthroplasty) | No |

Other options of treatment for chronic infections in total knee replacement are arthrodesis and resection arthroplasty. Arthrodesis has been accepted as a salvage procedure. On the other hand, resection arthroplasty is the treatment option for some patients who have a periprosthetic knee infection especially in elderly patient with chronic medical problem and a low functional demand[6]. The pitfall of this procedure is that patients may have pain on prolonged walking and valgus-varus instability. However, compared to arthrodesis the patient have certain amount of movement in the knee joint.

## REFERENCES


1. Mauerhan OR, Nelson CL, Smith DL, Fitzgerald Jr RH, Slama TG, Petty RW, Jones RE and Evans RP: Prophylaxis against infection in total joint arthroplasty. J Bone Joint Surg 1994; 76A: 39-45.
2. Wada M, Baba H and Imura S; Prosthetic knee Candida parapsilosis infection: J Arthroplasty 1998; 13: 479.
3. Selmon GPF, Slater RNS, Shepperd JAN and Wright EP: Successful 1-stage exchange total knee arthroplasty for fungal infection. J Arthroplasty 1998; 13: 114.
4. Lim EVA, Stern PJ: Candida infection after implant arthroplasty: a case report. J Bone Joint Surg 1986; 68A: 143.
5. Como JA and Dismukes WE: Oral azole drugs as systemic antifungal therapy. J Arthroplasty 1994; 330: 26.
6. Rand J, Bryan R, Morrey B, Westholm F: Management of infected total knee arthroplasty. Clin Orthop 1986; 206: 76.

CASE REPORT

# Neurological Recovery in a Patient with Recurrent Aggressive Giant Cell Tumour of the Axis - A Case Report

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**Summary**

A rare case of an aggressive recurrent giant cell tumour of axis is presented. The problems encountered in diagnosis and management are discussed. High dose dexamethasone was found to be useful managing this inoperable aggressive tumour which was compressing the cord. Early diagnosis would facilitate wide excision of the tumour with good prognosis.

*Key Words:* Giant cell tumour, Axis, Recurrent high dose steroid therapy

## Introduction

Giant-cell tumour is relatively common in adults and young people. It occurs mainly in the long bones, and its incidence is low in the vertebrae. In the spine, these lesions often present problems in diagnosis and management, and are frequently associated with neurological involvement. A case of aggressive type of recurrence giant-cell tumour of the spine initially diagnosed as an aneurysmal bone cyst is presented.

## Case Report

M.F. is a 36 year old Malay man presented with neck pain associated with reduced range of movement for one-month duration. This started following a motor vehicle accident in which he is said to have sustained a whiplash injury. The pain did not subside despite taking analgesic. On examination, he was quite a well-built person. He had markedly reduced neck motion and there was tenderness at the upper cervical region. He had no neurological deficit either in the upper or lower limbs. Other systems were normal. Plain radiograph of the cervical spine showed lytic lesion involving the body of C2 (Figure 1). The odontoid process and the spinous process looked normal.

MRI showed destruction of the C2 vertebral body with some extension into the pedicle. The C2 body was expanded posteriorly, indenting the thecal sac and the cord (Figure 2).

A differential diagnosis of Chordoma and Aneurysmal bone cyst was made based on radiological findings. His blood investigations were normal. He was put on halo-vest to immobilize the neck. Posterior stabilization with wire and fusion of C1 to C3 was performed. The second stage operation was performed about one month later in which anterior decompression and biopsy was taken via transoral approach with the ENT team. At operation, fleshy brownish tissue was curetted from the body of C2 vertebrae and haemostasis was secured. Post-operative recovery was uneventful. No neurological deficit was noted. Both surgeries were done while the patient was

