ORTHOPAEDIC SUPPLEMENT

Official Journal of the Malaysian Medical Association

The Medical Journal of Malaysia

Orthopaedic Supplement

Volume 56

Supplement D

December 2001

ISSN 0300-5283 PP 2121/11/99 MITA(P) 124/1/91

MJM

Official Journal of the Malaysian Medical Association

Volume 56 Supplement D December 2001

EDITORIAL BOARD

PP 2121/11/00 MCI (P) 124/1/91 ISSN 0300-5283

The Medical Journal of Malaysia is published four times a year
i.e. March, June, September and December.

All articles which are published, including editorials, letters and book reviews represent the opinion of the authors and are not necessarily those of the Malaysian Medical Association unless otherwise expressed.

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Subscription Rates:
Price per copy is RM70.00 or RM280.00 per annum, for all subscribers.

Secretariat Address:
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Publishing Consultant and Printer: New Voyager Corporation Sdn. Bhd. (514424-U)
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Books and Other Monographs

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   Osler AG. Complement: mechanisms and functions. Englewood Cliffs: Prentice-Hall, 1976.

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5. Editor, Compiler, Chairman as Author
   Rhodes AJ, Van Rooyen CE (comps). Textbook of virology: For students and practitioners of medicine and the other health sciences (5th ed). Baltimore: Williams & Wilkins, 1968.

6. Chapter in Book
   Weinstein L, Swartz MN. Pathogenic properties of invading micro-organisms. In: Sodeman WAJr, Sodeman WA (eds). Pathologic physiology: mechanisms of disease. Philadelphia: WB Saunders, 1974: 457 - 72.

7. Agency Publication
   National Care for Health Statistics. Acute conditions: incidence and associated disability, United States, July1968 - June 1969. Rockville, Me: National Centre for Health Statistics, 1972. (Vital and health statistics). Series 10: data from the National Health Survey, No 69). (DHEW Publication No (HSM) 72 - 1036).

Other Articles

8. Newspaper Article
   Shaffer RA. Advances in chemistry are starting to unlock mysteries of the brain: discoveries could help cure alcoholism and insomnia, explain mental illness. However, the messengers work. Wall Street Journal 1977; Aug 12: 1(col 1), 10 (col 1).

9. Magazine Article
   Roucehe B. Annals of medicine: the Santa Claus culture. The New Yorker 1971; Sep 4: 66 - 81).

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EDITORIAL

Orthopaedic Training in Malaysia 1981-2001: Two Decades of the Masters Programme

I Sharaf, FRCS, President (2001-2002), Malaysian Orthopaedic Association

Nearly a quarter century ago, Balasubramaniam[1] and Silva[2] wrote on the pressing need for a local training programme in orthopaedics. The advantages were obvious. A locally trained surgeon would be familiar with the local conditions and during this training, his/her services would be available locally. There were only about 30 members of the Malaysian Orthopaedic Association (MOA) then[3].

In 1981, the masters programme in orthopaedics started with the first intake in Universiti Kebangsaan Malaysia (UKM) under the late Prof. Q.M. Iqbal. This was followed by University Malaya (UM) in 1990 and Universiti Sains Malaysia (USM) in 1991. Orthopaedic surgery is a popular specialty for doctors wishing to specialize. More than 100 doctors apply annually to the three universities. The competition is keen, as training places are limited.

In 1996, the open programme started to allow more doctors to enter the programme without the public hospitals losing their services for the first 3 years. The final year is spent in the university hospitals where more emphasis is placed on the academic aspects of their training and in preparing for their Part 2 examination.

From 1981 to 2001, 172 doctors have qualified as orthopaedic surgeons from the 3 universities. Ninety-seven from UKM, 46 from UM and 29 from USM. It is now time to reflect on the two decades since and the future of the programme. What can we do to improve the programme?

The conjoined board in orthopaedics comprising representatives from the universities, Ministry of Health and the Academy of Medicine has been in existence for about a decade but have yet to agree on a common training programme and national examination. We need to agree on a national training programme and examination to ensure uniformity and the highest standards in training and assessment.

Could the Part 1 examination be open to all doctors with a pass in the Part 1 as a pre-requisite for entry into the programme? This will allow our trainees to utilize the 4 years fully in clinical work.

Over the past few years, the number of orthopaedic courses conducted locally has steadily increased. The intensive course, our annual scientific meeting, and the introductory course are now established events in our calendar. In addition, the subspecialty groups are actively conducting courses throughout the year. The time has come for subspeciality training to be conducted locally with a minimum period of 2 years including 6 months abroad.

The consultants in public hospitals are now actively supervising the trainees in the open

system. A small number of trainees have collaborated with surgeons in private hospitals in training and research. More is needed.

Over the past 25 years, our membership has increased ten-fold. We now have nearly 300 members including 13 lady orthopaedic surgeons. These changes augur well for orthopaedics. Malaysia needs more orthopaedic surgeons. Let us work together in training and teaching our younger colleagues.

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EDITOR'S NOTE

Orthopaedic Research in Malaysia: Our Legacy and Some Thoughts on Future Directions

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"The ideal would be to train orthopaedic surgeons who have a great skill with their hands, with a desire to improve the known and an inquisitiveness for the unknown"

...JF Silva, Founding Professor, Orthopaedics, University of Malaya; (16th AM Ismail Oration, 1989)

Orthopaedics in Malaysia had very humble beginnings. The first services in the public hospital system was available only after the second world war at the General Hospital Kuala Lumpur; and the first academic department was set up on 28th February 1966 at University of Malaya.

We never looked back since! Today we have nearly 200 trained and soon to be qualified surgeons in a comprehensive *public hospital system* complemented by *private hospital orthopaedic services;* backed up by 3 well established academic departments (UM, UKM, and USM) with 4 up and coming academic units (UNIMAS, IIU, UPM and IMU) at the newer medical schools. The cooperation from all these sectors is the envy of other disciplines. What an achievement in only half a lifetime!

We have never had a shortage of giants to look up to; legends in Malaysian Orthopaedics who have been honoured abroad by Hunterian Lectures (JF Silva), being cited in Robert Jones lectures (AM Ismail), and many others too numerous to mention here. We have produced pioneering and innovative work of international standard since the 1970's. Most notably of these are the Total Elbow Replacement, Experimental Scoliosis in monkeys, posterior spinal fixation devices, and the electron microscopy studies on Volkmann's Ischemic Contracture. Our surgeons have published in premier orthopaedic journals including the Journal of Bone and Joint Surgery (British and American Editions), Spine, Clinical Orthopaedics and Related Research, and Injury; just to name a few. Others have become associate editors of premier journals such as the Orthopaedic Clinics of North America, Spine and Clinical Orthopaedics and Related Research. Many have been contributing authors to well established international orthopaedic texts; and two now historically classic works have been produced, *"The Management of Neglected Trauma"* and *"Orthopaedic Surgery in South East Asia"*. Younger surgeons have regularly presented innovative scientific work at top notch speciality meetings such as the Scoliosis Research Society, American Orthopaedic Association, American Academy of Orthopaedic Surgeons, SICOT, British Scoliosis Society and many others.

How are we to maintain and expand on this legacy that we are heirs to? The following represent some personal thoughts of mine stimulated by JF Silva's charge to us in his AM Ismail Oration of 1989.

The first is to improve the clinical knowledge of what is ***known.*** It is still desirable to do clinical outcome studies. The natural history of some very common conditions surprisingly are not completely documented. There is vast potential for work here. The diabetic foot and the infected tibia non-union are ubiquitous in Malaysian orthopaedic practice, and are excellent areas for basic work. Molecular level orthopaedics, looking at the effects of growth factors, peptides and hormones are a rich area for study.

The second is to instill a spirit of ***inquisitiveness for the unknown*** in all our young trainees at their formative years. They should ask fundamental questions, and be encouraged to venture into experimental orthopaedics. Collaboration with Mechanical and Computer engineers can provide the solutions to many of the unsolved problems in today's orthopaedic frontiers. Potential areas for work are mathematical and simulation modeling in composite materials; and rapid prototyping of innovative orthopaedic devices. Experimental orthopaedics also encompasses animal work; and an area with potential for substantial work is experimental scoliosis, which we have already had some experience in the 1970's.

The third is to create the ***facilities*** to do this work. While we have orthopaedic laboratories at the academic units, we should strive to provide this opportunity for the young surgeons in the public hospital system or encourage them to do this type of work at academic units; perhaps working part time for higher academic doctoral degrees (e.g. PhD). If we are unable to provide this infrastructure to all our boys (and girls); some may have to go abroad to laboratories which can give them this opportunity. This can be arranged as part of larger and long term collaborative projects between institutes. An example would be a young surgeon from Malaysia going to the US for 3 months to do some laboratory work, maintaining his PhD candidature at a home University to complete his thesis; while the big project carries on.

The fourth and the last (perhaps the most developed of all for us at the moment) is the vehicle for the ***expression*** of this work. To this end we already have a peer reviewed and indexed journal (as a supplement to the Medical Journal of Malaysia - your journal!) which is an ideal milieu for rapid publication. Since its inception we have progressed from a single issue per year to 2 issues. The most striking development is in the quality of submissions, which have improved greatly in the past 3 years. The readership has largely been local but we hope to make it regional and international by expanding the scope of work published in it. The survival of this journal is dependent on the support of the orthopaedic community. Please submit your work.

Our legacy that we inherited will not be easy to match, let alone outdo. This is because our predecessors have set very high standards. Isaac Newton said that his achievements were only because he stood on the shoulders of giants; we stand on several giants' shoulders: AM Ismail, JF Silva, QM Iqbal, N Subramanium, P Balasubramaniam, S Sengupta, and many other great teachers and thinkers. Some are with us; and some have gone, but are still remembered very fondly as fatherly figures.

Publish or perish, that is the maxim of academic orthopaedics. As the line dividing academia and professional practice blurs, it becomes very clear that all surgeons have to publish. This is the only way to ensure rigorous peer audit of our practice. I end with Galileo's commandment,

"Science knows only one commandment: contribute to science."

In Bertolt Brecht, *The Life of Galileo.*

ORIGINAL ARTICLE

Risk Factors for Infection in Total Knee Replacement Surgery at Hospital Kuala Lumpur

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Summary

One hundred primary TKR surgeries done between January 1994 and December 1999 were reviewed after a mean follow-up of 37.4 months. The rate of superficial and deep wound infection were 2% and 9% respectively. The most common organism in wound infection was *Staphylococcus aureus*. The factors that were significantly associated with superficial wound infection were diabetes mellitus (p=0.005) and Rheumatoid arthritis (p=0.0000). The factors that were significantly associated with deep wound infection were diabetes mellitus (p=0.000). There was no significant difference between duration of surgery, and the mean age among patients with and without wound infections.

Key Words: Total knee replacement, Infection

Introduction

Total knee replacement (TKR) surgery represents a major advance in the treatment of degenerative joint disease, providing dramatic pain relief and good restoration of knee joint function. Both Freeman and Sheehan in the United Kingdom developed the total replacement of the knee joints surface by prosthesis in the late 1960's[1]. Since then, there has been enormous developments of different types of prosthesis. Additional difficulties have been encountered due to a thin capsule; and subcutaneous tissue and skin with variable blood supply that resists and counteracts infection poorly. Skin healing problems are more frequent at the knee, especially if the skin is handled carelessly[2].

Wound infection can be divided into two; superficial infection and deep infection. The superficial infection is defined as the localised inflammation at the suture site. Here the skin is mobile and drainage is minimum. On the other hand, the drainage is copious and persistent in the case of deep infection[3]. Once an arthroplasty joint infection has occurred, it is considered a catastrophic outcome, and presents a major problem in clinical management; resulting in a significant burden on the resources. This study was carried out with the objectives of determining the crude rate of superficial and deep wound infection of TKR done at Hospital Kuala Lumpur, and the factors associated with it.

Materials and Methods

Data on TKR surgery over a 6-year period between January 1994 and December 1999 were collected retrospectively and recorded into a standard performa sheet. The factors associated with superficial and deep wound infection in TKR were evaluated by a case-control study design; comparing patients who underwent TKR and subsequently developing wound infections, against controls who underwent TKR but did not develop wound infections.

SPSS for Windows V10.0.5 was used for analysis. Post-operative superficial and deep wound infections were analysed in relation to diabetes mellitus, previous surgery of the affected joint, inflammatory arthritis, sex, usage of bone grafts, surgeon's glove perforation, obesity and surgical approach. The statistical test applied for this was *Chi square with Yates correction*. Difference between age and duration of surgery was tested by *independent-sample T test* (Student's T test). Significance was set at $p<0.05$.

Results

Of a total of 136 primary TKR's, 100 (73.5 %) were available for study; 36 were excluded because of irretrievable records, inadequate information or less than 12 months follow up. The mean follow up of the 100 study cases was 37.4 months (range 14 to 84 months, SD 20.5 months). All patients received pre and post operative prophylactic antibiotics. The mean preoperative stay was 5.58 days (range 2 to 64) and the mean post operative stay was 15.93 days (range 7 to 71). The mean duration of surgery was 164.15 minutes (range 60 to 325 minutes, SD 46.77). The indications for surgery are shown in Table I. Twenty-nine patients had complications as listed in Table II. The rate of superficial wound infection was 2%; and deep wound infection was 9%.

Superficial Infection: Six cases had superficial infection. Of these, 4 cases progressed to deep infections. The two true superficial infections grew *Staphylococcus aureus* (methicillin resistant) and *Pseudomonas aeruginosa,* strongly suggesting nosocomial contamination. Diabetes mellitus and rheumatoid arthritis were associated with superficial infections. The factors that were not significantly associated with superficial infection were previous history of surgery in the joint, sex, bone graft usage. There was no difference in the mean duration of surgery (180

Table I
Indication for Primary Total Knee Replacement Surgeries

Indication	Number of Knees			(%)
	Male	Female	Total	
Osteoarthritis	10	75	85	85
Rheumatoid Arthritis	0	12	12	12
Other Connective Tissue Disease	0	2	2	2
GCT of tibia	0	1	1	1

Table II
Complications of Total Knee Replacement Surgeries

Complication	Number of Knees	(%)
1. Deep Infection	9	9
2. Superficial Infection	6 (4 progressing to deep)	6
3. Urinary Tract Infection	4	4
4. Aseptic Loosening	2	2
5. Peroneal nerve palsy	1	1
6. Severe occipital headache	1	1
7. Numbness of L5/S1 dermatome	1	1
8. Patellar instability	1	1
9. Knee haemarthrosis	1	1
10. Epilepsy fit	1	1
11. Deep vein thrombosis	1	1
12. Acute myocardial infarction	1	1

Table III
Organisms Identified in Deep Wound Infections

Organism	Frequency
Staphylococcus aureus	2
Acinetobacter species	2
Streptococcus group-D	1
Candida albicans	1

mins and 163.14 mins respectively, p=0.397) and age of patient at surgery (55.3 yrs and 61.00 yrs respectively, p=0.195).

Deep Infection: Nine cases of deep infection were recorded, 4 progressing from superficial infection. Organisms were identified in 6 cases (Table III). Four cases developed early deep infection (less than 1 month after surgery) and 5 cases developed deep infection later (more than 1 month); of which 1 case presented 2 years after surgery. Diabetes mellitus was significantly associated with deep wound infection. The factors that were not significantly associated with superficial infection were rheumatoid arthritis, previous history of surgery in the joint, sex, bone graft usage. There was no difference in the mean duration of surgery (172.78 mins and 163.30 mins respectively, p=0.566) and age of patient at surgery (61.44 yrs and 60.58 yrs respectively, p=0.813).

Discussion

The true incidence of deep sepsis in joint replacements is unknown in the UK or USA due to lack of national data[4]. The only national figures available are from the Swedish knee studies. The Swedish Knee Arthroplasty Project found a 1.7% incidence in osteoarthrosis and 4.4% rate in rheumatoid arthritis[5]. Charnley diagnosed an arthroplasty infection when a sinus was present, and reported a 1.1% infection rate in hips when antibiotics and 'clean air' was used[6]. We now know that low grade pathogens can lie dormant in wounds, and that sub-clinical infection may present as loosening; leading us to conclude that the true incidence of hip arthroplasty infections may never be known, and at best always under reported. This is even higher in knee arthroplasty[7].

The rate of deep infection in this study was 9.0%. We recognise that this may represent an under reporting of infection in this institute, but it gives us a baseline to compare with. Infection rates in conventional operating rooms have been reported to be as high as 8.2%[7]. While special measures such as body-exhaust suits, ultra clean air and laminar airflow system[8] were not necessary for hip arthroplasties in the same institute[9], these may be a consideration for knee arthroplasty.

The most common infecting organism identified in deep infection was *Acinobacter* and *Staphylococcus aureus,* with one (50%) of them being methicillin resistant (MRSA). This has dire consequences if allowed to progress. In this study, diabetes mellitus and rheumatoid arthritis are significantly associated with superficial wound infection, while diabetes is significantly associated deep wound infection. Diabetes is a well-known factor of poor wound healing and increased risk of subsequent wound infection. Rheumatoid arthritis is also associated with poor wound healing. Previous operation on the affected joint, sex, usage of bone grafts, surgeon's glove perforation duration of surgery and age at surgery were not found to be significantly associated with infection in this study.

Conclusion

The rate of superficial and deep wound infection in TKR procedures done in hospital Kuala Lumpur is 2% and 9% respectively. The most common organism in superficial wound infection was *Staphylococcus aureus* and *Acinobacter sp.* The factors that were significantly associated with superficial wound infection are diabetes mellitus (p=0.005) and rheumatoid arthritis (p=0.0000). The factor that were significantly associated with deep wound infection were diabetes mellitus (p=0.000).

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ORIGINAL ARTICLE

Vulnerability of the Lower Limb in Non-Fatal Motorcycle Injuries

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Summary

Motorcyclists form the highest group of fatalities on Malaysian roads. This is a prospective study conducted at 3 major hospitals for a period of 12 months to determine the type of motorcyclist injuries that usually required hospitalization. Four hundred and twelve consecutively injured motorcyclists were available for study. One hundred and eighty six (45.15%) were fatally injured and 226 (54.85%) were seriously injured and surviving. The main cause of fatalities was head injury, while lower limb injuries accounted for majority of hospitalisations. This study highlights the vulnerability of the motorcyclist to lower limb injuries.

Key Words: Motorcycle injuries, Lower limb

Introduction

Malaysia has undergone tremendous industrialisation in the past 20 years, with consequent change in economic status. A direct effect of this is a changing demography of the injury patterns[1], where road traffic accident deaths are now the leading cause of deaths[2]; in contrast to 20 years ago when communicable diseases was the leading cause of death. In 1997, there were 6,302 deaths due to road traffic accidents, of which 3,760 (59.6%) were motorcyclists[2]. The purpose of this study was to determine the type of injuries sustained by the motorcyclists that required hospitalization.

Materials and Methods

Four hundred and twelve motorcyclists and pillion riders who were road traffic accident victims were studied prospectively in 3 study hospitals (two level 1 and one level 2 trauma centres) during a period of 12 months between 1st January and 31st December 1998. Data were collected at the pre hospital level with the involvement of the Royal Malaysian Traffic Police, Malaysian Red Crescent Ambulance Services, Fire and Rescue Services, Hospital Emergency Services; and subsequent clinical ward records. Two outcomes were set for this study; either (i) *fatal* or (ii) *seriously injured and surviving*. The injured and surviving were the focus of this study to determine the injury which required hospitalisation.

Results

One hundred and eighty six (45.15%) of the motorcyclists admitted to the designated hospitals were fatally injured and 226 (54.85%) were seriously injured and surviving.

There were 225 severe organ injuries leading to the 186 fatalities investigated. Sixty-one (32.8%) fatalities were listed as having more than 1 severe organ injury causing death. When stratified according to organs injured, 117 of the total injuries (62.9%) were head injuries, 31 (16.7%) were neck injuries, 68 (36.6%) were chest injuries and 27 (14.5%) were abdominal injuries. Seventy-one point five percent of the fatalities occurred at the scene, and 25.3% of the fatalities within 3 hours of admission (Fig. 1).

Two hundred and twenty six patients survived were available for study. Integument injuries were commonest accounting for 48.1% of all patients in this group (abrasions 29.9%, lacerations 13.3%, and contusions 4.9%). Fractures and fracture dislocations of skeletal structures and joints occurred in 37.6% of this group. When analysed according to body part injured, 56.1% had lower limb injuries with upper limb injuries accounting for 20.0%. Injuries to limbs were greater in number than injuries to head, chest or abdomen (Fig. 2). Lower limb injuries were responsible for longer hospital stays (Fig. 3).

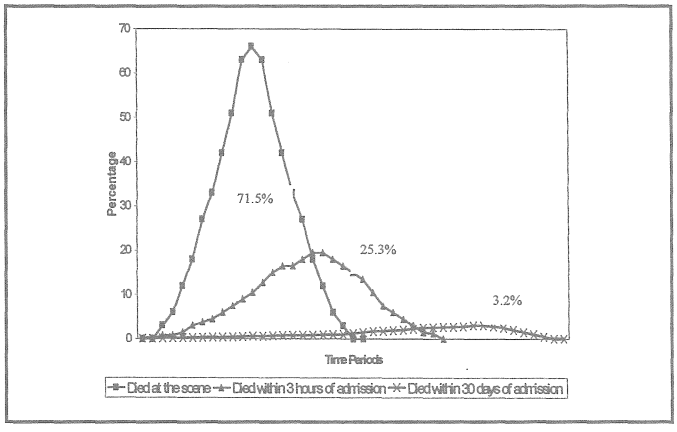

Fig. 1: Time period of deaths.

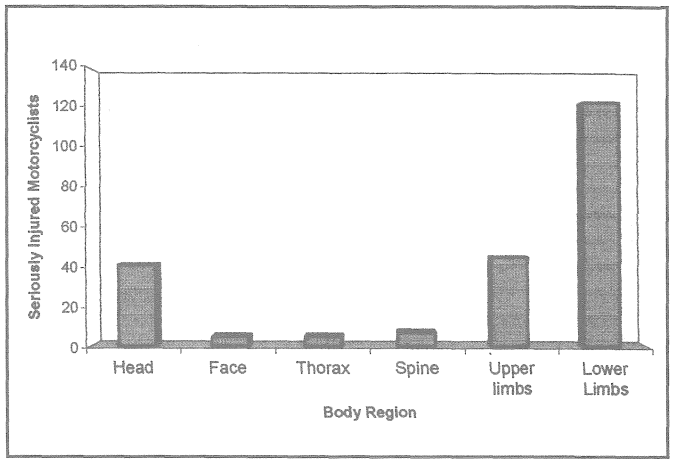

Fig. 2: Anatomical part injured in surviving casualties.

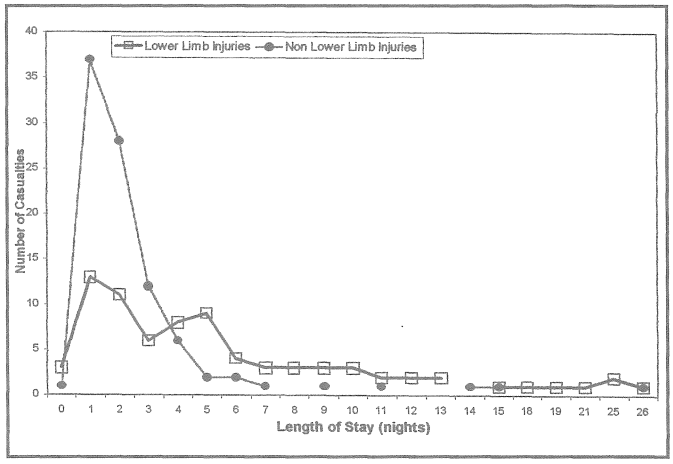

Fig. 3: Length of stay in hospital for lower limb and non-lower limb injuries.

Discussion

Motorcyclists account for 60 percent of road deaths in Malaysia[2]. Among motorcyclist that died, 71.5% occurred at the scene, or soon after the event. This is consistent with the findings of Harms[3] and Whittaker[4]. The reason for such high fatality rates is due to the fact that these are unsalvageable trauma, usually as a result of severe head injury. Although the wearing of

motorcycle safety helmets have been compulsory by law since 1971 in Malaysia, the compliance and proper wearing of these helmets is still an issue[5].

Non-fatal casualties involved injuries to limbs. This is consistent with the findings of Begg[6]. Lower limb injuries predominated in this study, and contributed to long-term hospitalisation (Fig. 3). This is consistent with the findings of Grattan[7]. The injury patterns that are seen here are similar to that of the high income first world countries[8], however the fatalities are proportionately higher. Little can be achieved in unsalvageable fatal trauma, so efforts should be directed to preventing trauma from occurring by increasing road user awareness on road safety issues, and improving pre hospital care[9,10]. Another area for active intervention is the prevention of, or reduction of severity of the lower limb injuries sustained by these motorcyclists. The possibility of rigid leg protectors or design modification of the motorcycle are areas for consideration. This will directly translate to reduced hospital admissions and reduced length of hospital stay.

Conclusion

Limb injuries constitute the majority of admissions among those admitted following motorcycle accidents. The lower limb is the most vulnerable to injuries, and once injured requires longer hospitalization.

Acknowledgements

This study is supported by a grant from the Ministry of Transport, Malaysia. We would like to acknowledge the assistance of the Emergency Departments, the Pathology Departments, and the Orthopaedic Departments of Hospital Universiti Kebangsaan Malaysia, Hospital Kuala Lumpur, and Hospital Kajang, Malaysia. We would also like to record our appreciation to The Royal Malaysian Police.

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ORIGINAL ARTICLE

Mechanical Failure of Dynamic Hip Screw (DHS) Fixation in Intertrochanteric Fracture of the Femur

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Summary

We studied 60 intertrochanteric fractures of the femur fixed with Dynamic Hip Screw (DHS). There were 10 cases (16.7%) with cutting-out of device through femoral head and neck. Stable fracture pattern, postero-inferior and central position of screw in the femoral neck and head produced high percentage of good result, whereas anterior or superior position of screw produced higher incidence of cut-out. We found osteoporosis and distance of screw tip to subchondral bone to have no influence on the final outcome.

Key Words: Intertrochanteric fracture, Dynamic Hip Screw, Mechanical failure

Introduction

Intertrochanteric fractures of femurs are commonly seen in elderly women in 8th decade due to osteoporotic bone[1]. They caused high morbidity and mortality until the introduction of sliding hip device[2,3]. The Dynamic Hip Screw (DHS) has become a standard method of fixation for this fracture because of its telescopic properties, which allows femoral head collapse, and subsequent impaction of the fractures[2,4]. Early results obtained have been very encouraging, but recent studies have shown complications due to mechanical failures[5]; namely penetration of the joint by tip of the devices, loss of reduction with varus angulations of the femoral neck, cutting-out of the device through the superior portion of the femoral head and neck which is associated with varus angulations. Mechanical failure has been related to factors such as osteoporosis, fracture pattern stability, screw placement and distance of screw tip from subchondral bone. This study was carried out to ascertain the factors that contributed to mechanical failure at our institute.

Materials and Methods

The medical records and radiograph of 70 consecutive patients who had intertrochanteric fractures of the femur treated with DHS at Hospital University Science Malaysia (HUSM) from January 1989 to December 1995 were reviewed. Three patients who had pathological fractures, four with ipsilateral long bones and three who sustained bilateral intertrochanteric fractures were excluded; leaving 60 patients available for the study. The stability of the

fractures before the operation was classified according to Jensen's classification[6]. Bone quality was graded based on Singh's Index (SI)[7] and position of screws in the femoral head as seen on anteroposterior radiographs were assigned as superior, center and inferior; while the position in the lateral radiograph were assigned as anterior, center and posterior. The distance of screw tips from subchondral bone was measured using Doppelt's method[8]. The fixation was considered failed according to Simpson criteria[5]. The data were analysed for significant association with Chi-square method using SPSS 9.05.

Results

Intertrochanteric fractures in this study were commonly seen males (65%=39 males; 35%=21 female). The average age of the patients in our study was 56.4 years with a range from 18 to 97 years old. Majorities of them were in 6th, 7th and 8th decades of life with two peaks of incidence [20 - 40 years (26%) and 60 - 80 years (40%)]. Right and left femurs were equally affected. Mechanical failure occurred in 10 patients (16.7%). Four patients (6.7%) had hip joint penetrations by the screw, 4 (6.7%) screw cutting through the superior femoral neck and 2 patients (3.4%) had broken implants (Table I).

The younger patients (less than 60 years old) attained a higher percentage of good results whereas those patients above 70 years had failure of fixation of more than 50% (Table I). Most of the fractures (61.7%) were classified as stable according to Jensen classification with the majority being Type 2. Sixty-eight percent of good result were seen in stable fractures with 70% of mechanical failure was observed in unstable fractures. There was statistically significant association between mechanical failure and stability of fractures (Table II).

Thirty-seven (61.7%) of the intertrochanteric fractures were not osteoporotic with Singh's Index of grade 4 and above and one of 23 patients (38.3%) had osteoporosis with Singh's Index Grade 1

Table I
Age and Outcome

Age	< 50	50 - 60	61 - 70	> 70
Stable fixation	22 (44%)	6 (12%)	7 (14%)	15 (30%)
Failed fixation	3 (30%)	1 (10%)	1 (10%)	5 (50%)

Chi-square = 1.521, df = 3, p = 0.6775

Table II
Type of Fracture (Jensen Classification) and Outcome

Type of Fracture	Stable			Unstable		
Jensen Type	I	II	III	IV	V	VI
Stable fixation	12	19	3	4	6	6
Failed fixation	0	2	1	2	2	3

Chi-square = 5.939, df = 1, p = 0.0148

Good bone quality of proximal femur produced 64% of stable fixation, however in the failure group, there were equal percentages (50% - 50%) of patients from low grades (I, II, III) and high grade of Singh Index. However, there was no statistically significant association between mechanical failure and degree of osteoporosis (Table III).

Stable fixation were seen in 24 of 27 (88.9%) fixations with screws positioned at the center, 24 of 28 (85.7%) screwed placed at the inferior position showed stable fixation as well, whereas failure of fixation were observed in 3 of 5 (60%) fixation with screws tip were at the superior position. On lateral projection radiographs, 7 of 15 (46.7%) fixations with screw placement at the anterior position resulted in failed fixation, but 23 of 25 (92%) fixation with screw placement at the center and 19 of 20 (95%) fixations with tip of

Table III
Degree of Osteoporosis (Singh index) and Outcome

Degree of Osteoporosis	Osteoporotic			Normal		
Singh index	I	II	III	IV	V	VI
Stable fixation	1 (2%)	4 (8%)	13 (26%)	14 (28%)	8 (16%)	10 (20%)
Failed fixation	0	1 (10%)	4 (40%)	3 (30%)	1 (10%)	1 (10%)

Chi-square = 1.483, df = 5, p = 0.9150

Table IV
Position of Screw in the Femoral Head and Outcome

Screw position	Antero-posterior view			Lateral view		
	Sup	Cent	Inf	Ant	Cent	Post
Stable fixation	2 (4%)	24 (48%)	24 (48%)	8 (16%)	23 (46%)	19 (38%)
Failed Fixation	3 (30%)	3 (30%)	4 (40%)	7 (70%)	2 (20%)	1 (10%)

Chi-square = 20.506, df = 5, p = 0.001

screws placed at the posterior produced stable fixation. It was obvious that central and postero-inferior position of screw produced equally good result (Table IV).

Fixation failure was observed in one of 6 fixations with screw tip-subchondral distance of less than 5mm, 4 (19%) of 25 fixations with screw tip-subchondral distance between 5 to 9mm, 3 of 18 fixations (20%) with screw tip-subchondral distance between 10 to 14mm, and 2 of 11 (22%) fixations with screw tip-subchondral distance of more than 15mm. It was observed that there was no statistically significant association between distance of screw tip from subchondral bone and final outcome (Table V).

Table V
Distance of screw tip and Outcome

Screw tip Subchondral Distance (mm)	Stable Fixation	Failed Fixation	Percentage of Failure (%)
0 - 4	5	1	20
5 - 9	21	4	19
10- 14	15	3	20
>15	9	2	22

Chi-square = 0.026, df = 3, p = 0.9989

Table VI
Timing of Fixation and Outcome

Timing of Fixation	Stable Fixation	Failed Fixation	Percentage of Failure %
< 1week	15	3	20
1 - 2 weeks	23	6	26
> 2 weeks	13	1	7.7

Chi-square = 1.266, df = 2, p = 0.5311

There were 18 patients operated before one week of injury, 29 patients between one to two weeks and 14 patients were operated after 2 weeks. Interestingly we noticed 3 had failed fixation in 18 cases (20%) who underwent operation before 1 week, 6 (26%) fixation failure in 29 patients had operation performed between 1 to 2 weeks and only 1 (7.7%) had fixation failure in 14 fractures operated after 2 weeks (Table VI).