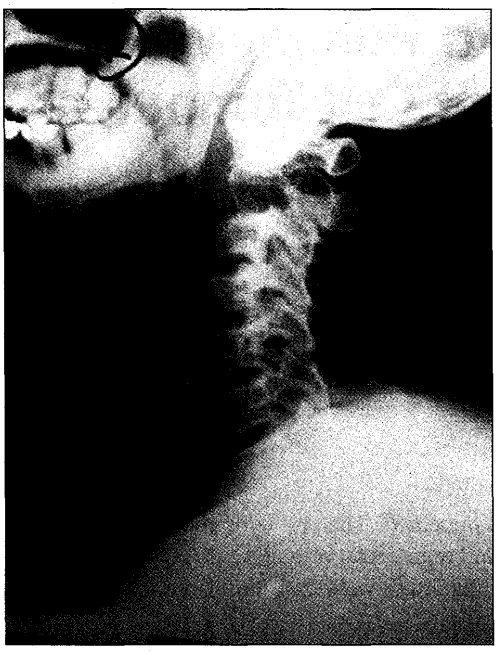

**Fig. 1**

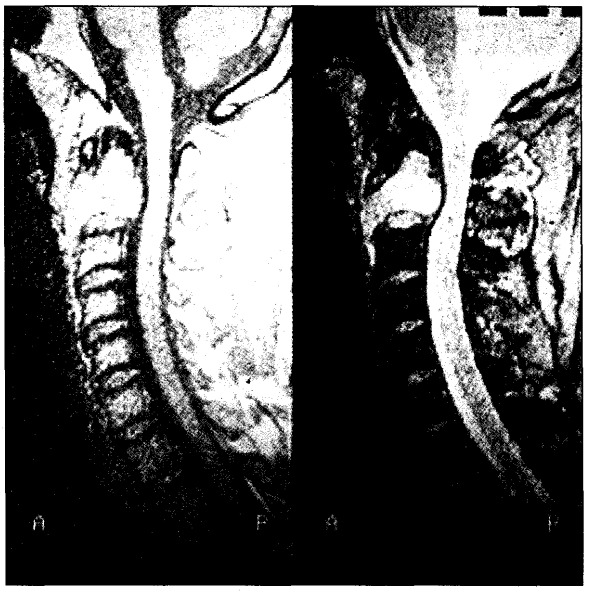

**Fig. 2**

wearing halo-vest. The histopathological examination was reported as aneurysmal bone cyst. He wore the halo-vest for three months and then changed to a philadelphia collar brace. He was asymptomatic for a year before he presented again with progressive numbness and weakness of upper and lower limbs bilaterally. The right limb weakness was affected more compared with the left side. His right upper and lower limbs power was 3/5 and the left upper and lower limbs power was 3+/5. MRI was ordered and showed that the whole body of C2 involved by the tumour, which extended to involved the odontoid. The tumour also extended posteriorly to compress the cord (Figure 3).

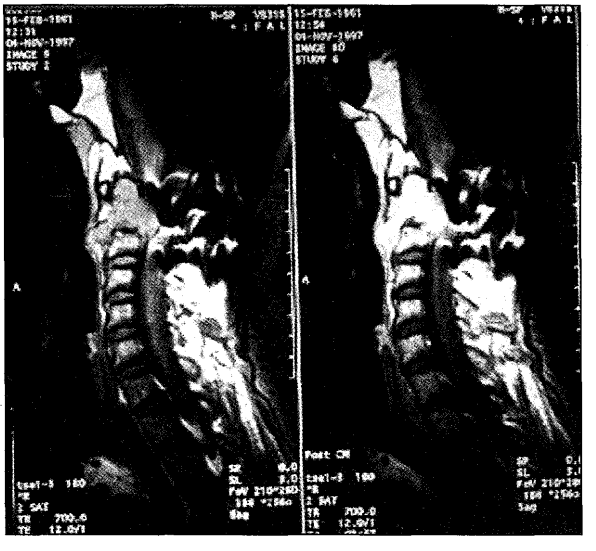

**Fig. 3**

Another transoral decompression was performed with the ENT team and the tumor was curetted as much as possible to decompress the cord. His neurology improved to grade 5 on the left side and the right upper and lower limb power improved to grade 4. However the numbness was still remained the same. The histopathological examination results came back as Giant-cell tumour of the axis and review of his previous biopsy was also suggestive of a similar finding. Because of the progressive symptoms and inability to excise the tumour completely due to the location, he was referred to the Oncologist for radiotherapy. He received radiotherapy five days per week for one month with dose

of 4,000 rads. His symptoms remained the same. While receiving radiotherapy, he developed sudden onset of progressive neurological deficit with severe myelopathy (grade 2 upper and lower limbs). He also had respiratory embarrassment. The irradiation was stopped and respiration was assisted with oxygen therapy. Intravenous high dose Dexamethasone was given and his condition improved after 2 weeks. He was discharged well and at the latest review 2 years after surgery, he could walk without support had returned to work.

## Discussion

Giant-cell tumour of the spine presents a surgical challenge and its treatment remains controversial. Giant-cell tumours of bone are rare in the vertebrae except the sacrum. In the spine, it constitutes 6.5% of all giant-cell tumours of bone seen at the Mayo Clinic[1]. More than 50% of tumours cause expansion of the bone and the cortex was always affected. Females are most commonly affected and the incidence is common in the second and third decades of life. Savini *et al*[2], found that 2.9% of giant-cell tumours involved the vertebrae above the sacrum. In previously published series of giant-cell tumours, spinal locations of these tumours averaged 2% - 3% in prevalence[3,4,5].