Discussion

Intertrochanteric fracture of femur has been established effecting primarily in elderly[1]. Mean age of patients effected by intertrochanteric fractures varies from study to study. The mean age reported in these patients is 73 to 76 years[1,9]. Our study showed a mean age of incidence to be 56.4 years with two peaks of incidence; younger age group (20 - 40 years) comprised 26% of the patients and 40% of older age groups whose age

were between 60 - 80 years old. All of the younger patients were involved in road traffic accident and had good bone quality, whereas majority of this fracture among old patients were due to fall or injury at home. We observed a higher incidence of intertrochanteric fracture among male patient with ratio of 1.9 to 1. This finding contradicts Gallanger *et. al.* report[10] which female to male ratio of 1.7 to1 to8 to1 in Dahl series[11]. These differences could be explained by the facts that in this study, there were a high proportion of the young male patients involved in motor vehicle accidents.

We have noticed majority of our patients (61.1%) had a higher percentage of stable fractures compared to reports by Simon *et al* in 1989 (30%) and Leung in 1992 (26.7%) but was comparable with Kyle's series in 1986 (57%) and Hogh's reports in 1980 (71%)[12,13,14,15]. However majority of Simon *et al* and Cheung patients were old and they used different set of classifications[14,15]. Most of unstable fractures in our series were young patients who sustained the fractures following motor vehicle accidents.

Osteoporosis has been attributed as an important aetiological factor contributing to proximal femoral fractures[16,17,18]. Through our experience there was no direct association between osteoporosis and severity of fracture in our series. Most of our osteoporotic patients were female (38.8%). This was consistent with reports by Gallagher *et.al.* 1980, Aitken 1984 and Cumming 1990[10,16,17]. The influences of the bone quality on the outcome of fracture fixation is still a controversial issue. Some authors believe that presence of good quality of cancellous bones in femoral head is essential for good fixation[19] but Davis 1989[20] proved that bone density had no significant influences on the outcome of fixation. They was no significant influences on the outcome in osteoporosis and non-osteoporotic bone in our series.

Rate of fixation failure in our study was 16.6%. This is very much higher compared to previous reports by other authors[14,21,22]. Cutting out through femoral head and neck is usually due to technical errors rather than failure of screw to slide predispose to implant to cutting through head and neck[15,23] and hence, it acts likes a fixed device. There are four possible causes for screw failing to slide; callus growing over upper end of the plate, jamming of the two parts of the devices, insufficient slide available and additional fixation around the devices[5]. In this study the fixations were done by surgeon of all grades and seniority, that could be one of the explanation for the higher cutting out rate compared to previous studies[21,23]. Fixation failure has also been related to stability of fractures, inadequate reduction, osteoporosis and placement of the dynamic hip screw within the femoral head[19,20,22]. Seventy percent of fixation failures in our series were due to fractures inherently unstable. This would predispose to displacement of the fracture to a position of varus angulation with shortening of the femur during healing[14].

Many authors believe the cut-out rate is determined by the positioning of the implant in the femoral head[22,25]; however the controversy over central versus posteroinferior placement of chosen implant has been unsettled[21]. There is common acknowledgement that the anterosuperior position should be avoided[26,27]. We have observed that the central and posteroinferior placement of the screw produced a higher percentage of good result whereas anterosuperior position produced unfavorable outcome.

Jensen and Kyle advised that the distance of screw tip from articular surface of the femoral head should be 10mm and above[13,28]. However, we could not find any significant different in the various distances of screw tip to the subchondral bone. This study concurs with the findings reported by Davis[20].

We tried to correlate the timing of the fixation and the outcome of fixation. However, we found that the timing of fixation yielded no significant effect on the outcome and to our surprise most of the fractures, which resulted in implant failure, were fixed earlier than two weeks. We were unable to justify this finding to statistical significance.

Conclusion

We observed the incidence cutting-out through femoral head and neck was higher in our study. Stability of the fracture, position of the screw in the femoral head and age of the patient influenced the outcome. Central and postero-inferior placement of screw in the femoral head and neck produced equally good results. On the other hand, quality of cancellous bone in the proximal femur and distance of screw tip from subchondral bone did not influence the end results of fixation.

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ORIGINAL ARTICLE

Outcome of Meniscus Surgery at University Malaya Medical Centre

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Summary

Between January 1994 to December 1998, 133 patients had a meniscal surgery at University Malaya Medical Centre. Fifty-four patients were assessed and scored with the Lysholm and Tegner scoring system. Twenty-nine patients had partial meniscectomies and 25 had meniscus repair. The outcome was successful in 80% with meniscal repair and 51.7% with partial meniscectomy. The outcome of meniscal repair in this study is comparable to other reported series. However, the failure rate for partial meniscectomy was high.

Key Words: Meniscus surgery, Partial meniscectomy, Meniscus repair

Introduction

Knee injury in an active sportsman is a common cause of inability to participate in sports. It causes more morbidity in active sportsmen then any other joint injury. The commonest injury to the knee is a meniscal tear[1].

In the past it was often advocated that total meniscectomy provided the best results. The athletes could return to sports earlier with good short-term results[2]. However, as early as 1940s there were experimental and clinical studies reporting degenerative changes after meniscectomies. It was not until basic science studies showed the biomechanical importance of the meniscus was there change in the opinion regarding meniscal preservation.

In Malaysia opinions are similarly changing regarding the treatment of meniscal tears. Meniscal tears are now increasingly repaired. To the best of the authors knowledge there is no report regarding the outcome of meniscal repair and meniscectomy in Malaysia. This study reports the outcome of meniscal repair and arthroscopic partial meniscectomy in University Malaya Medical Centre, Kuala Lumpur.

Materials and Methods

Between January 1994 and December of 1998, 133 patients had meniscal repair, meniscectomy or both. At presentation demographic data, mechanism of the injury and physical findings on examination were collected. Intraoperative findings and the surgery performed were documented.

Patients with arthroscopically diagnosed meniscal tear that was stable or was healing with no further intervention performed and patients who had arthroscopic ligament reconstruction without any meniscal surgery were excluded.

All patients were contacted for review by telephone or letters sent to their last known address. Fifty-four patients agreed to participate in the study that was conducted between October 1999 and April of year 2000.

Patients were examined for knee effusion, joint line tenderness, range of motion and instability.

Lysholm knee scoring system[3] was used to assess the outcome of the surgery. The pre-injury and current activity level was scored using the Tegner activity score[3].

The results were analysed with Statistical Packages for the Social Sciences (SPSS) 9.05. The statistical analyses were done using the Fisher's Exact test (two tailed) and the Wilcoxon Rank-Sum test (Mann-Whitney U test) with statistical significance defined as $p<0.05$[4].

An anterior cruciate ligament (ACL) stable knee was defined as arthroscopically proven intact ACL. Stability of reconstructed ACL was determined by clinical examination. The ACL was considered stable with normal or Grade 1 laxity on Lachman and Anterior Drawer testing. Grade 2 and 3 laxity was considered ACL deficient. Laxity of the ACL was graded as shown below:

Grade 1: <5mm anterior translation with a bony end point.
Grade 2: 5 - 10mm anterior translation
Grade 3: >10mm anterior translation with a soft end point.

Patients were considered to have a successful outcome if the Lysholm score was more then or equal to 80 with the absence of joint line tenderness or effusion and a normal range of movement of the joint that was similar to the uninjured knee[5]. The presence of ACL laxity was not considered a failure if all the other criteria were fulfilled. Patients that required further surgical procedures to the meniscus were also considered to be unsuccessful.

Results

From the overall population of the 133 patients we reviewed a total of 54 patients. The two groups were similar in terms of average age, ethnic and gender distribution (Table I). Football was the commonest cause of the meniscal tear (Table II) whereas knee pain was the commonest presenting symptom (Table III) in both groups.

Of the 54 patients in the review group 25 had injuries to their left knee and 29 to their right knee. The duration between the time of injury and the operation date averaged 15.6 months (3 weeks to 84 months). The lateral meniscus was most commonly involved (30 cases). Sixteen patients had tear of the medial meniscus and 8

Table I
Demographic Data of the Overall Population and the Review Group

Ethnic Distribution	Overall Population (No)	Review Group (No)
Chinese	13 (9%)	5 (9%)
Indian	60 (45%)	24 (44%)
Malay	58 (44%)	24 (44%)
Others	2 (2%)	1 (2%)
Total	133	54
Average age	29.6(12 - 52)	29.4 (17 - 45)
Gender		
Female	15 (11%)	5 (9%)
Male	118 (89%)	49 (91%)
Surgery Done		
Meniscectomy	84 (63%)	29 (54%)
Repair	41 (31%)	25 (46%)
Both	8 (6%)	0

Table II
Mechanism of Injury

Mechanism of Injury	No
Accident other then MVA	6
Badminton	2
Football	30
Hockey	1
Rugby	3
Motor vehicle accident (MVA)	5
Other games	7
Total	**54**

Table III
Presenting Symptoms

Presenting Symptoms	No
All	7
Pain	9
Pain & Effusion	14
Pain Effusion & Instability	9
Pain & Locking	3
Pain, Locking & Effusion	7
Other Combination	5
Total	**54**

Table IV
Pattern of tear

Pattern of Tear	No
Bucket handle	12
Complex	2
Flap	11
Longitudinal	24
Radial	3
Other Combination	0
Unclassified	2
Total	54

Table V
Location of Tear

Location of Tear	No
Anterior Horn	18
Anterior and Posterior	4
Centre	18
Centre and Posterior	1
Posterior Horn	13
Total	54

patients had tears of both menisci. Longitudinal tears were the commonest pattern of tear seen in 44.4% of cases followed by bucket handle type of tear in 22.2% of patients (Table IV). The anterior horn and the middle third were the commonest location for tears with 18 cases at each site (Table V). There were 31 patients (57.4%) with concomitant ACL tear. Chondral defects were seen in 23 patients (42.6%). The medial femoral condyle (13%) was the commonest site of the defect. Only 9 patients had plica noted during the operation. Medial femoral plica was the commonest type.

The operations were performed by 7 different surgeons. Twenty-nine patients had arthroscopic partial meniscectomy and 25 had meniscal repair. Of the 31 patients who had an associated tear of the ACL, only 12 had concomitant ACL reconstruction done. In 19 patients the ACL was not reconstructed as their main symptoms were of knee pain without instability.

Based on our definition of success, the success rate of meniscal repair was 80% (20 of 25 patients) and 51.7% (15 of 29 patients) for partial meniscectomy.

The success rate of meniscal repair was higher in ACL stable knees at 88.2% compared to 62.5% in the ACL deficient knees. However, this observation was not statistically significant (Table VI).

Meniscal repair was more successful at 86% (6 of 7 cases) if there was concomitant ACL reconstruction at the time of surgery. When compared to isolated meniscal tears without an associated ACL tear the success rate was 73% (7 of 11 cases) but this finding was not significant (Table VI).

Table VI

Variables	Success	Rates	P value*
ACL	Stable (88.2%)	Deficient (62.5%)	0.283
Co morbid factor	Concomitant ACL reconstruction (86%)	Isolated meniscal tear (80%)	1.000
Chondral defect	Present (70%)	Absent (86.7%)	0.358
Mean duration of delay of surgery	Successful (6.1 months)	Failure (15.8 months)	0.009
Mean age of patients	Successful (29.2 years)	Failure (35.4 years)	0.065

Variables affecting outcome meniscal repair
**Significance level p<0.05)*

Table VII
Preoperative and Post-operative Tegner Activity Score

Tegner Score	Meniscal Successful	Repair Failed	Partial Successful	Meniscectomy Failed
Preoperative	7.2	7.0	7.6	7.5
Postoperative	6.2	5.2	5.6	5.4

The outcome of meniscal repair improved when performed early. The mean duration of delay in surgery was 6.1 months in the group that had a successful outcome whereas it was 15.8 months in the group that the surgery failed (Table VI).

The age of the patient and presence of chondral defect did not affect the outcome of both meniscal repair and partial meniscectomy (Table VI).

The patient's preinjury Tegner Activity score reduced from a preinjury score of 7.2 to 6.2 postoperatively in those who had successful meniscal repair. Similar observations were seen in the group that had partial meniscectomy. The preinjury Tegner Activity score were reduced from 7.6 to 5.6 (Table VII).

Discussion

In this study, although the drop out rate was high (59.4%), there is sufficient information to draw some general conclusions. The review group was similar to the whole population and is representative of the whole population that required meniscal repair (Table I).

The 80% success rate for meniscal repair reported in this study is comparable to other reported series. The success rates of meniscal repair vary from 63% to 91%[5,6,7]. In contrast partial meniscectomies had a failure rate of 48.3%. However, these groups are not comparable as the indications for a repair and partial meniscectomy may be different at the time of the surgery. The high failure rates for partial meniscectomy at a relatively short follow up (mean duration of 38 months) period was disappointing.

The criteria for success in this study included symptoms based on the Lysholm knee scoring system. However, there are limitations relying on non-specific subjective data. DeHaven *et al*[5] in their review of the long-term results of meniscal repair used only clinical examination and the Lysholm scoring system. They felt that there was no meniscal retears that required repeat surgery

that was not detected by clinical methods alone. Furthermore there is good correlation between clinical methods of evaluation and second look arthroscopy as reported by Morgan *et al*[8]. We therefore feel that using clinical methods of assessment is valid and accurate.

This study suggests that the success of meniscal repair is significantly better if done earlier. The group with a successful repair had a mean duration of 6.1 months delay between injury and surgery. The group that had failed meniscal repair had a delay of 15.8 months (p value 0.009). Stone *et al*[9] believed that the time between injury to the time of surgery is one of the most important factors in determining the success of the repair. They had 100% success in repairs done within 8 weeks of injury as compared to 64% in repairs done after 8 weeks. Buseck and Noyes[10] reported similar findings.

In this study meniscal repair had a success rate of 88.2% in ACL stable knees compared to 62.5% in the ACL deficient knees. Although this observation was not statistically significant (p value 0.283) this finding was consistent with other studies in the literature[5]. DeHaven *et al* documented higher failure rates for meniscal repairs in ACL deficient knees i.e. 46% (6 of 13) versus 5% (1 of 201) in ACL stable knees[5].

The success rate of meniscal repair is also greatly enhanced if the repair is done concomitant with an ACL reconstruction. In this study the success rate was 86% (6 of 7) in the group with concomitant ACL reconstruction as compared to 73% (8 of 11) for the isolated meniscal tears. The result was not statistically significant (p value 1.000), but it is consistent with other reported series[4,5].

The mean Tegner activity score fell from a preinjury score of 7.2 to a postoperative score of 6.2 (Table VII). Similar decrease in the Tegner activity score was also reported by DeHaven et al[5]. Forty percent (8 of 20) patients who had successful meniscal repair returned to their previous level of participation in sports. However, 60% (3 of 5) patients who had failed meniscal repair returned to their previous level of activity. Shintaro *et al*[11] postulated that the lower Tegner activity score could be protective. Similar findings were reported by Sommerlath and Hamberg[12].

Even with a short mean duration of follow up of 38 months, the average failure rate of 48.3% after partial meniscectomy was disappointing. This is lower than published data with short-term outcome of arthroscopic partial meniscectomies that reports a success rates between 80% to 95%[13]. The large difference may be, due to several reasons. The large number of patients lost to follow-up may have biased the results. The high percentage of patients with prexisting chondral defect (45%) may explain the high failure rate. In addition the amount of meniscus removed may be extensive. It has been reported that the incidence of degenerative changes is proportionate to the amount of meniscus that is removed[14]. However in this study the amount of meniscus removed was not documented. It may be postulated that the removal of a large portion of the meniscus contributed to the high failure rate.

Conclusion

The success rate for meniscal repair in this study is comparable to other reported series. This study suggests better results when meniscal tears are repaired earlier. The high failure rate of partial meniscectomy group is disappointing. Further studies are needed to determine the cause for this.

Acknowledgement

My sincere thanks to Ms. Malathi for her assistance in preparation of this manuscript.

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ORIGINAL ARTICLE

Comparison Study Between Reamed and Unreamed Nailing of Closed Femoral Fractures

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Summary

Intramedullary nailing is an accepted procedures for femoral fractures gives uniformly good results. Various methods of intramedulary fixation have been practised in the past. Recently intramedullary fixation without reaming has come into vogue. Preservation of the endosteal blood supply, less blood loss and quicker union have been the alleged benefits of not reaming the medullary canal.