Campanacci *et al*[3] and Enneking[6] have developed similar staging systems for giant-cell tumours based on a combined radiographic presentation and a histologic grading system of increasing stromal atypia. Campanacci's radiographic grade 1, 2 and 3 correspond to Enneking's surgical stage 1, 2 and 3, which represent the latent, active and aggressive clinical presentations. The only difference between them is that Campanacci grade 3 is a malignant sarcoma that most frequently is found following radiation treatment of a conventional giant-cell tumour. Enneking's histologic grade 3 has increased stromal atypia, but is still considered nonmalignment. Based on the above criteria, this patient falls into Enneking's stage 3 and Campanacci's grade 3.

In the spine, wide resection can only be achieved at the risk of neurological deficit and spinal instability. The technique requires combination of anterior and posterior fusion, depending on the site of the lesion. Curettage with a lesion margin, however, is still generally used to preserve neurological function. Surgical approach is dependent on the site, size and extent of the lesion. In this patient, the high cervical lesion made it impossible to excise the tumour completely.

The use of radiation therapy remains controversial. Some authors have found it to be helpful while others do not recommend it because of teh risk of sarcomatous change, which occurs in the 10% of patients. This patient was sent radiation therapy in view of the aggressive nature of the tumour that recurred very quickly, causing progressive neurological deficit.

In combination with surgery, the radiation dose can be kept to reasonable levels to protect against cord myelitis, and to lower risk of sarcomatous degeneration[7]. Bell *et al.*[8], in his series showed no case of malignant transformation of a giant-cell tumour after a mean follow-up period of 12 years. However, he did not recommend radiotherapy for primary treatment of giant-cell tumour, but may be indicated in exceptional circumstances.

Giant-cell tumour has a wide spectrum of clinical and radiological presentation. Some lesion expand very slowly and rarely seem to undergo necrosis, scarring and spontaneous arrest of growth. Others, on the contrary, are rapidly aggressive. The local recurrence rates were 27% after intralesional excision, only 8% after marginal excision, and zero per cent following wide or radical procedure. Local recurrances usually appear in the first three years after surgery[3].

Dahlin *et al.*[9,10] found a 44% recurrence rate for all giant-cell tumors, with only 16.5% recurrence rate when these tumours arose in the spine. Larsson *et al*[11], reported a recurrence rate of 26% for all lesions after curettage, but none of the four lesions above the sacrum recurred. Other authors estimate the overall recurrence rate of spinal giant-cell tumors as between 25% to 42%[1,2]. A recent review found an overall recurrence rate of 28% for giant-cell tumours of the spine, with a rate of 19% for lesions managed at a tertiary care referral center[12]. The initial surgery should be as aggressive as possible and radiation should be used only for lesions that are incompletely resectable or that have recurred.

## Conclusion

Giant-cell tumour of the spine presents a surgical challenge and its treatment remains controversial. Surgical management is by curettage or *en bloc* excision depending on the location and the extent of the tumour. Because of the risk of sarcomatous transformation, radiation therapy should be reserved for patients with incomplete excision or for those with local recurrence. Excessive irradiation can lead to irradiation necrosis.

## References


1. Sanjay BKS, Sim FH, Unni KK, McLeod RA. Klassen RA. Giant cell tumors of the spine. J Bone Joint Surg (Br) 1993; 75: 148-54.
2. Savini R, Gherlinzoni F, Morandi M, Neff JR, Picci P. Surgical treatment of giant cell tumor of the spine: The experience at the Istituto Ortopedico Rizzoli. J Bone Joint Surg (Am) 1983; 65: 1283-9.
3. Campanacci M, Baldini N, Boriani S. Giant cell tumor of bone. J Bone Surg (Am) 1987; 69: 106-14.
4. McDonald DJ, Sim FH, Mcleod RA, Dahlin DC. Giant cell tumor of bone. J Bone Joint Surg (Am) 1986; 68: 235-42.
5. Sung HW, Kuo DP, Shu WP, Chai YB, Liu CC, Li SM. Giant cell tumor of bone: Analysis of 208 cases in Chinese patients. J Bone Joint Surg (Am) 1982; 64: 755-61.
6. Enneking WF. A system of staging musculoskeletal neoplasms. Clin Orthop 1986; 204: 9-24.
7. Shikata J, Yamamuro T, Shimizu K, Kotoura Y. Surgical treatment of giant cell tumors of the spine. Clin Orthop 1992; 278: 29-36.
8. Bell RS, Harwood AR, Goodman SB, Fornasier VL. Supervoltage radiotherapy in the treatment of difficult giant cell tumors of bone. Clin Orthop 1983; 174: 208-16.
9. Dahlin DC. Giant cell tumor of vertebrae above the sacrum: A review of 31 cases. Cancer 1977; 39: 1350-6.
10. Dahlin DC, Cupps RE, Johnson EW Jr. Giant-cell tumor. A study of 195 cases. Cancer 1970; 25: 1061-70.
11. Larsson SE, Lorentzon R, Boquist L. Giant cell tumor of bone: A demographic, clinical and histopathological study of all cases recorded in the Swedish Cancer Registry for the years 1958 through 1968. J Bone Joint Surg (Am) 1975; 57: 167-73.
12. Hart RA, Boriani S, Biagini R, Currier B, Weinstein JN. A system for surgical staging and management of spine tumors: A clinical outcome study of giant cell tumors of the spine. Spine 1997; 22: 1773-82.