This study is a prospective randomised study conducted to compare intramedullary nail fixation of closed femoral fractures with and without a reaming procedure to assess the validity of the above assumptions.

One hundred and two consecutive cases of skeletally mature patients with closed fracture of femoral shaft were randomised into two groups, i.e. Reamed (52) and Unreamed (50). The average follow-up was 36 weeks (range 28 - 86 weeks).

Average time taken for various stages of the operation and total operating time were longer in the reamed group (109.9min vs 78.6min) and the blood loss was also increased (320mls vs. 190mls).

Bridging and callus formation were seen to occur earlier in the reamed group compared to the unreamed enabling the patients in the reamed group to return to normal functions earlier. Limb length discrepancy and rotational alignment measured clinically and with CT scan did not however show any significant difference between the two methods. Nails used in this study group were notably of a smaller diameter and of shorter length when compared to those used in the western population highlighting the difference in the femur in the Asian population. Complications were notably more in the unreamed group where these were screw breakage (3/50) delayed unions (9/50) and non-unions (4/50). In the reamed group however there were only delayed union (2/50) and all fractures eventually united without any implant failure.

We conclude that closed, reamed, antegrade insertion of an intramedullary nail is the treatment of choice in femoral shaft fractures, especially those involving the distal 1/3. The unreamed procedure should be reserved for certain exceptions, such as in polytrauma, where a shorter operative time and less blood loss is desired.

Key Words: Reamed, Unreamed, Femoral nailing

Introduction

At present, there are a variety of treatment modalities being practised for fixation of femoral shaft fractures. Intramedullary nailing is one of the accepted procedures for fixation of femoral shaft fractures which gives uniformly good results.

Over the last decade, advances in surgery, metallurgy and operative techniques, coupled with a better understanding of biomechanics, and soft tissue management and rehabilitation have brought about a better outcome in treatment of femoral fractures. With the advent of interlocked intramedullary nailing, closed reamed antergrade insertion of the nail was a logical choice. However, concern over the adverse effects of reaming namely increased intramedullary pressure[1,2] fat embolism leading to decreased pulmonary function[3,4] and adult respiratory distress syndrome (ARDS)[5,6] have prompted surgeons to perform closed insertion of a solid nail without reaming[7,8,9]. The advantages accorded to this method are shorter operative time, less blood loss, fewer pulmonary complications, decreased infection[10] and earlier union[11,12] as endosteal blood supply is not disrupted[13].

Experimental studies done on the reamed products have however shown that they act as a cell source bringing osteoblast to the fracture site and promoting healing[14]. Studies using labeled microspheres showed periosteal blood reserve in the reamed cases were found to compensate for the reduction in medullary blood supply[15,16]. These studies and others on cortical circulation[17,18], have caused the controversy of "to ream or not to ream". Although many studies regarding the physiology of reaming and non-reaming have been done, the rate of union and return to function have not been studied in detail. The aim of this study was to compare these parameters and evaluate the outcome in reamed and unreamed femoral nailing.

Materials and Methods

One hundred and two consecutive skeletally mature patients with closed femoral shaft fractures presenting to one hospital were entered into a prospective randomized study trial between January 1996 and October 1997. The mean follow-up period was 36 weeks (range 28 - 86 weeks).

All patients were randomized into two trial groups. For the purpose of this study, Russel-Taylor nails (Smith & Nephew) (designated as RT) were used after reaming the medullary canal and AO nails (Synthes) (designated as AO) were used without reaming. There were 52 patients in reamed and 50 in unreamed groups respectively. Two patients in the reamed group sustained Iatrogenic femoral neck fracture intra-operatively and were subsequently deemed as failures. They were included only as complications and excluded from all other data, leaving 50 patients in each group. Exclusion criteria included pathological fractures, patients with metabolic bone disease, previous fracture of the same femur, all open fractures and those with presence of other long bone or extremity fractures. The two main groups reamed and unreamed were then subclassified according to the type of fracture pattern in accordance with the AO classification of fractures and also according to their age, gender, race, mode of accident and side and site of fracture.

Majority of the patients were males (86%) with a mean age of 26.05 years (10.29SD) (range 15-74 years). Motor vehicle accidents accounted for the main cause of fracture (86%) in particular motorcyclists. There was no prediliction for the side fractured, however mid-shaft fractures were notably more (69%) compared to lower third (18%) or upper third (13%). Type B fractures (according to the AO classification of fractures) represented the largest series (51%) with Type B1 occupying the bulk of Type B fractures (25% of the total fractures) followed by Type A (37%) and Type C (6%) respectively.

Table I
Operative Time (in minutes with sd) of the Stages of Surgery between Reamed and Unreamed Nails

Operative Timings	Reamed	Unreamed
Skin to Proximal Locking	52.28 ± 10.05 min	35.13 ± 13.44 min
Distal Locking Time	26.30 ± 18.23 min	7.60 ± 6.49 min
Total Operating Time	85.90 ± 15.12 min	52.18 ± 18.36 min

The parameters looked into were:- operative timings at various stages of the operation, blood loss, limb length discrepancy, rotational malalignment, functional recovery of movements of adjacent joints, time to union, effect on activity of daily living (ADL), and return to function, and complications.

All operations were performed in the standard manner as stipulated for each technique. Intraoperative blood loss and oxygen saturation was recorded as were any complications either due to surgery or anaesthesia.

Operative timing at different intervals were recorded, i.e. timings from skin to proximal locking, distal locking and total operative time. All fractures in the AO group were treated with a size 9 solid nail to avoid a light cortical fit. In the RT group the medullary canal was reamed until a good resistance was felt to reaming and a nail one size smaller was inserted (size 9=3, 10=12, 11=28, 12=7). The most frequently used nail length was 380mm (55%).

The post-operative rehabilitation protocol included static quadricep exercise on the first post-operative day with addition of NWBC from day two up to 2 weeks post-operatively. Thereafter, ambulation was continued with protected weight bearing progressing to full weight bearing as tolerated. All patients were reviewed at intervals of 2 weeks, 6 weeks, 3 months, 6 months and thereafter monthly till union. Evaluation during these follow-ups included subjective criteria like pain, gait abnormality and return to function, and objective criteria which included weight bearing, range of movement at the hip and knee joints, quadriceps wasting, along with radiological evaluation for callus formation, gap, bridging and union on standard antero-posterior and lateral films. Limb length discrepancy and rotational malalignment were measured clinically and with CT scan with rotational alignment measured clinically in the prone position.

Results

Operative timing from skin to proximal locking was longer in the reamed group (52.28 ± 10.05min), unreamed (35.13 ± 13.44 min) along with distal locking time reamed (26.30 ± 18.23 min). Unreamed (17.60 ± 6.49 min) which naturally prolonged the total operating time in reamed (85.90 ± 15.12min), unreamed (52.18 ± 18.36min) (Table I). Blood loss was also notably more in the reamed group (355.60 ± 101.16ml.) and unreamed (234.80 ± 106.64ml).

The subjective criteria did not show any significant difference between both the study groups except for return to function where in 90% (45/50) of the patients in the reamed group were able to return partial or full work by 3 months compared to 28% (14/50) in the unreamed group for the same given time frame ($p=<0.001$). Ability to full weight bearing was also seen earlier in the reamed group (7.34 ± 1.19 weeks) undreamed (10.92 ± 4.80 SD weeks). Statistics also indicated that predictability to full weight bearing was within a shorter time frame in

reamed (±2 weeks) vs (±5weeks) in unreamed. Limb length discrepancy and rotational malalignment measured clinically and by CT scan did not show any significant difference between the two study methods.

On follow-up radiographic evaluation in time taken for bridging callus formation in the reamed and unreamed were 8.92 ± 4.22 weeks and 12.72 ± 5.86 weeks respectively. This was found to be significant (p=0.001). Subsequently union was achieved earlier in the reamed group (17.88 ± 7.12 weeks) compared to unreamed group (22.74 ± 9.70 weeks) (p=0.004).

Complications were also notably more in the unreamed group which included 10% implant failure (i.e. breakage of distal screw=(4), loosening of proximal cap=(1), narrow canal necessitating reaming=(2), soft tissue interposition =(1), delayed union = [11 (22%)] and non-union = [5 (10%)]. Complications encountered in the reamed group were latrogenic femoral neck fracture (2) and delayed union=[2 (4%)]; however all subsequently progressed to union.

Discussion

Fixation of femoral fractures has evolved a long way since Kuntscher introduced the first intramedullary fixation method. Presently, antegrade insertion of a locked intramedullary nail[5] is widely practised and gives uniformly good results. In the recent years however, the need to ream the medullary canal has produced much controversy. A reamed canal with a larger nail that is biomechanically more stable and the reaming products that promote osteoblastic aggregation at the fracture site promoting healing and union have been largely overshadowed by its proposed adverse effects like increased intramedullary pressure and destruction of endosteal blood supply[13], pulmonary embolism and ARDS. This however was not seen in this study as determined by intra-operative oxygen saturation monitoring during reaming. Longer operative time in the reamed group was essentially due to reaming and also the design at the distal locking eye on the hollow nail which is circular in reamed and has to be negotiated exactly perpendicularly in comparison to the AO nail which has an oval eye which will guide the drill through the solid nail even if slightly angulated. The nails used in this study were also found to be of a smaller diameter and shorter lengths compared to those used in the western population, a point to keep in mind when nailing femoral fractures in the Asian population. Although total blood loss was more in the reamed group, this did not significantly affect the overall outcome and no patient necessitated post-operative transfusion for blood loss.

The earlier bridging callus and subsequent union seen in the reamed group had again directly influenced the rehabilitation program and ability to obtain full range of movements at the hip and knee joints in a shorter time span once again enabling them to earlier return to full function.

Difficulties during rehabilitation were noted in both the methods although there were more in the unreamed group probably due to implant and bony failure, increased time for callus formation and union.

However further research could be done, looking into the results of insertion of a smaller diameter solid nail with minimal reaming.

Conclusion

This study showed that closed antegrade insertion of a femoral nail with reaming gave a better overall result and should be the mainstay for fixation of femoral shaft fractures.

Unreamed nailing may be considered in cases of polytrauma where in a shorter operative time and less blood loss would be desirable.

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ORIGINAL ARTICLE

Are Diabetic Foot Lesions Precipitated by Accidental Trauma?

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Summary

Diabetic foot lesions may arise from frictional trauma due to tight or inappropriate footwear, repetitive stresses on parts of the foot, overlying bony prominence generated by walking and accidental trauma to the neuropathic foot. Many diabetics have been found to be unaware of their foot lesion, or know what the precipitating cause was. Based on the assumption that accidental trauma would affect the foot in a random fashion and result in lesions distributed evenly throughout the foot, a study was performed to determine whether foot lesions were distributed evenly or concentrated to certain areas of predilection. It was found that foot lesions were not evenly distributed but concentrated to certain areas of predilection. Even though relatively high proportion of the study population walked about in open slippers and barefeet, the study showed that accidental trauma was not a predominant precipitant of diabetic foot lesions. Diabetic foot lesions tend to occur as a result of cumulative, repetitive trauma to areas of prediliection rather than accidental trauma.

Key Words: Diabetic foot, Accidental trauma

Introduction

The diabetic foot is one of the most feared complications of diabetes. Diabetics have a 15 to 30-fold risk of lower limb amputation[1], and 45% of lower limb amputations are performed on people with diabetes[2]. Subsequent to a precipitating cause, commonly trauma, the complex interplay of neuropathy, ischaemia, and infection act in synergy to result in diabetic foot complications which can range from the simple neuropathic ulcer to the septic gangrenous foot with limb and life threat. Diabetic foot lesions may be precipitated by, or may result from: -

1. friction from imperfect footwear commonly affecting the toes[4],
2. repetitive stresses over bony prominences from walking, typically responsible for lesions overlying prominent metatarsal heads[3], and
3. accidental trauma[5].

Diabetic patients are frequently unaware of the event precipitating their foot lesion, and sometimes even of established foot lesion itself. In a study[4] only 56.3% of diabetic foot lesions were discovered by the patient, 5% by relatives or friends and in 38.7%, only as a result of routine examination by health professionals. Although conventional educational advice stress the need to avoid walking barefoot, it is noted that walking barefoot was an uncommon factor leading to foot damage[4]. As a relatively larger proportion of the

Malaysian population goes about wearing open slippers and barefooted, compared to Western populations, we sought to determine whether accidental trauma was a significant precipitating cause of diabetic foot lesions. As many diabetics will not even have discovered their foot lesions themselves, or know the precipitating cause, direct questioning would have been unhelpful.

This study is based on the assumption that within a patient population, accidental trauma to the foot would affect different areas of the foot in a random fashion. If accidental trauma as a predominant precipitant within a particular patient population, then resultant foot lesions within that particular population would be evenly distributed, throughout different areas of the foot. This study was thus performed to determine whether diabetic foot lesions were evenly distributed or whether the foot lesions were concentrated to certain areas of predilection.

Materials and Methods

Patients admitted to the Orthopaedic Department of Hospital Kuala Lumpur for treatment of diabetic foot lesions were interviewed and their foot lesions were examined. Data collected included precipitating factors of the foot lesion if known, type of occupation, type of footwear at work, and type of foot ware when predominantly foot borne.

The foot was examined, and foot lesions were classified according to clinical diagnosis of the predominant pathology present; which were ulcers, abscesses, cellulitis and gangrene. The site of the lesion was designated on the basis of the foot being divided arbitrarily into 4 parts of approximately equal surface area, which were: -

1. the toes
2. the plantar aspect overlying metatarsal heads
3. the plantar aspect of mid foot, and
4. the heel.

To avoid observer bias, the clinicians involved in determining the diagnosis and designating the site of lesion were blinded as to the objectives and methods of the study. Although gangrenous lesions may occur as a result of pressure necrosis there is a possibility that some may have been predominantly due to ischaemia. Thus the analysis of the distribution of lesions was performed for: -

1. all types of lesions including gangrenous lesions, and
2. for only ulcer, abscess and cellulitis (excluding gangrenous lesions).

The distribution of the lesions on the foot were analysed to determine whether they were distributed evenly, by evaluating whether there was a statistically significant difference in the number of foot lesions occurring in each of the 4 arbitrarily designated areas of the foot. Statistical analysis used was the chi square test with $p<0.05$ taken as significant.

Results

Sixty consecutive patients with diabetic foot complications were included. The mean age was 57.16 years, and most were between 50 - 70 years. Forty-six (76.7%) patients were unaware as to how and when their foot lesion commenced. Fourteen (23.3%) admitted to the possibility of trauma as a precipitating cause. Table I shows the predominant footwear worn during activity. Table II shows location and type of lesion. Table III shows number of foot lesions at the various sites on the sole of the foot (excluding 4 who had ankle lesions).

When the 56 patients with foot lesions (including gangrenous lesions) were analysed for the distribution of lesions, statistical analysis showed significant differences between the number of foot lesions occurring on the: -

Table I
Predominant Footwear Utilised during Activity

Activity	Manual workers at work	Home based workers at work/home	Non manual Professional at work	Type of footwear while footborne
Shoes	27	0	11	38
Slippers	8	1	0	9
Barefoot	2	11	0	13
Total	37	12	11	60

Table II
Location and Type of Lesion

Type of lesion	Ulcer	Abscess	Cellulitis	Total (excl Gangrenous Lesions)	Gangrenous	Total (incl Gangrenous Lesions)
Toes	10	9	2	21 (48%)	11	32 (53.3%)
Overlying metatarsal heads	1	5	2	8 (18.6%)	2	10 (16.7%)
Plantar aspect of midfoot	3	3	2	8 (18.6%)	3	11(18.3%)
Heel	1	1	0	2 (4.6%)	1	3 (5%)
Ankle	3	0	1	4 (9.3%)	0	4 (6.7%)
Total	18	18	7	43 (100%)	17	60 (100%)

Table III
Number of Foot Lesions at Various Sites on the Sole of the Foot (excluding 4 ankle lesions)

	Number of lesions (excl gangrenous)	Number of lesions (incl gangrenous)
Toes	21 (53.8%)	32 (57%)
Overlying metatarsal heads	8 (20.5%)	10 (17.9%)
Mid-foot	8 (20.5%)	11 (19.6%)
Heel	2 (5.1%)	3 (5.3%)
Total	39 (100%)	56 (100%)

1. toes compared with all the other 3 designated areas i.e. metatarsal heads (p=0.001), midfoot (p=0.001) and heel (p=0.000); and
2. between the number of lesions on the plantar midfoot region compared with number of lesions on the heel (p=0.033).