CASE REPORT

# X-Linked Hypophosphatemic Rickets - A Report of 2 Cases and Review of Literature

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**Summary**

We report two cases of x-linked dominant hypophosphatemic rickets involving a man and his daughter. The family tree consists of 44 members with 13 of them having short stature and bowing of the lower limbs. The study of this family tree strongly suggests an x-linked dominant inheritance.

## Introduction

X-linked hypophosphatemic rickets is the most frequent cause of familial rickets, with an incidence of 1 in 20,000 births.

This condition is due to an isolated phosphate transport defect at the renal tubule with recent studies indicating that affected persons may also have tubular defect in regulation of renal 1,25 dihydroxycholecalciferol synthesis[1].

## Case 1

LF, a 68 year old Chinese man, first presented to us in 1992 for weakness of all 4 limbs and numbness below the level of C6. He also complained of progressive kyphosis and stiffness of the back. He developed bowing of lower limbs in childhood, and at the age of 35, corrective osteotomies were attempted for both the femurs but failed. Physical examination revealed frontal bossing, short stature, severe bowing of both lower limbs more in the femurs. He had upper motor neuron lesion with weakness and hyperreflexia of both the upper and lower limbs. There was kyphosis and decreased range of movement of the throracolumbar spine.

Serum phosphate was 0.6mmol/1; calcium was 2.2mmol/1 and alkaline phosphatase was 200i.u/1. Radiographs of the right radius and ulna, the lumbosacral spine (Fig. 1) as well as both the hips showed extensive bony overgrowth about the sites of muscular and ligamental attachments. CT scan revealed excessive osteophytes posterior to the vertebral bodies at the level of C3 to C6 causing narrowing of the spinal canal.

Patient was advised to undergo decompression of the cervical spine, but he refused. He is currently wheel chair bound.

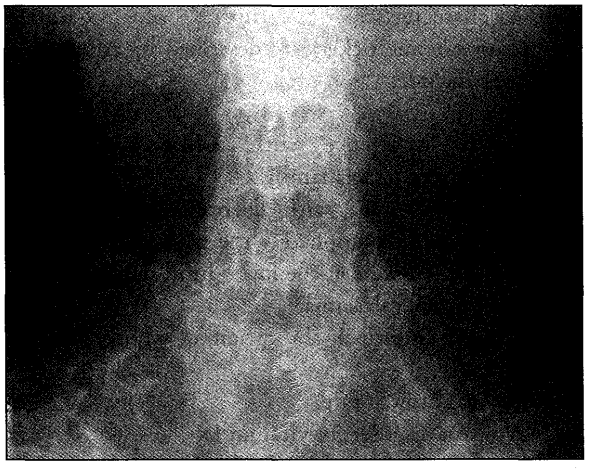

**Fig. 1: Radiographs of the right radius and ulna, the lumbosacral spine.**

## Case 2

LSF, a 21 years old Chinese female, is the daughter of LF. She was first noted to have bowing of the lower limbs at one and a half years of age. She was investigated at the age of four, whereby the biochemical results showed normal calcium level; phosphate of 0.5mmol/1 and alkaline phosphatase of 400i.u/1. Parathyroid hormone level was not raised and the 24 hour urine phosphate level was within normal limit. The diagnosis of x-linked hypophosphatemic rickets was made mainly due to the strong family history, but she was lost to follow up before any treatment could be started.

She was seen again at the age of 21 for bowing of both lower limbs and short stature. She was otherwise independent and worked as a clerk.

On examination, she was noted to be short and had frontal bossing. Her height was 129cm and arm span was 133cm. Both her lower limbs were bowed with the tibiae and femurs equally involved.

She had corrective osteotomies for both her femurs with interlocking nail fixation and is currently awaiting further operative correction of both the tibiae.

## Discussion

The charecteristic features of x-linked hypophosphatemic rickets are described by Albright *et al*[2]. These include:

1. Familial occurrence with x-linked dominant inheritance as in this family.
2. Hypophosphatemia with decreased renal tubular reabsorption of phosphate - the phosphate levels in both the cases were at the lower limit of normal.
3. Typical normocalcaemia.
4. Decreased intestinal absorption of phosphate and calsium.
5. Decreased growth rate.
6. No known disorders of vitamin D.
7. Rickets and osteomalacia in more severely affected individuals, unresponsive to vitamin D.
8. Increased bony density in adulthood with bony overgrowth at the sites of muscle attachment.

The extended family history strongly suggests an x-linked dominant (Fig. 3) inheritance. The sons and daughters of affected females have 50% chance of being affected, whereas the daughters are always affected if the father suffers from the disease. The x dominant gene is passed down from the affected father to his daughters as seen in the families of LF and his brother. However, in the case of LF's grandmother, both her daughter and son were involved. Similar patterns could be seen in the other affected females and their offsprings.

Few authors have reported patients with x-linked hypophosphatemic rickets (XLHR) complicated by signs of cord compression. Cartwright *et al*[3] reported a patient with cervical stenosis from C3-7 and lumbar stenosis from L1-S1. He further analysed lumbar spine radiographs of 17 adults with XLHR and noted that the AP and transverse diameters were significantly smaller than normal controls. Similar findings were noted in case 1. Spinal stenosis in these patients are often due to

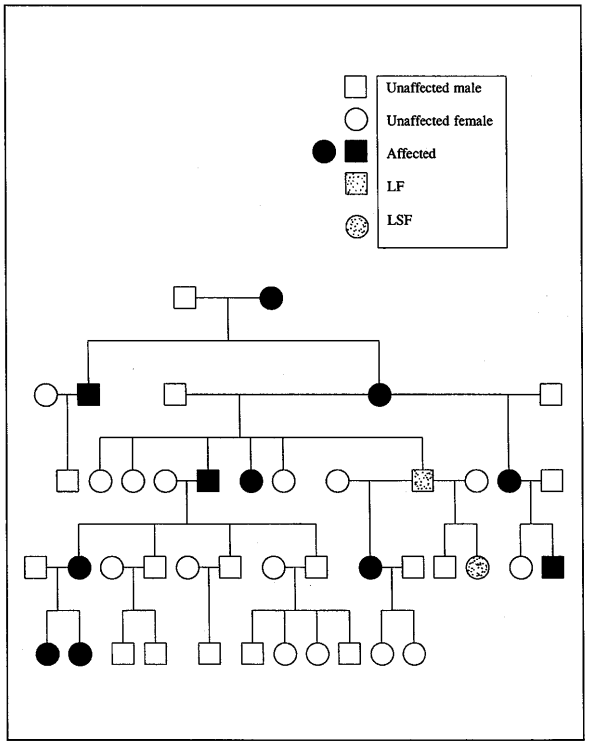


**Fig. 2: The distribution of the area of origin.**

**Fig. 3a**

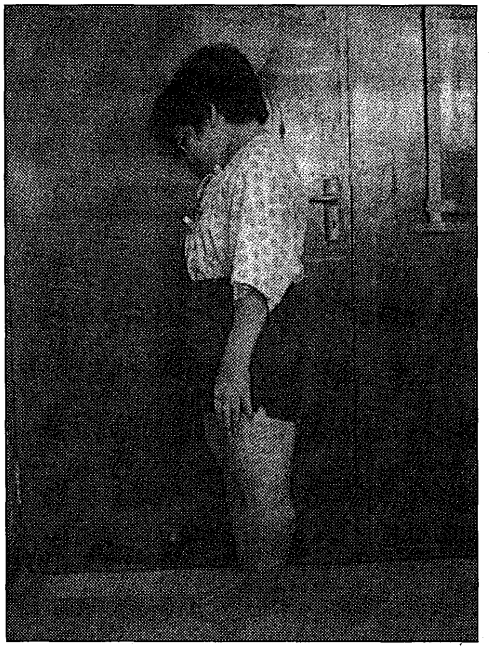

**Fig. 3b**

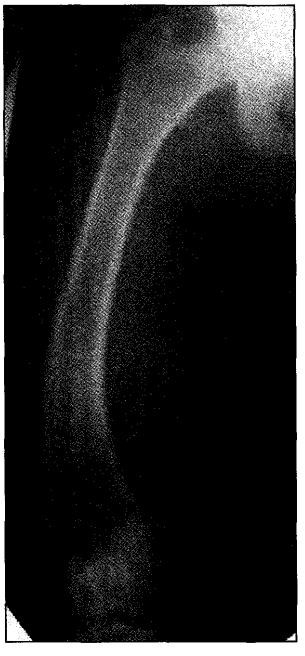

**Fig. 4**

the bony overgrowth about the sites of muscular or ligamental attachment. Ligamentum flavum may be ossified due to mechanical stress and an increase in calcium retention. Any of these factors can contribute to spinal stenosis.