All other comparisons were not statistically significant.

When the 39 patients with foot lesions (excluding gangrenous lesions) were analysed for distribution of lesions, statistical analysis showed

significant differences between number of lesions on toes with other 3 designated sites i.e. metatarsal heads (p=0.016), midfoot (p=0.016) and heel (p=0.000). All other comparisons were not statistically significant.

These results suggest a non-random occurrence of diabetic foot lesions, but a predilection of sites, eluding to the fact that accidental trauma which a random event, is unlikely to be a predominant precipitating factor.

Discussion

This study sought to determine whether accidental trauma to the foot was a predominant precipitant of diabetic foot lesions. It was based on the assumption that the sites affected by accidental trauma would be distributed evenly in a random fashion and thus foot lesions precipitated by accidental trauma would be found at sites which are evenly distributed throughout the foot. However in this study, we find the distribution of lesions to be not evenly distributed to all sections of the foot. The most commonly affected part of the foot were the toes (53.3%), followed by plantar aspect of midfoot region (18.3%); metatarsal heads (16.6%); and heel (5%) being the most infrequent. These findings are similar to a study in Nottingham[4] which reported toe lesions in 43.1% and metatarsal head lesions accounting for 17.8%

The significance of these findings for the Malaysian population who go about largely with slippers or barefeet; is that the diabetic foot lesions occur in long standing pressure points on the feet, and are not due to accidental trauma (for example kicking stones or gravel) with a random pattern of occurrence. If randomness was the case, then the lesions would be evenly distributed in all 4 designated areas of the foot. Our findings also suggest that foot lesions occur because of predisposing factors that have evolved due to neuropathy, e.g. hammer toes, prominent metatarsal heads and rockerbottom deformities[6] with subluxed tarsi; making the toes, the metatarsal heads and the plantar midfoot, areas of predilection for foot lesion.

Cumulative repetitive stresses over these areas generated when walking with tight or inappropriate shoes finally result in skin necrosis and/or breakdown with subsequent ulceration and its sequelae. If wearing of open slippers does not predispose to; and accidental trauma is not a predominant precipitant, of diabetic foot lesions; then wearing open slippers instead of tight covered shoes may possibly reduce the incidence of foot lesions that occur because of frictional trauma to the toes from tight and otherwise inappropriate shoes.

Conclusion

From our study, we conclude that diabetic foot lesions are more likely to occur as a result of cumulative, repetitive trauma to areas of predilection in the foot, rather than being generated randomly in the sole of the foot.

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ORIGINAL ARTICLE

Early Remodeling in Children's Forearm Fractures

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Summary

The forearm fracture is a fracture of the upper limb between the elbow and the wrist. It is a common injury in children, accounting for more than half of all children's fractures, and mostly occur when a child falls on the outstretched arm. A difficult clinical problem that often arises is how much angulation can be accepted in the child and how much remodeling will occur. One hundred consecutive cases of forearm fractures that were admitted at Childrens Orthopaedic Ward, Institute of Paediatrics at Hospital Kuala Lumpur between 1st January 1997 to 31st December 1998 were studied. We found that all fractures united 3 to 6 weeks, with a remodeling rate of about 2.5 degrees/month; the proximal fractures having the most potential to remodel. We conclude that the early remodeling potential of forearm fractures in children is 1.5 degrees/month in midshaft fractures and 2.5 degrees/month in distal and proximal fractures. We recommend accepting a 10 - 20 degree angulation in midshaft fractures, and a 20 - 30 degree angulation in metaphyseal fractures; based on our study of early remodeling potential.

Key Words: Children, Forearm fractures, Early remodeling

Introduction

The forearm fracture is a fracture of the upper limb between the elbow and the wrist. It is a common injury in children, accounting for more than half of all children's fractures, and mostly occur when a child falls on the outstretched arm. It is seen that there is a higher incidence of forearm fractures in children by the age group of 0 - 9 years, and also in the elderly in the age group above 79 years[1]. The reason for the predominance of this injury in children is because at this early age the bones have not matured fully and it is still at the ossification stage. Thus, anatomically the bones of the forearm region are very fragile.

A difficult clinical problem that often arises is how much angulation can be accepted in the child between certain ranges of age after healing. In children remodeling after fracture is usually so perfect that eventually the site of the fracture becomes indistinguishable in radiographs. So the need for perfect anatomic reduction is rarely indicated in younger children due to their remodeling potential. The residual angulation during the healing process will reduce, until the fractured bone is back to its original anatomic fashion[2].

This study was done to determine the time to radiological union in children's forearm fractures in relation to age, and to determine the

remodeling rate in relation to site of fracture, and age of patient; in an attempt to determine the rate of early remodeling for these fractures in the local population.

Materials and Methods

The study population consists of 100 consecutive cases of forearm fractures that were admitted at Children's Orthopaedic Ward, Institute of Paediatrics at Hospital Kuala Lumpur between 1st January 1997 to 31st December 1998. All patients records and radiographs were reviewed for confirmation of diagnosis; and post reduction radiographs, radiographs at clinical union, and radiograph at last follow up were reviewed for each patient.

The end point was when the patient was discharged from follow up or did not turn up for review. It was assumed that the doctors accepted the deformity at the last visit as clinically acceptable; and that the parents of patients who defaulted follow up accepted the clinical deformity of the forearm as acceptable at the last visit. The data that was collected was:

1. angulation at post reduction radiograph (either at AP or Lateral view-whichever was the most displaced);
2. angulation at radiological union (of the most displaced initial view); and
3. angulation at last review (of the same view)

The angulations were measured from the selected views via a protractor; using the intersections of the axis at the fracture ends. These axes were determined by 3 points for each segment (1 mid metaphyseal, and 2 mid diaphyseal points for diaphyseal fractures; and 2 mid diaphyseal points with the perpendicular to the epiphysis for metaphyseal fractures). The intersections were measured for each radiograph and recorded.

For time to clinical union, data was obtained from the post reduction radiographs, and the radiograph at clinical union. For the rate of remodeling; data was obtained from the radiograph at clinical union and the radiograph at last visit. Data was recorded in *weeks* for clinical union, and in *degrees/month* for remodeling. Statistical analysis was used to determine the significance of any differences in data, with $p<0.05$ as significant.

Results

The study population consisted of 100 cases. The age of the patients ranged from 2 years to 12 years with a mean of 7.89 years. Majority of the cases (46.0%) occurred in late childhood (age 9 to 12 years). Table I shows the distribution according to age. There were 76 boys (mean age of 8.21 years) and 24 girls (mean age of 7.25 years). Thirty-one were greenstick fractures, while 8 were epiphyseal fractures. Fig. 1 show the sex, age and frequency of the cases. Fifty-one fractures

Table I
Distribution of Cases by Age Groups

Age Groups (years)	Number	Percentage (%)
1 - 4 (Infant)	12	12.0
5 - 8 (early childhood)	42	42.0
9 - 12 (Late childhood)	46	46.0
Total	100	100.0

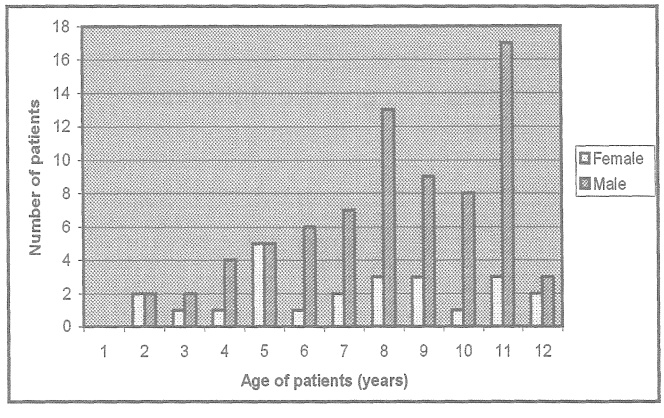

Fig. 1: Distribution of cases by age and sex.

Table II
Age Groups and Mean Time to Radiological Union (Weeks)

Age Group (years)	Mean Time to Union Radiological (±SD)
1 - 4	3.44 ± 1.12
5 - 8	5.63 ± 6.53
9 - 12	3.94 ± 2.91

Kruskal-Wallis Text; X^2=5.804, df=2, P>0.05, n=100

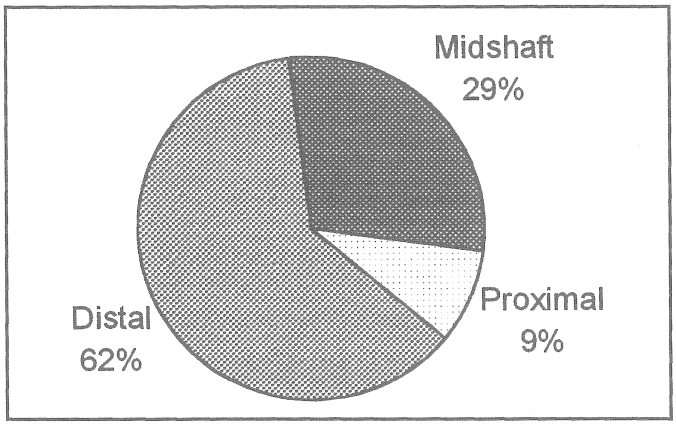

Fig. 2: Distribution of cases according to location of fracture.

were in the left arm, while the remaining 49 were in the right arm. Ninety-four fractures were closed and six were open fractures. Fig. 2 shows the location of the fracture in the forearm; and Fig 3 shows the bones involved. Table II shows the mean time to radiological union measured in weeks, stratified by age. The differences between the groups are not significant.

Sixty-seven patients records were available till a follow up of at least 3 months to study the rate of remodeling. Table III shows the rate of remodeling for each age group; the differences being not significant. Table IV shows the rates of remodeling in relation to site of fracture; the differences were not significant also.

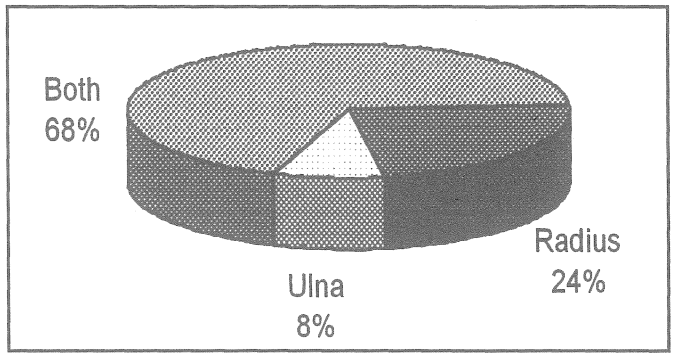

Fig. 3: Distribution of cases according to bone of forearm.

Table III
Age Groups and Mean Rates of Remodeling (degrees per month)

Age Group (years)	Mean Rate of Remodeling (±SD)
1 - 4	1.83 ± 1.48
5 - 8	2.91 ± 2.22
9 - 12	2.34 ± 2.61

Kruskal-Wallis Text; X^2=2.805, df=2, P>0.05, n=67

Table IV
Location of Fracture and Mean Rates of Remodeling (degrees per month)

Location of Fracture	Mean Rate of Remodeling (±SD)
Distal	2.92 ± 2.55
Midshaft	1.62 ± 1.39
Proximal	2.42 ± 1.87

ANOVA=1.922, df=2, P>0.05, n=67

Discussion

Remodeling is defined as the difference in fracture angulation at the time of healing and at the time of follow-up study. Some worker[3,4] have

advocated calling the post union bony changes 'rounding off" as opposed to "remodeling". The remodeling capabilities of fractures of the forearm bones in children are often unpredictable; and relates to the age of the child, location of the fracture, and the degree of angulation. Many have advocated the simple rule that the younger the child, the more distal the fracture, the more likely for remodeling to occur. Younger found that remodeling of all forearm fractures regardless of fracture position or severity of injury to be only 8.6° and 4.4° at midshaft[5]. This apparent contradiction on the remodeling potential leads us to conduct our current investigation.

As for our patients, we found that all fractures united between 3 to 6 weeks, with a remodeling rate of about 2.5 degrees/month; the proximal fractures having the most potential to remodel. The apparent difference (not significant) we saw in the time to healing for the fractures in the 5 - 8 years old group were possibly related to these fractures being more angulated at the start of treatment. This was possibly also the same reason for the lower remodeling rates seen in the 1 - 4 years old group, as these fractures were minimally angulated at the start of treatment.

Based on our findings on the early remodeling, we recommend a low tolerance of angulation acceptance in midshaft fractures because of its low remodeling potential of only 1.5 degrees/month. We agree with Daruwalla that an angulatory deformity of more than 10° in this region is unlikely to correct in an older child[6]; while younger children will most likely remodel a deformity if angulated <20° but correction should be considered in children over the age of 4 years or any child with a deformity >20°[7].

Similarly, we recommend that in a child younger than 10 years of age with a fracture close to the metaphyseal plate, 20° to 30° angulation is acceptable and would remodel, culling on Hughston's[8] recommendations to accept a 30° to 40° of angulation.

Conclusion

We conclude that the early remodeling potential of forearm fractures in children is 1.5 degrees/month in midshaft fractures and 2.5 degrees/month in distal and proximal fractures. We recommend accepting a 10 - 20 degree angulation in midshaft fractures, and a 20 - 30 degree angulation in metaphyseal fractures; based on our study of early remodeling potential.

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ORIGINAL ARTICLE

Crossed-Pin Versus Lateral-Pin Fixation in Pediatric Supracondylar Fractures

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Summary

A retrospective study was done on 56 patients treated with percutaneous pinning of displaced supracondylar fractures of the humerus in the Paediatrics Institute of Hospital Kuala Lumpur between November 1999 and October 2000, to ascertain whether there is any significance clinically in the stability of a crossed pinning medial compared with lateral pinning method. There was equal number of patients in each group (28 patients).

The radiographs were evaluated for change in Baumann's angle and Lateral Humero-capitellar angle from immediate post-op until the last follow-up. The changes in the angles did not reveal any statistically significant difference in the ability to maintain reduction of the fractures.

There were 3 instances of iatrogenic ulnar nerve injury in the crossed pinning group; the lateral pinning group had 1 case each of anterior interosseous nerve and radial nerve injury post operatively. No vascular injury was noted. Two cases of superficial pin tract infection were present in each group.

The lateral percutaneous pinning technique of displaced supracondylar fractures of the humerus therefore offers a viable alternative to the crossed pinning group as it offers the same stability without the incipient risk of iatrogenic ulnar nerve injury.

Key Words: Supracondylar humeral fractures, Percutaneous pinning, Nerve injury

Introduction

Supracondylar fractures of the humerus are the second commonest fractures in children (16.6%) and the most frequent before the age of seven years. Treatment is controversial and often technically difficult and complications are common.

Cubitus varus is the most frequent problem with a mean incidence of 30%. This deformity is due to medial tilting of the distal fragment, associated with rotation. It unfortunately does not remodel well with growth, is progressive and is not due to physeal injury.

The methods of treatment of these fractures can be classified into four groups: Closed reduction and cast application, traction, closed reduction and percutaneous pinning and lastly open reduction and pinning. Percutaneous pinning has been the increasingly popular choice of treatment of the displaced type of supracondylar fractures of the humerus.

There are several advantages to this method of fixation: firstly it avoids the hyperflexed elbow position of closed reduction and cast application, secondly, it does not require the prolonged hospitalisation and associated higher costs incurred by the traction method, thirdly, closed pinning minimizes the intraoperative trauma and decreases the risk of myositis ossificans and associated loss of motion often associated with open pinning.

The disadvantages include the need for general anaesthesia, the potential for superficial pin tract infections and associated osteomyelitis and a greater risk of causing nerve injury (7 - 16%)[1,2] with the ulnar nerve most susceptible.

The rate of iatrogenic injury to the ulnar nerve due to the medial and lateral pinning has been estimated to be two to five percent[3,4,5,6].

Numerous variations in the pinning techniques have evolved which are believed to have sufficient stability of the fracture and minimize the risk of complications to the ulnar nerve. These include the unique placement of the medial pin, in which it is introduced from anterior and angled posterior laterally, "milking" the swelling, the use of a small percutaneous skin incision (to visualize and thus avoid nerve injury) in cases of gross swelling and the use of a nerve stimulator to locate the ulnar nerve.

The lateral pinning method was developed based on the concern of iatrogenic ulnar nerve injury[7,8,9]. By not pinning the fracture through the medial condyle, this obviates the theoretical risk of an ulnar nerve injury.