Therapy in XLHR is still controversial. Current treatment for XLHR consists of daily doses of oral phosphate in combination with 1,25 DHCC. However the treatment is unsatisfactory due to poor success rate in correction of biochemical abnormalities, bone density, prevention of deformities and short stature. It is also associated with increased incidence of nephrocalcinosis and hyperparathyroidism. Conclusions from earlier studies did not favour treatment at all since the complications outweighed the benefits. However, more recent studies demonstrate that treatment may prevent progressive ankylosis of the spine and major joints, dental caries, pseudofractures and other complications in untreated patients[4,5]. Growth hormore is currently being evaluated to be used in conjunction with 1,25 DHCC as a phosphate sparing agent to decrease tthe incidence of nephrocalcinosis[6].

Reade *et al*[7] in 1986 localised the human hypophosphatemic gene to the distal end of the x-chromosome at the Xp22 region. More advances could be made in the study of this gene as newer techniques such as subtraction hybridization, automated DNA sequencing and polymerase chain reaction are available. This may eventually lead to early diagnosis and gene therapy for the affected individuals.

## References


1. Shriver CR, Reade, DeLuca HF, Hamstara AJ. Serum 1, 25 dihydroxyvitamin D levels in normal subjects and patients with hereditary rickets or bone disease. N Eng J Med 1978; 299: 976-9.
2. Albright F, Butler AM, Bloomberg E: Rickets resistant to Vitamin D Therapy. AM J Dis Child 1937; 54: 529-47.
3. Cartwright DW, Latham SC, Masel JP, Yelland JDN: Spinal canal stenosis in adult with hypophosphatemic vitamin D resistant rickets. Aust NZ J Med 1979; 9: 705-8.
4. Hardy DC, Murphy WA, Siegel BA, Reid IR, Whyte MP. X-linked hypophosphataemic rickets in adults: prevalence of skeletaal radiographic and scintigraphic features. Radiology, 1989: 171: 403-14.
5. Reid IR, Hardy DC, Murphy WA, Teitebaum SI, Bergfield MA, Whyte MP. X-linked hypophosphataemia: a clinical, biochemical and histopathologic assessment of morbidity in adults. Medicine. 1989: 68: 336-52.
6. Patal, P.E. Clayton, C. Brain, E. Pelekouda, M. Addison, D.A. Price and M.Z. Mughal. Acute biochemical effects of Growth Hormone treatment compared with conventional treatment in familial hypophosphataemic rickets. Endocrinology 1996; 44: 687-96.
7. Reade AP, Thakker RV, Davis KE, *et al*. Mapping of human x-linked hypophosphatemic rickets by multilocus linkage analysis. Hum Gnet. 1986: 75: 267-70.

CASE REPORT

# Tuberculosis of the Distal End of the Radius Mimicking a Giant-Cell Tumour

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**Summary**

We report a case of a lady presenting with a lesion in the distal radius with classical radiological features of a giant-cell tumour. These tumours are often resected without preliminary histological confirmation. A biopsy done in this patient showed it to be tuberculosis.

*Key Words: Giant-cell tumour, Distal radius, Tuberculosis*

## Introduction

The distal radius is a common site for giant-cell tumours. In reported series for treatment and reconstruction, the procedures are sometimes performed without prior histological confirmation. This is justified on the premise that the radiological findings are classical and that it would obviate an extra opportunity for complications. However, we need to keep in mind that tuberculosis is a "master mimic" and can readily be mistaken for giant-cell tumour in that location.

## Case Report

A 50 year-old lady was referred from the outpatients' clinic with a complaint of a swelling over the left wrist of two months' duration. The swelling had been gradually increasing in size and the patient felt a mild throbbing pain. On examination, there was a diffuse swelling over the distal end of the radius, more prominent over the dorsum.

Plain radiographs were reported by the radiologist as a well-defined expansile lesion at the distal end of the left radius with a "soap-bubble" appearance, consistent with giant-cell tumour of the distal radius. The lesion was bounded by the subchondral plate and slightly eccentric, being more dorsally placed. As such, we concurred with the findings and graded it as a stage 3 tumour as it seemed to have broken through the cortex at the styloid process. (Fig. 1)

The condition was explained to the patient and a biopsy done. At surgery, after a cortical window had been made over the distal radius, a cheesy, yellowish white material oozed out. This was sent for Ziehl Nielsen stain and showed numerous acid fast bacilli. Histopathological examination confirmed the diagnosis of tuberculosis. The patient was given the appropriate anti-tuberculous chemotherapy.