The lateral pinning method, though decreasing the risk of ulnar nerve injury, has its critics. The stability of the lateral pinning configuration has been questioned with regards to maintenance of the reduction, and subsequently developing cubitus varus or valgus.

This study aims to review the clinical and radiographic results of displaced supracondylar humeral fractures in children treated with two laterally inserted percutaneous Kirschner wires as compared to two crossed percutaneous Kirschner wires. More importantly, it aims to see if there is a significant difference between these two pinning configurations with regards to maintenance of reduction, and stability. In addition, it attempts to record any complications from the two types of fixation, and whether the risk of complications outweighs the purportedly superior fixation using the crossed pinning method.

Materials and Methods

This is a retrospective study of 56 children with displaced Gartland's Type II and III extension supracondylar humeral fractures, treated with closed reduction and percutaneous pin fixation from November 1999 to October 2000, in the Paediatric Institute of Hospital Kuala Lumpur.

Between those two periods, a search of the operation records revealed a total of 74 children who were treated with percutaneous pin fixation for displaced supracondylar fracture of the humerus. Eighteen patients were excluded from the study due either to compound fractures, concomitant ipsilateral limb fractures or followed up in different hospitals.

The data that was collected from the records included sex, age, date and time of injury, the extremity involved and any preoperative neurovascular injury. Regarding the surgery, the date, operating time, surgeons' experience, and technique used was recorded. The date of discharge and subsequently the length of stay were recorded. The follow-up notes were

scrutinized for date of removal of pin, any neurological deficit noted plus any other general complications.

All the X-rays taken were measured for the Baumann's angle and the Lateral humero-capitellar angle. These were done for the immediate post op and last follow-up radiographs.

Children with displaced supracondylar fractures of the humerus who were seen in the Casualty Department of Hospital Kuala Lumpur were initially splinted, and subsequently admitted to the Orthopaedic Ward of the Paediatric Institute of Hospital Kuala Lumpur. The patients are subsequently scheduled for percutaneous pinning at the next available operating day.

While awaiting pinning, straight lateral skin traction was applied in the ward to reduce swelling and close observation was made on the circulation and neurological status of the affected extremity. Under anaesthesia and image intensifier control, the fracture is disimpacted and reduced. Adequacy of the fracture is checked under the image intensifier.

The elbow is then hyperflexed for pinning. For crossed pinning method, the arm was externally rotated and the pin introduced through the medial epicondyle. The arm was then internally rotated and the lateral pin inserted in a crossed fashion.

For the lateral pinning method, the reduction was done in the usual way. With the elbow resting on the image intensifier and flexed, the first Kirschner wire was introduced through the lateral epicondyle. The forearm remains in neutral position, not internally nor externally rotated. The insertion of the wire is checked on the AP view on the image intensifier. We preferred to insert the two wires divergently as described by Kallio[10].

The first wire is inserted more horizontal, while the second one is placed as vertical as possible, up the shaft of the humerus, and engaging the far cortex. The elbow is then externally rotated to confirm the placement of the pins on the lateral view. Parallel lateral wires have the theoretical risk of the lower pin penetrating the joint and subsequent septic arthritis.

Once the reduction and fixation was deemed satisfactory as shown by the AP and lateral views on the image intensifier, the pins were bent outside the skin to prevent migration and then cut off. A sterile dressing was applied and a long posterior back slab was applied with the elbow in flexion and the forearm in neutral position. The patient is then sent back to the ward for observation. The next day, check radiographs were taken to confirm the fixation and also for documentation purposes. Having assessed the neurological and vascular status, the patient is usually allowed back home the day after the surgery.

Results

Immediate post-operative films revealed an average Baumann's angle of 78.5 ± 4.19 degrees for the lateral pinning method, whereas the crossed pinning method had an average angle of 78.71 ± 4.97 degrees. The average Baumann's angle on last follow-up for the lateral pinning group was 77.82 ± 5.51 degrees, whereas the crossed pinning group had an average of 79.04 ± 5.01 degrees.

The average degree of change in the Baumann's angle for the lateral pinning group was 3.75 ± 2.77 degrees. On the other hand, the average degree of change in the Baumann's angle for the crossed pinning group was 3.04 ± 2.83 degrees. A Student's T-test done on the results did not reveal any statistically significant difference between these two values ($p>0.1$).

For the lateral humero-capitellar angle, the average angle in the immediate post-operative period was 40.32 ± 5.5 degrees for the lateral pinning group, as compared to 40.64 ± 6.62 in the crossed pinning group. On the last follow up, the

lateral humero-capitellar angle for the lateral pinning group was 39.86 ± 5.87 degrees, whereas the crossed pinning group had an average angle of 38.86 ± 6.72 degrees.

The average degree of change in the Lateral humero-capitellar angle was 4.39 ± 3.45 degrees in the lateral pinning group. Similarly, the average change in the lateral humero-capitellar angle for the crossed pinning group was 3.79 ± 3.00 degrees. Tests of significance using the Student's T-test did not reveal any statistically significant difference between the two groups in question ($p>0.1$).

Data for range of motion of the elbow at the last follow-up was obtained only for 12 patients in the lateral pinning group and 12 patients in the crossed pinning group. The range of motions of the elbow for the remaining 32 patients was recorded as good and fair in the patient's notes. Hence these were excluded from the data. The available data was then analyzed for the average range of motions of the elbow.

The average elbow flexion attained at last follow-up was 130 ± 21.11 degrees in the lateral pinning group, whereas the crossed pinning group had an average elbow flexion of 119.17 ± 20.12 degrees. For the extension of the elbow, the average attained for the lateral pinning group was 8.46 ± 11.62, as compared to the crossed pinning group, which had an average angle of 7.08 ± 10.1 degrees. Statistical analyses of the two variables, using the Student's T-test did not reveal any statistically significant difference of range of motions between the two groups ($p>0.1$).

In the crossed pinning group, there were three cases of nerve injury post-operatively. All the nerve lesions involved the ulnar nerve. All three patients were noted to have an ulnar claw of the hand, indicative of ulnar nerve lesion during the first follow-up. The wires were removed, and the lesion was treated conservatively and expectantly with close follow-up of the lesion.

However, at the time of the latest follow-up, two patients did not show evidence of recovery. Further follow-up was still being carried out on these two patients. In the third patient, the lesion was of a transient nature and she subsequently regained full function of the ulnar nerve thereafter.

For the lateral pinning group, there was two cases of nerve injury. One patient had decreased sensation of the first web space of the hand of the affected extremity, during the follow-up. This was treated conservatively initially. Unfortunately, the patient did not turn up for the subsequent follow-ups and subsequently no record of recovery was noted.

The second patient had a transient right radial nerve injury, presenting as a wrist drop on the first follow-up. This was also treated conservatively, and the nerve function recovered thereafter. We presumed that the nerve palsy was present before the surgery and it was possible that it was missed on pre-operative examination.

Discussion

Zionts *et al*[11], in cadaveric studies have shown that biomechanically, the maximum stability was provided by two crossed pin in a medial-lateral pin configuration, which gave 37% to 80% more torsional stability as compared to the two laterally placed pins. Topping[12], however has successfully rebutted this finding, showing clinically that crossed wires had no significant advantage over two parallel, laterally placed wires. He stated that the in-vitro studies did not take into account the additional stability of cast application in the post-reduction treatment of these fractures and added that the thickened periosteum in the paediatric population certainly offers significant resistance to displacement after reduction and pinning.

France and Strong[13] noted that "in the clinical setting, neither methods of percutaneous pinning (crossed pinning and lateral pinning) are more stable than the other".

In our study population, the change in the Baumann's angle averaged 3.75 degrees for the lateral pinning group and 3.04 degrees for the crossed pinning group. Statistically, there was no difference in the mean of these two groups ($p>0.1$). Similarly, the average degree of change in the Lateral Humero-Capitellar angle was 4.39 degrees in the lateral pinning group and the average change for the crossed pinning group was 3.79 degrees. Again, tests of significance using the Student's T-test did not reveal any statistically significant difference between the two groups in question ($p>0.1$). This demonstrates that in terms of stability and maintenance of reduction, the crossed pin configuration had distinctly no superiority to the lateral pin configuration.

In a developing society, the treatment of children's fractures have to take into consideration the fact of man (woman) hours lost in a parent being required to accompany the child throughout the hospital stay. With the majority of families dependant on two incomes, this crucial factor needs to be measured while debating the type of treatment being formulated. Hence, without doubt early pinning would certainly minimize hospital stay. Another pressing issue is the increased demands of a more educated population where an iatrogenic neurological deficit would occasionally lead to litigation.

Conclusion

With the lateral pinning technique being shown to be marginally safer, it should be considered as the method of choice in displaced supracondylar fractures of the humerus on children.

Supracondylar Fractures: Crossed Versus Lateral Pinning

Sex	Lateral	Crossed	Total
Male	18	17	
Female	10	11	
Total	28	28	
Age			
Average	6.79	6.89	
Std Dev	2.85	2.48	
Side Injured			
Left	16	16	32
Right	12	12	24
Displacement			
Postero Medial	19	20	39
Postero Lateral	9	8	17
Grading of Displacement			
II	9	4	13
III	19	24	43
Days Post Injury to Surgery			
Average	3.00	2.50	
Std Dev	1.72	1.23	
Operative Time (Mins)			
Average	40.71	42.50	
Std Dev	19.99	16.19	
Ward Stay (Days)			
Average	4.07	4.25	
Std Dev	1.84	2.07	
Length of Fixation (Days)			
Average	22.32	25.21	
Range	7 - 32	8 - 35	
Std Dev	6.64	6.65	

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ORIGINAL ARTICLE

Screw Osteosynthesis in the Treatment of Fracture Lateral Humeral Condyle in Children

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Summary

We reviewed the results of screw osteosynthesis for the treatment of fracture lateral condylar physis in twenty children whose average age was six years old (range, two to ten years) at the time of operation from January 1998 till December 2000. The average interval between the injury and the operation was three and half days (range, one day to two weeks). The average duration of follow up was one year (range, one year to two years). Osteosynthesis was revised in two patients due to anterior placement of screw and rotated distal fracture fragment. Osseous union was achieved in all twenty patients. The result was rated excellent in nineteen patients and good in one patient.

Key Words: Screw osteosynthesis, Lateral humeral condyle fracture

Introduction

Fracture of the lateral condyle of the humerus is the second commonest injury in children's elbow. Its represent 17% of all fractures in children and occur between 5 and 10 years of age, although they have been reported to occur in children as young as 2 years and as old as 14 years[1]. Impaired function or pain is rare after appropriate treatment. The best results are to be expected when anatomical reduction are achieved and maintained. Smooth pins have become the most popular method of fixation of the fragment[2,3,4]. However, non union, delayed union, stimulation of the radial physis with condylar overgrowth, variation of the elbow deformities (varus or valgus); as well as fishtail deformities of the distal end of the humerus are reported[2]. Most recent authors[5] suggested screw osteosynthesis rather than wire or pin fixation. The study was done to assess the functional outcome of humeral lateral condyle fracture treated with screw osteosynthesis and to evaluate the complications with this type of fixation.

Materials and Methods

This is a prospective study, of 20 patients treated at the Orthopaedic Department of Universiti Kebangsaan Malaysia from 1998 - 2000. Inclusion criteria was an acute traumatic displaced (more than 2mm) of the fracture of lateral condyle of humerus in Anterioposterior (AP) and lateral radiograph. All patients were treated with AO 4.0 mm partially threaded cancellous screw fixation. The fractures, diagnosed clinically, radiologically, were confirmed during surgery. Seventeen

patients were operated within 24 to 48 hours after the trauma. While 3 patients were diagnosed and treated 1 - 3 weeks after injury because the fracture was missed during the initial examination, while another had an upper respiratory tract infection caused the surgery to be delayed, and the last patient presented late after failed traditional treatment.

A standard lateral approach was used, and fracture site entered via the plane between extensor carpi radialis brevis and extensor carpi ulnaris. The fracture was reduced and fixed with partially threaded 4.0-mm AO cancellous screw. The forearm was then placed in supination and is immobilized with an above elbow Plaster of Paris, at 90 degrees of elbow flexion.

Wound inspection was done on day fourteen and the plaster slab was removed after one-month. Active mobilization of elbow was then begun. The screw was removed after solid union of fracture was observed on Radiograph (AP and lateral). This was usually around 3 months post surgery.

The patients were evaluated for terms of pain, apprehension, range of motion, deformity and activities of daily living at one year period. The result was rated as excellent, good, fair, or poor, according to a modification of the functional rating index of Broberg and Morrey[1]. A total score of 95 to 100 points indicated an excellent result; 80 to 94 points, a good result; 60 to 79 points, a fair result; and 0 to 59 points, a poor results.

The radiographs were evaluated for evidence of early closure of the epiphyseal line, hypertrophy of the lateral condyle, fishtail deformity, and congruity of the joint (to assess the extent of remodeling of distal end of humerus).

Results

There were 14 boys and 6 girls. All but one of the fractures was caused by falls. The exception was a fracture caused by direct trauma to a door. Falls occurred indoors as well as outdoors. There were 16 left and 4 right-sided fractures. The result was rated excellent in nineteen patients and good in one patient, with a modification of functional rating index of Broberg and Morrey[1]. The physeal plate was seen to be open in all of the patients. Seven patients had lateral condyle hypertrophy and five patients had mild fishtail deformity. Seven patients had screw penetration at physeal plate, five patients at periphery and two patients center to the physeal plate. Seven patients had lateral bony hyperthropy and five patients had fishtail deformity. Osteosynthesis was revised in two patients; one due to anterior placement of screw and, another rotated fractured fragment.

Of the 20 patients, 3 (15%) patients had complications. One patient had a delayed union due to a technical error in which the screw track was drilled twice in an attempt to improve the direction of screw insertion; however the screw had backed out and was removed at six weeks. The patient however, progressed very well and had an excellent result. One patient had a minor wound infection, which resolved with antibiotic treatment without any long-term sequalae, and the last patient developed ten degrees cubitus varus secondary to lateral bony overgrowth.

Discussion

Intraarticular fractures involving the growth plate are difficult to treat and carry a high risk of complication. Particularly in the lateral condyles of humerus in children (Salter-Harris IV fractures) that extend through the articular cartilage, epiphysis, physis and metaphysis. These have the highest risk of premature physeal closure.

Traditionally, Kirschner wires that cross the physis have been widely used. Screw fixation avoiding the physis have been rarely used except in a child nearing skeletal maturity or non-union cases. Both methods have the same goal, which is to achieve anatomical reduction of the physis and the articular surface as well as a stable fixation.

Kirschner wires or pins do not provide significant interfragmentary compression and have less desirable results. Donigian[6] reported only 17% of their patients maintained an anatomical reduction of the articular surface (<1mm displacement) using this technique. There is a risk of wire migration if smooth pins are used and not bent over. If the Kirschner wires are left protruding outside the skin, there is a risk of pin tract infection or even osteomyelitis.

Seven patients had screw penetration at physeal plate, five patients at periphery and two patients considerably center to the physeal plate. At one year of follow up none of our patients had physeal arrest. This was confirmed radiologically where the physeal plates were well seen in all the cases with no evidence of physeal bony bridge noted.

Jacob[2] concluded that the result of open reduction more than three weeks after the fracture faired no better than those without surgical treatment. In our series, all of the patients were operated within three weeks and had excellent result. A review of all radiographs showed anatomical reduction of joint surface and no evidence of avascular necrosis of the fracture fragment. A prominent lateral condyle deformity is a noted deformity with this fracture. One of our patients had clinically significant varus deformity of 10 degrees.

In similar study, Sharma[5], in his review of 49 patients with lateral condyle fracture treated with cancellous screw fixation reported osteosynthesis with screw fixation has a better outcome with no functional complication. It can prevent condylar overgrowth by guaranteeing fracture healing in anatomic position within 3 - 4 weeks.

Our series has shown that screw osteosynthesis of the lateral humeral condyle fracture in children is a safe, reliable and stable method of fixation.

Conclusion

Screw osteosynthesis to the lateral condyle of humerus in children has a good clinical outcome.