## Discussion

Approximately 10 percent of giant-cell tumours occur in the distal end of the radius. This location is the third most common for giant-cell tumours of bone. As with giant-cell tumours in other sites, it has a predilection for female patients. Together with the classical radiographic appearance found in this patient it was easy for us to be misled. On hindsight though, there were two factors in

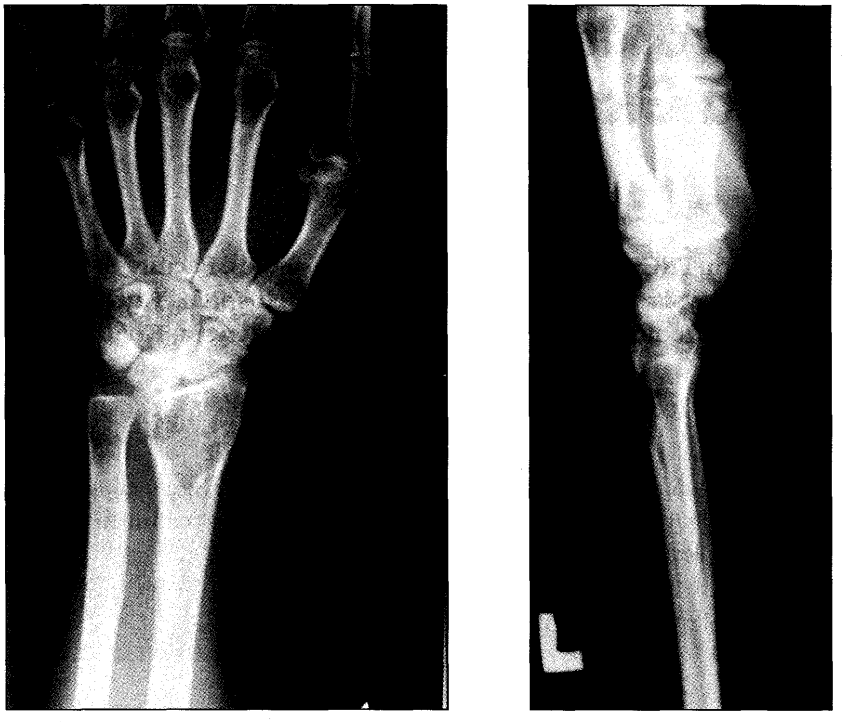

**Fig. 1a & 1b: Anteroposterior and lateral radiographs of the wrist showing the lesion.**

this patient not typical of a giant-cell tumour. The first was that the patient was 50 years old. Giant-cell tumours usually present in the third and fourth decade. The second was that the swelling felt knobby and was more hard in consistency than what one would expect of a giant-cell tumour.

Murray *et al.*[1] in Houston reported 18 cases of giant-cell tumours of the distal radius treated by resection and fibular autograft interpositional arthrodesis. In five of these patients, "definitive treatment was carried out without a preliminary histological confirmation because the lesion was sufficiently classic in its clinical and radiographic presentation to justify the procedure and avoid one opportunity for complication". Pho[2] in Singapore reported five similar cases treated by a free vascularised fibular transplant. In two patients, "the radiographic changes were consistent with malignant giant-cell tumour and the tumour had involved the whole circumference of the distal end of the radius; therefore, a primary en bloc resection without biopsy was performed."

From our experience in this case, we would hesitate to perform major excision and reconstruction procedures before histological confirmation. With the increasing incidence of tuberculosis in Malaysia, it may be more prudent to do biopsy first.

## References

1. Murray JA, Schlafly B. Giant-cell tumours in the distal end of the radius. J Bone Joint Surg. 1986; 68A: 687-94.

2. Pho RWH. Malignant giant-cell tumour of the distal end of the radius treated by a free vascularised fibular transplant. J Bone Joint Surg. 1981; 63A: 877-84.

CASE REPORT

# Osteopoikilosis - A Case Report

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**Summary**

Osteopoikilosis is a rare, inheritable, sclerosing bone dysplasia; sometimes mistaken for osteoblastic bone metastases. We report a case in a 25 year-old lady.

*Key Words:* Osteopoikilosis, Case report

## Introduction

Osteopoikilosis, as known as spotted bones disease, is a rare osteosclerotic dysplasia. It is often an incidental finding when radiographs are taken for other purposes. It needs to be distinguished from osteoblastic bone metastases. To the best of our knowledge, it has not been reported in Malaysia.

## Case Report

A 25 year-old lady was seen at the orthopaedic clinic with a complaint of low backache of 6 months' duration. She had been referred from the outpatient' clinic where a plain radiograph of the lumbar spine was reported to have shown lesions suspicious of metastatic disease or of lymphoma. There was no history of trauma and she had otherwise been well.