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ORIGINAL ARTICLE

Relevance of Cobb Method in Progressing Sagittal Plane Spinal Deformity

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Summary

Non-traumatic, progressing sagittal plane deformities are uncommon, but can lead to neurological deficit if untreated. The currently used Cobb method in assessing sagittal spinal curves is based on measuring the tilt of the end vertebrae. This study describes a method which quantifies the apex of the sagittal curve based on the apical quality as measured by the radius of curvature. Both this and the Cobb methods are compared to determine which has relevance in determining neurological deficit. Radiographs of 36 consecutive patients diagnosed with congenital kyphosis were reviewed. Twenty-four had normal neurology and 12 had neurological deficit as a result of sagittal curve progression. Both groups of patients had their weight bearing lateral radiographs analysed to measure the sagittal curve by the usual Cobb method and the Radius of Curvature method. There was no difference for the Cobb values for negative neurology and patients with positive neurological deficit ($p=0.3$). There was a difference in these two groups when the radius of curvature method was used ($p< 0.0005$). The Radius of Curvature method has more relevance than Cobb method in quantifying sagittal plane deformity in congenital kyphosis when assessing neurological deficit.

Introduction

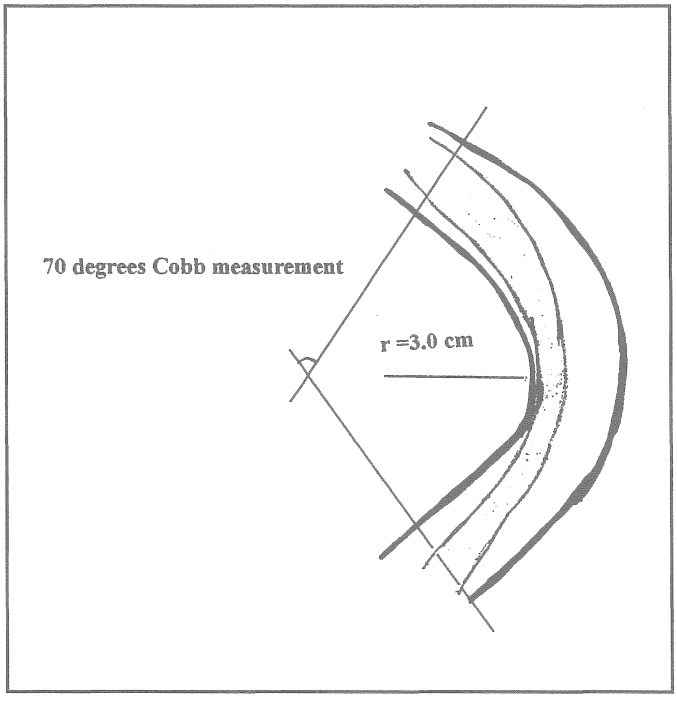
Non-traumatic, progressing sagittal plane deformities are uncommon, but important. If untreated, they (the deformities) can lead to neural damage. This neural damage is most likely to occur in the mid thoracic spine[1] because of the reduced intracanal space and the precarious blood supply to this region[2]. It is important to distinguish non-traumatic from traumatic causes of sagittal plane deformity, as the mechanics of the neural damage are very different. In non-traumatic conditions such as congenital kyphosis, the mechanism of neural damage is thought to be due to the bow stringing of the neural elements over the apex of the deformity[3,4]. This neural damage is further aggravated if the neural element is under traction with the application of a transverse force on the neural elements[5]. This situation occurs in conditions where the apex occludes the spinal canal as the sagittal plane deformity progresses. If these deformities are allowed to progress, the eventual outcome is neural injury[1]. Fortunately, neural injury does not occur rapidly[6]. The early stages of neural dysfunction such as paraparesis and sphincter disturbances can be recognized, and intervention

undertaken before irreversible neural damage occurs. The understanding of how and when this neural injury occurs is also important as surgical treatment can be planned before the start of neural injury. The situation is different in traumatic conditions; where factors such as rapid canal occlusion[7] with direct injury to neural elements are thought to cause the neural injury.

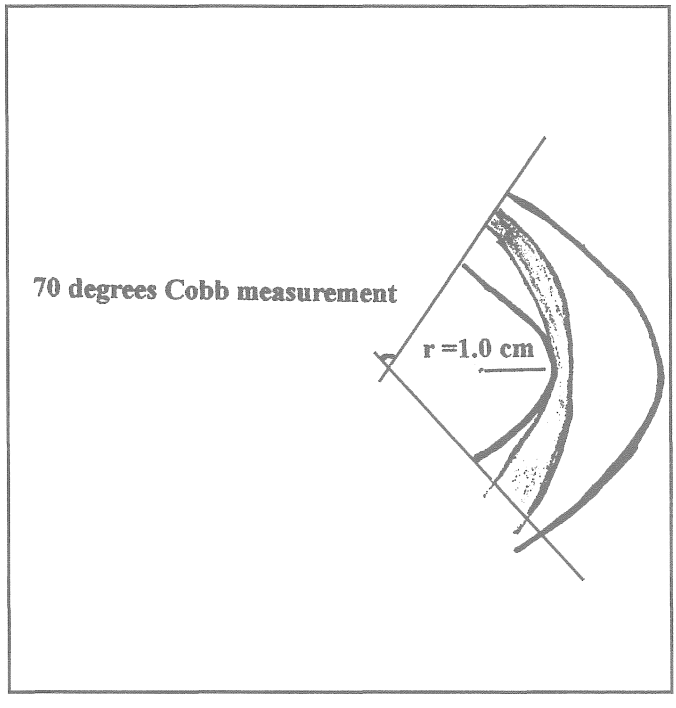
Cobb method is currently used to quantify sagittal plane deformities[8]. This method utilizes the tilt of the cephalad and caudad vertebra of the curve and does not impart any information about the apex of the curve. The quantification of an apical quality is more likely to reveal useful information than a measurement of tilt of end vertebrae, as the apex causes the transverse compression on the neural elements. To examine this further, a diagrammatic model was developed based on the sagittal profile of the apex of the curves in congenital kyphosis (Figure 1A and 1B), a non-traumatic, progressive sagittal plane deformity. This revealed the apices of the curves could be measured by mapping out their circumferi and obtaining their radii of curvature. This radii of curvature of the apex method was then used to evaluate the apices of sagittal plane deformity in radiographs of severe curves and comparing it with the current Cobb method in the same curves.

Materials and Methods

The clinical records and lateral weight bearing (sitting or standing) radiographs of 36 consecutive patients diagnosed with congenital kyphosis with severe sagittal curves were studied. Special attention was made to exclude other types of



A. Cord compression present. Apex is sharp and angular. Cobb measurement is 70 degrees, and radius of curvature is 1.0cm.



A. Cord compression absent. Apex is smooth and rounded. Cobb measurement is 70 degrees, and radius of curvature is 3.0cm.

Fig. 1A and 1B: Diagrammatic Model of Cord Compression in Congenital Kyphosis.

kyphosis such as Sheuermann's disease, myelomeningocoele, traumatic, metabolic and infective causes. Twenty-four of the patients had no neurological symptoms and the remaining 12 had neurological symptoms such as paraparesis, paraplegia and bladder or bowel sphincter disturbances. The radiographs were also analyzed to determine the type of vertebral anomaly and level of apex. Cobb value and radius of curvature of apex were measured in both the groups and compared. Cobb value was measured with a protractor (W 5 C - Thru Ruler Company, 6 Britton Drive, Bloomfield, Conn. USA); using the intersection of the perpendicular lines from the maximally tilted end vertebrae. The radius of curvature at the apex of the curve was determined by a specially designed template. The template was made on a transparent sheet with the outlines of various radii of curvature, ranging from 0.25 centimeters to 11.00 centimeters.

The template was referenced to three points on the radiograph,

1. the mid - point of the apical vertebrae, along the posterior longitudinal ligament,
2. the mid - point of the adjacent cephalad vertebra, also along the posterior longitudinal ligament; and
3. the mid - point of the adjacent caudad vertebra, along the posterior longitudinal ligament.

The kyphosis template is referenced to the radiograph; and the values were recorded to the nearest 0.25 centimeters. The group with no neurology had the most recent radiograph analysed, and the group with neurological symptoms had the radiograph at the onset of symptoms analysed. The level of apex in patients with neurology was further correlated with the symptoms to confirm the level of neural compression. No corrections were made for the magnification of the radiographs. No interobserver variations were estimated. Paired t-test was used to analyze data.

Results

Table I shows Cobb and Radius of Curvature measurement for both groups. Cobb value of sagittal curves of patients in both these groups were not significantly different (102.6 ± 19.5 degrees versus 105.9 ± 31.8 degrees, 95% CI between 0.00 and 12.64; p=0.3). The radius of curvature of apex in patients in both groups was significantly different (3.38 ± 1.2cm versus 1.06 ± 0.62cm, 99% CI between 0.97 and 3.81; $p < 0.0005$). Of the 36 patients, only 4 could not have their radii of curvature of the apex measured, due to poor quality radiographs. This did not change the significance of the result.

Discussion

Cobb's value for patients with and without neurological symptoms are not significantly different indicating the Cobb's value is unable to discriminate between both the groups of patients, and is of limited value in a progressing, non-traumatic sagittal plane deformity. The radius of curvature of the apex of the two groups are significantly different, and can discriminate between the two groups. This provides better information, and has more relevance in deciding when intervention should be undertaken for a particular sagittal curve. A small radius of curvature is commonly referred to as a 'sharp' or 'angulated' curve; while a large radius of curvature is usually referred to as a 'smooth' or 'gradual' curve. The author feels this study provides an insight into the evaluation of a progressing sagittal plane deformity; and recommends that the radius of curvature of the apex of such curves be considered and evaluated as part of the overall assessment when considering decompression and/or arthrodesis of such curves.

The idea of applying the principle of radius of curvature in curves was first discussed by White and Punjabi for coronal curves in scoliosis. They proved that two scoliotic curves can be markedly different and have the same Cobb measurement,

Table I
Cobb and Radius of Curvature Measurements between Patients with Negative Neurology and Patients with Positive Neurology The Patients are in the Same Sequence

Cobb Method (p = 0.3)		Radius of Curvature (p < 0.0005)	
Negative Neurology (degrees)	Positive Neurology (degrees)	Negative Neurology (cm)	Positive Neurology (cm)
119	111	0.5	1.5
126	92	2.0	0.5
87	44	2.0	1.5
92	101	2.5	1.5
92	127	4.0	0.5
89	55	-	2.0
88	87	5.0	0.5
90	120	4.0	2.0
107	135	4.5	0.25
88	148	4.0	1.0
96	121	-	0.5
90	130	4.0	1.0
100		5.5	
100		3.5	
105		-	
109		4.0	
100		4.5	
140		-	
90		2.5	
169		3.0	
88		2.5	
89		4.0	
106		2.5	
102		3.0	
N = 24	N = 12	N = 20	N = 12
Mean = 102.6	Mean = 105.8	Mean = 3.375	Mean = 1.0625
sd = 19.5	sd = 31.8	sd = 1.2	sd = 0.623
Range = 88 to 169	Range = 44 to 148	Range = 0.5 to 5.5	Range = 0.25 to 2.0

and further concluded that the radius of curvature is a more precise and descriptive quantification of a curve. They also alluded to the fact that a template could be used to quantify the radius of curvature and described the mathematical derivation of the radius of curvature of a curve[9]. In this study, the same principle with some modification is applied to a curve in the sagittal plane.

The experimental determination of the effect of a progressive sharp angle spinal deformity on the

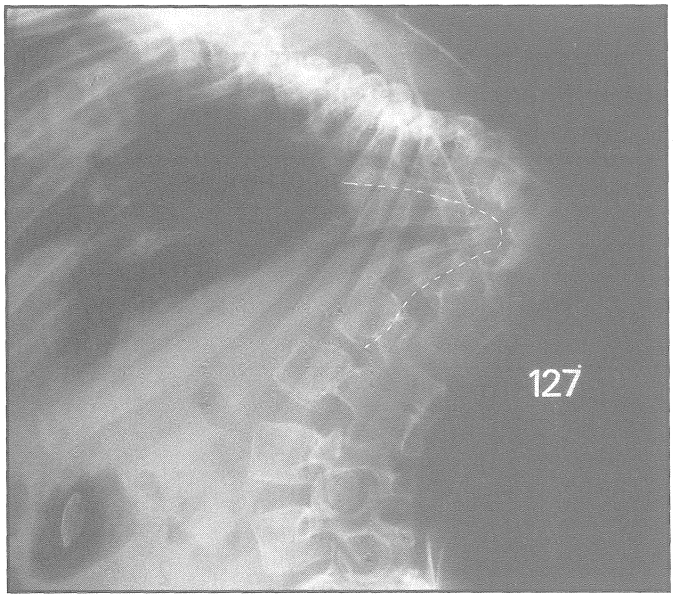


Fig. 2A: Lateral weight bearing radiograph of a patient with neurological deficit. The Cobb value is 127 degrees, and the radius of curvature is 1.00 cm.

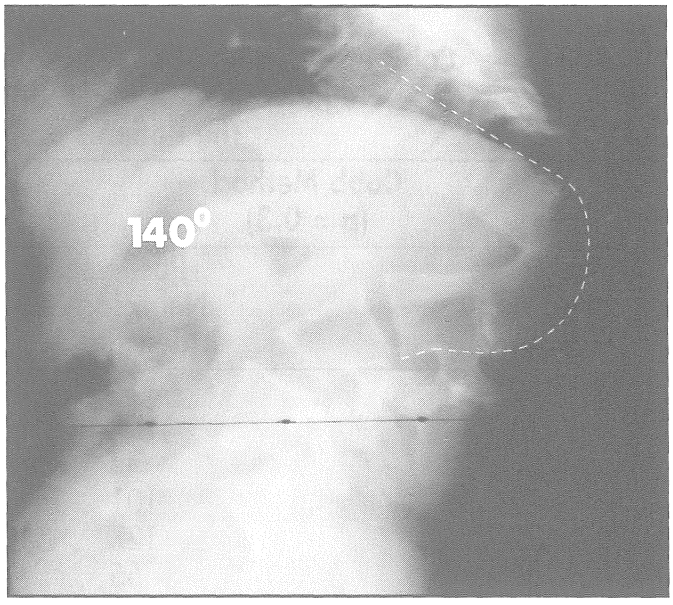


Fig. 2B: Lateral weight bearing radiograph of a patient who has normal neurology. Here the Cobb value is 140 degrees, larger than the subject in Figure 2A, and the radius of curvature is 3.25 cm.

spinal cord was also studied and showed that compression on the neural elements was seen at 90 degrees[10]. Although this is fairly reliable in clinical situations, we still see smaller Cobb values which have self reported neurological symptoms, and larger Cobb values with no self reported neurology (Figure 2 A and 2 B).

Conclusion

The Radius of Curvature method of quantifying a non-traumatic, progressing sagittal plane deformity is more relevant than the Cobb method in quantifying severe sagittal curves that are likely to develop neurological symptoms. This method also allows the 'sharpness' or the 'smoothness' of a sagittal curve to be quantified objectively.

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CASE REPORT

Acute Haematogenous Osteomyelitis: An Unusual Complication Following a Closed Fracture of the Femur in a Child

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Summary

We report a rare case of an acute haematogenous osteomyelitis of the femur in a five-year-old boy following a closed fracture of the femur. Because of its rare occurrence, the diagnosis of osteomyelitis was missed initially. He presented with a groin abscess seven weeks after injury. He was treated with external fixation, repeated debridements and intravenous antibiotics. Culture grew Staphylococcus aureus. The latest follow-up one-year after the injury showed resolution of the infection and union of the fracture. The range of knee movement is limited from 0 - 90 degrees due to quadriceps contracture.

Case Report

A 5-year-old boy was admitted to our hospital with a closed fracture lower third of the right femur following a motor vehicle accident (Fig. 1). He was treated with fixed traction on Thomas splint, and a hip spica was applied two weeks later. A check X-ray showed that the fracture was well aligned with good callus formation.

He was reviewed three weeks later. The fracture site was noted to be angulated 45 degrees. Closed manipulative reduction of the fracture was done under general anesthesia, and a hip spica reapplied. Two weeks later he was re-admitted with a three-day history of a right groin abscess. He was febrile and tachycardic. The white blood cell count was 11,000 cells/mm, and there were proportional increase in neutrophils. The ESR was 110 mm/h. X-ray (in spica) showed minimal callus and the sequestra were not obvious. He

Fig. 1: Closed fracture of the right femur.

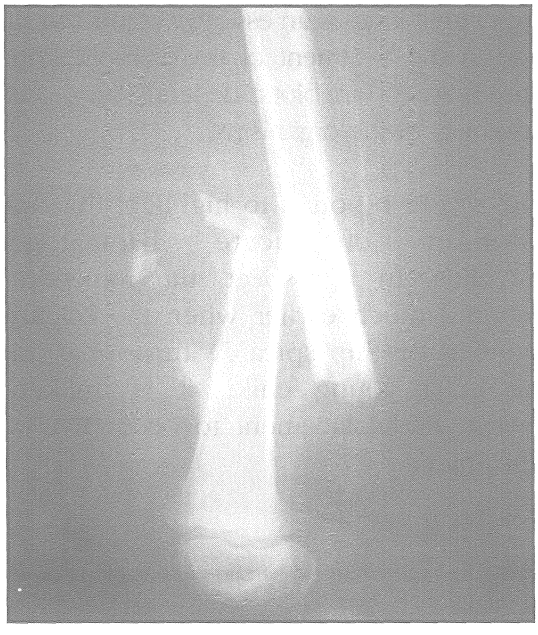

Fig. 2: Osteomyelitis seven weeks after the injury. Multiple pieces of sequestra and no evidence of union.

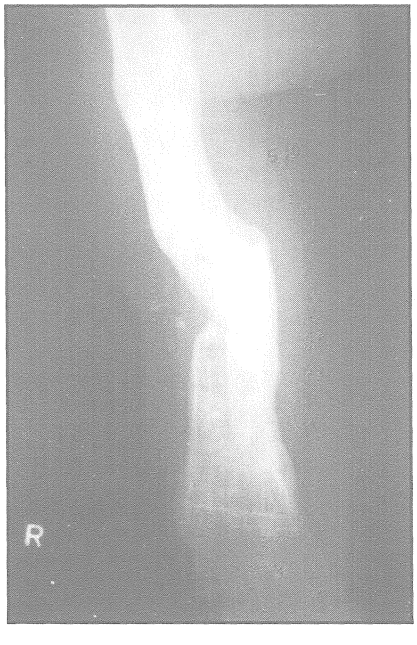

Fig. 3: One year after injury, the infection has resolved and the fracture united.

was referred to the pediatric surgery unit for drainage. Intraoperatively pus and pieces of sequestra were drained. A repeat X-ray of the right femur confirmed the presence of osteomyelitis (Fig. 2). Wound debridement, abscess drainage and external fixation were done the following day. The wound was left opened for daily dressings. Deep tissue culture grew *Staphylococcus aureus.*

He was treated with multiple debridements and a combination of cloxacillin and fusidic acid intravenously for two weeks followed by oral therapy for another four weeks. The external fixator was removed after six months. The latest follow-up at one year showed resolution of infection and fracture healing (Fig. 3). The knee is stiff with a range of motion from 0 - 90 degrees and he may require a quadricepsplasty if there is no further improvement.

Discussion

Children are more susceptible to haematogenous metaphyseal osteomyelitis. An increased in blood supply, decrease in flow rate and the presence of growing cells were thought to be the cause of the susceptibility to infection. The hips and knees are the most common locations for osteomyelitis.

Osteomyelitis in a closed fracture in children is very rare. Waldvogel *et al.*[3] reported a few cases of trivial injury preceding the development of acute hematogenous osteomyelitis but no evidence that closed fractures was involved in the aetiology of osteomyelitis. However, others have shown that closed fractures can be complicated by acute haematogenous osteomyelitis[1]. Trauma is thought to precede osteomyelitis, perhaps by making the area more susceptible to infection by increased blood supply or by the presence of chemotactic factors at the fracture site. In most cases reviewed by Hardy and Nicol[2], the primary source of infection is always present. These include the urinary tract, respiratory tract, ear, nose or skin infection.

Delay in recognizing the diagnosis of acute osteomyelitis is the rule in most of the cases[1,2]. Patients may present with septicemia, compartment syndrome or abscess. In our patient, the groin abscess was thought to be a localized problem. Hence the diagnosis of acute osteomyelitis was not considered initially.

The prognosis for this complication is usually good in children, but poor in adults. Hardy and Nicol[2] reported five of their nine adult patients died. All of their patients were immunocompromized.

The use of antibiotics is an essential adjunct to surgical drainage in the treatment of this complication. The ultimate choice of antibiotic depends on the culture and sensitivity of the organisms.

The aim of our report is to highlight this unusual complication of acute haematogenous osteomyelitis. In retrospect, the infection may have started much earlier when the fracture re-displaced in the hip spica. With normal fracture healing in a young child, it is unlikely for angulation or displacement to occur five weeks after the injury.

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CASE REPORT

Haemorrhagic Lumbar Synovial Cyst

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Summary

Hemorrhagic lumbar synovial cysts are not commonly reported in English literature. Post-resection recurrence of synovial cyst is unusual and therefore recurrence symptoms required repeat MRI or CT scan. We reported a case of hemorrhagic lumbar synovial cyst presented with neurological deficit that recovered initially after surgery but subsequently developed recurrent of symptoms at a higher level due to fibrous tissue.

Key Words: Hemorrhagic synovial cyst, Lumbar vertebra, Recurrent of symptom

Introduction

Lumbar facet synovial cysts are rare entities and were first described by Kao *et al.* in 1968. With the increasing application of computed tomography scanning and magnetic resonance imaging of the spine has increased the awareness of synovial cysts of the lumbar facet joint[1]. Although intraspinal synovial or ganglion cysts are widely recognised, there are not more than ten cases of hemorrhagic synovial cysts have been reported in the English literature[2]. Patients with lumbar synovial cyst commonly present with intermittent low back pain, with or without radiculopathy. Neurological deficit are infrequent and occurrence of acute exacerbation of symptoms or cauda equina syndrome, which may be caused by an intracystic bleed, is rare[1-4]. Surgical excision of the synovial cyst is a safe, effective and definitive treatment for symptomatic lesions[1]. Post-resection recurrence of synovial cyst is unusual and therefore recurrence symptoms required repeat MRI or CT scan.

We describe a case of hemorrhagic lumbar synovial cyst presented with neurological deficit that recovered initially after surgery but subsequently developed recurrent of symptoms at a higher level.

Case Report

A 60-year-old housewife complained of sudden onset of severe low back pain which radiating down up to the dorsum of left foot following an exercise on the static bicycle, for ten days duration. She had associated left lower limb numbness, paresthesia and weakness. There was a history of low back pain for more than five years and about a year ago she had a fall from a chair. There were no bladder and bowel dysfunction and her both upper limbs were also asymptomatic. Her medical history was unremarkable. She is on hormone replacement therapy since last year. There were no family and social histories of significant.

She is pink but overweight. She was quite anxious, and in obvious discomfort. General and systemic physical examination did not revealed any abnormalities. There were no abnormalities detected on her both upper limbs and right lower limb. However, there was mild wasting of her left lower limb. She had weakness of the left extensor hallucis longus (EHL) and tibialis anterior muscles (MRC grade 3/5). Sensation was diminished to light touch and pinprick in the distribution of L5 dermatome. Joint position sense was intact and reflexes were normal. Left straight-leg-raise test elicited pain in the leg at 40 degree, which was exacerbated further by ankle dorsiflexion. The anal tone was intact.

Her lumbar sacral plain radiographs showed lumbar spondylosis with degenerative changes of the facet joints of L3-L4 and L4-L5, mild spondylolisthesis of L4-L5 and sacralization of L5 vertebral body (Fig. 1a and 1b). Magnetic resonance (MR) imaging revealed an extradural mass in the left postero-lateral aspect of the lumbar spinal canal immediately adjacent to a degenerated left L4-5 facet joint and compression of the ipsilateral L5 nerve root (Fig. 2a, 2b and 2c). These findings were considered to be characteristic of an intraspinal synovial cyst arising from the left L4-5 facet joint. In view of the neurological deficit and intolerable nature of pain that disturbed her activity of daily living, surgery was offered to her.

The patient underwent a left hemilaminectomy at L4-L5, with a partial medial facetectomy under general anaesthesia. The intraspinal cystic mass located posterior to the nerve roots and was found compressing the dura and L5 nerve root. It was excised en-masse (Fig. 3a, 3b and 3c). Hypertrophied of the left L4-L5 facet joint also noted. Histological examination of the surgical specimen revealed a haemorrhagic synovial cyst (Fig. 3d).

Post-operatively, she had dramatic reduction of pain and her EHL and tibialis anterior muscles power has improved to MRC grade 4+/5. At the time of her discharge on the sixth post-operative day, she has mild residual paresthesias and pain, which is controlled with analgesics.

Five months after operation, her muscles power had recovered but she still has low back pain and

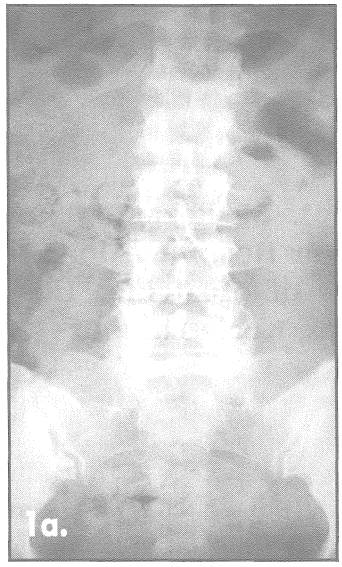

Fig. 1a: AP view of Lumbar sacral X-ray.

Fig. 1b: Lateral view of Lumbar sacral X ray.

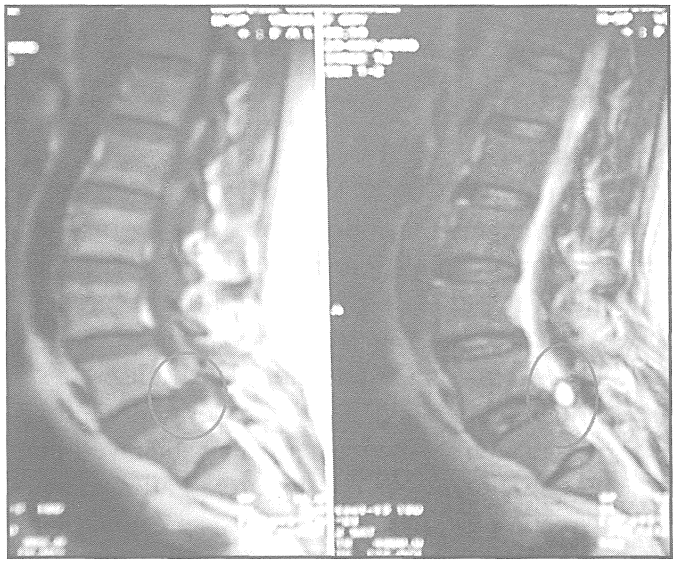

Fig. 2a: MRI T1 and T2 weighted lateral views.

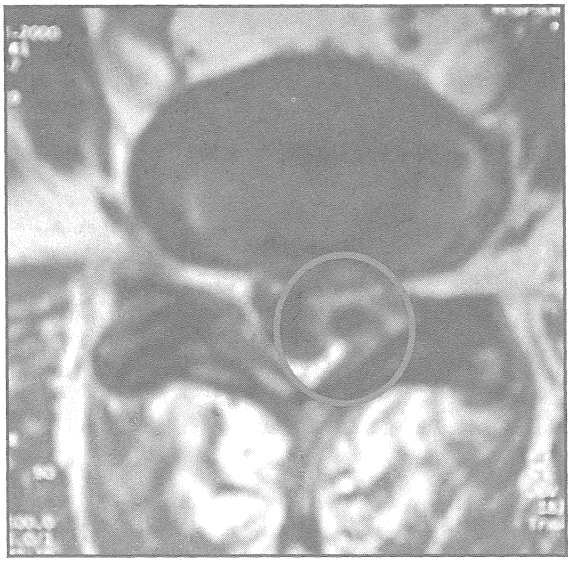

Fig. 2b: MRI T1 weighted axial views.

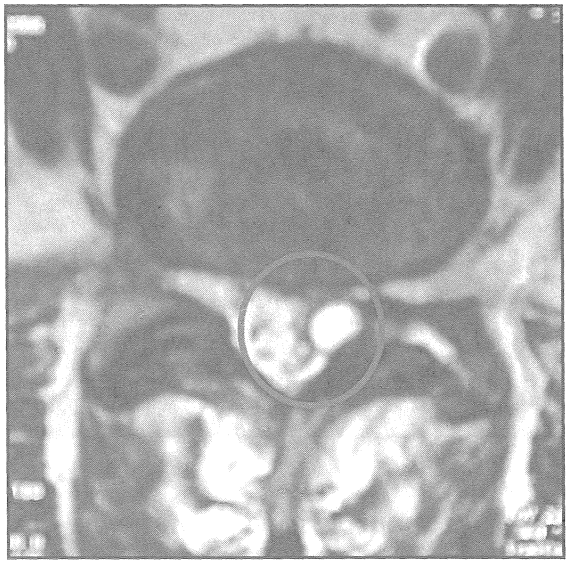

Fig. 2c: MRI T2 weighted axial views.

Fig. 3a: The cyst located adjacent to facet joint and adhered to the dura.

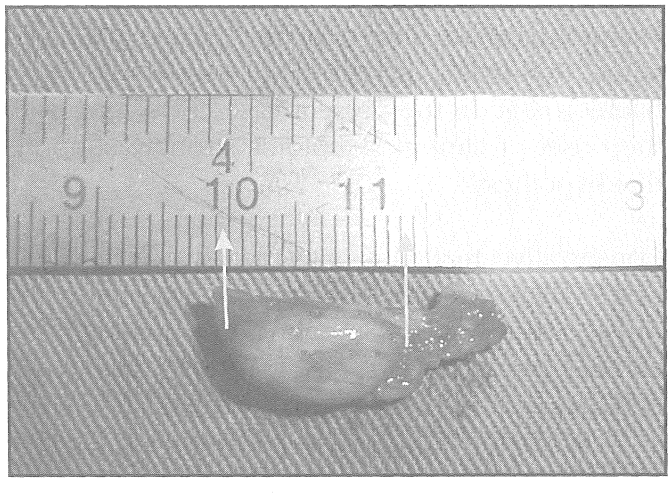

Fig. 3b: The excised cyst.

numbness of the left leg in the distribution of L4 dermatome. Repeat MRI showed present of fibrous tissue on the left side of the spinal canal at the L4 level with encasement of proximal exiting L4 nerve root. At the time of writing this report she was still treated conservatively.

Discussion

Synovial cysts can occur adjacent to any synovial joint that is affected by degenerative joint disease, rheumatoid arthritis, trauma or joint destabilization[3]. The majority of synovial cysts are found in the lower lumbar spine, especially at the L4-L5 level, the level with the greatest facet mobility, as in this case[1]. The cause of

Fig. 3c: An hourglass deformity of the L5 nerve roof was noted.

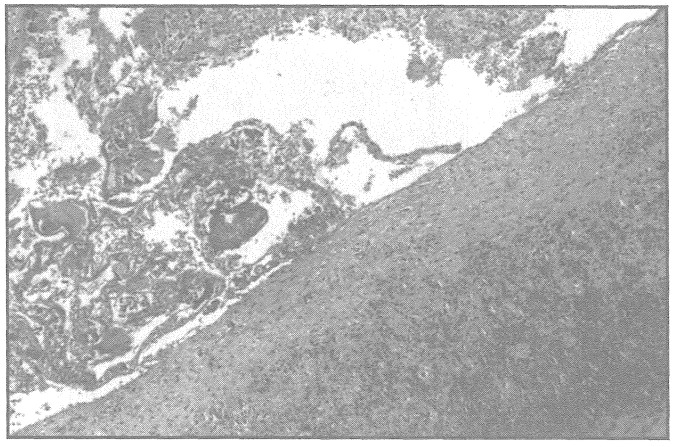

Fig. 3d: Histology of synovial cyst wall showing haemorrhage in the cyst wall (thick arrow) as well as fibrous tissue (thin arrow).

haemorrhage into a synovial cyst is unknown. Synovium is known to be richly vascularized, with venules being the predominant vessels type. Haemorrhage may account for the expansion of some synovial cysts. The observation of haemorrhage in the present case correlating with the onset of clinical symptoms strongly supports this hypothesis[2].

Conservative treatment may be advocated if the cyst wall is not calcified and the radiculopathy show improvement. Surgery is the treatment of choice, producing excellent results[1]. A limited hemilaminectomy with partial medial facetectomy and excision of the cyst was performed at the side of the involved level[4].

Recurrent of synovial cysts are rare. Finkelstein in 1993 described that the development of a juxta-facet cysts after surgery has not been reported previously and reported a case of a new contralateral cyst[3]. However, in our patient she had a recurrent of symptoms 5 months after operation, which could be due to the encasement of the proximal exiting L4 nerve root secondary to the fibrous tissue but degenerative spondylolisthesis or sacralization of L5 must be kept in mind.

References

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