On examination, the patient was a healthy looking young lady of Indian descent. There were no positive findings, both generally and locally at the spine. There was also no evidence of any skin lesion.

Radiological examination showed numerous circular foci of increased radiodensity in the spine, pelvis, wrists, elbows, shoulders, hips; knees and ankles. (Fig. 1).

**Fig. 1a: Pelvis and hips.**

The condition was explained to her and reassurance given. Analgesics were prescribed for the backache and when last seen three months later she did not have any more pain.

## Discussion

Osteopoikilosis, spotted bone disease or osteopathic condensans disseminata is one of the rare hereditary dysplasia of the skeleton. Since the first description of

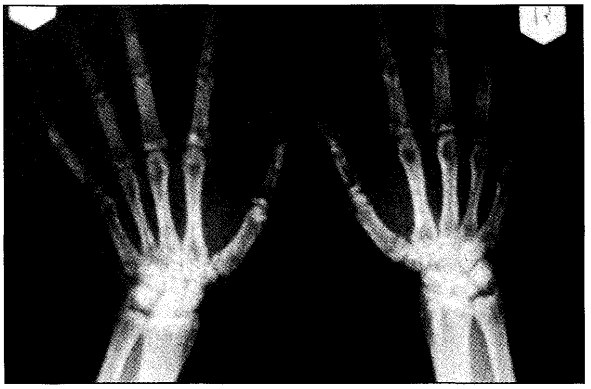

**Fig. 1b: Hands and wrists.**

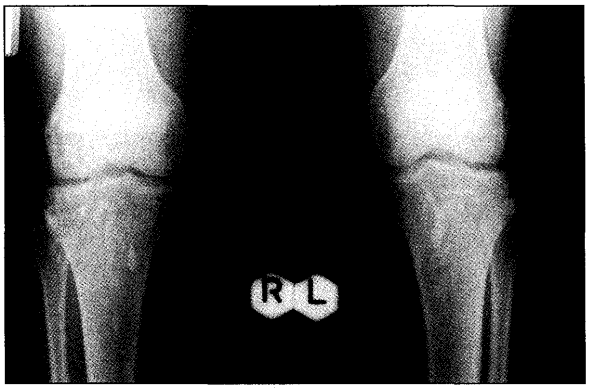


**Fig. 1c: Knees.**

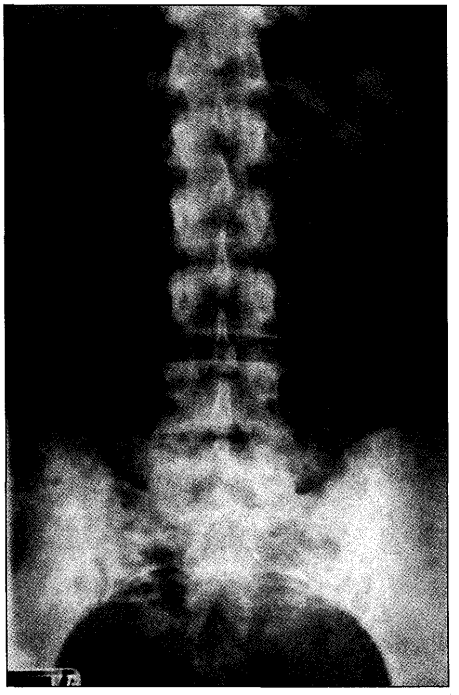

**Fig. 1d: Lumbar spine.**

osteopoikilosis in 1915, about 300 cases have been reported[1]. It is an asymptomatic osteosclerotic dysplasia with an obscure aetiology and pathogenesis. Its familial occurrence indicated an autosomal dominant pattern of genetic transmission. It may be associated with whitish spots in the skin (disseminated lenticular dermatofibrosis). The radiographic findings are highly diagnostic and consist of numerous symmetrically distributed[2] well-defined circular or ovoid foci of increased radiodensity in medullary bone. There is a predilection for the epiphyseal and metaphyseal areas of the long tubular bones, carpus, tarsus, pelvis and scapulae. These areas do not demonstrate increased activity on bone scan[3]. It can be mistaken on first look for osteoblastic bone metastases, as happened in our patient.

## References

1. Szabo AP. Osteopoikilosis in a twin. Clin. Orthop. 1971; 79: 156-63.
2. Chigira M, Kato K, Mashio K, Shinozaki T. Symmetry of bone lesions in osteopoikilosis. Report of 4 cases. Acta Orthop Scand 1991; 65 (5) 495-6.
3. Ostrowski DM, Gilula LA. Mixed sclerosing bone dystrophy presenting with upper extremity deformities. A case report and review of the literature. J Hand Surg (Br). 1992 Feb; 17 (1): 108-12.