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EDITORIAL

Iatrogenic Instability of the Lumbar Spine

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Lumbar Spine Surgery has undergone marked evolution since Mixter and Barr first performed disc surgery in 1934. The Anatomy and Biomechanics of the lumbar spine is better understood. It is the region of the body that is often operation. In 1987 there were over 10 per 100,000 persons undergoing lumbar spinal operation in the United States. The success rates have been reported at anywhere from 59% to 96% depending on the study and the type of surgery[1].

The causes of failure of Lumbar Spinal Surgery may be due to the following:-

1. Poor Patient selection;
2. Wrong indications;
3. Inadequate decompression;
4. Archnoiditis;
5. Epidural fibrosis;
6. Neuropathic pain syndrome;
7. Instability - either pre-existing instability not addressed or iatrogenic instability due to excessive decompression;
8. Infection;
9. Injury to nerves, vessels and other organs.

Iatrogenic instability may be defined as a clinical syndrome in which the patient develops a recurrence of back and leg pain with radiographic findings of a new or progressive slip of greater than 3mm or flexion-extension films that show greater than 4mm of motion or 10^0 of angulation in one motion segment[2].

Typically, patient with iatrogenic instability present with a history of initial relief of their preoperative complaints but present with back pain that radiates down one or both legs several months later. The back and leg pain can often be relieved by assuming a recumbent position.

Spondylolisthesis after disectomy is a relatively rare occurrence and occurs in 5% to 18%[3] of cases, but may occur in up to 70% of patients with pre-existing spondylolisthesis undergoing wide laminectomy with complete facetectomy[4].

Many preoperative, intraoperative and postoperative factors may contribute to postoperative instability.

Preoperative indicators of potential instability are:-

i) Degenerative spondylolisthesis (especially higher grade);
ii) Greater than 4mm translation on sitting flexion and extension lateral radiographs;
iii) Greater than 10^0 of disc-space angulation on flexion-extension lateral radiographs;
iv) Female sex (4:1);
v) Minimally degenerated L4-5 disc (i.e. preserved disc height);
vi) Markedly degenerated L3-4 disc;
vii) L4-5 disc space lying above the intercrestal line;

Intraoperative factors leading to instability are:-

i) Wide laminectomy;
ii) Greater than 50% facet removal at the same level or unilateral total facetectomy;
iii) Removal of facet capsules and articular cartilage;
iv) Pars interarticularis resection;
v) Multiple-level decompression (4-fold increase);

Postoperative factors leading to instability are:-

i) Postoperative stress fracture in a facet or pars interarticulars in a very active patient;
ii) Pseudoarthrosis of the posterolateral or anterior spine fusion;

All patients who undergo lumbar spine surgery should undergo radiographic and clinical follow-up to detect signs of instability that may not occur for several years after surgery. Lateral lumbar radiographs will detect patients who are undergoing frank slippage of one or more lumbar motion segments. In suspicious cases, flexion and extension lateral radiographs may be added.

In symptoms of spinal instability arises, conservative treatment includes physiotherapy, short periods of bracing, nonsteroidal anti-inflammatory drugs, and oral steroids. Due to epidural scar tissue, epidural steroid injections may not be possible or efficacious in these cases. Operative intervention is indicated in cases of progressive neurologic deficit, intractable back pain, or sciatica that does not respond to conservative treatment. All patients should undergo preoperative assessment with computed tomography myelography or magnetic resonance imaging to rule out recurrent disc herniation or other sites of nerve-root compression.

In most cases, the surgical treatment is instrumented postolateral fusion with autogenous iliac crest autograft.

Conclusions

Postoperative instability of the lumbar spine is a relatively common cause of failed back syndrome. Many of the risk factors for this condition can be identified preoperatively, and many other cases can be avoided by appropriate surgical technique. In some cases, it will develop regardless of preoperative planning and must be looked for on postoperative lateral radiographs, as well as flexion-extension radiographs if necessary. Conservative management is often unsuccessful, but surgical management is usually very successful.

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Major Limb Amputations in Seremban Hospital: A Review of 204 Cases from 1997-1999

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Summary

We conducted a retrospective study of 3 years duration beginning from the 1st January 1997 to the 31st December 1999 in order to identify the epidemiology of major limb amputations in Seremban Hospital. Two hundred and four patients were included in this study out of which 65.7% were male and 34.3% were female. The mean age of the amputees was 39.7 years old.

Non traumatic amputations constitute 85.8% of the cases mainly due to diabetic ulcers or gangrene (91%) followed by peripheral vascular disease (7%) and malignancy (2%). Traumatic amputations represent 14.2% of the cases with road-traffic accident as the major cause (82.8%) followed by industrial accident (17.2%).

Lower limb amputations were performed in 97.5% of the cases with below knee amputations as the commonest procedure (72%), followed by above knee amputations (27%) and Syme amputations (1%). Five patients had upper limb amputations done. Four of them were below elbow amputations while one had forequarter amputation done of the left shoulder.

Of note, there were increasing number of amputations done over the last three years with alarming increasing trends of traumatic amputation. The three main risk factors for major limb amputations are diabetes mellitus, male gender and road traffic accident.

Key Words: Amputation, Major, Limb

Introduction

Limb amputation is a widely acknowledged and commonly performed surgical procedure. The causes of this amputation vary in different parts of the world. Limbs may require amputations if it poses a threat to the patients' life due to severe trauma or gangrene. It may also be the treatment of choice to eliminate chronic uncontrolled sepsis in some cases of osteomyelitis or

neuropathic ulceration. Occasionally, amputation should be done as a salvage procedure for certain stage of malignancy.

In general, the roles of amputations are to improve mobility, to relieve pain and even to save life. Despite the advances in the knowledge of the diseases and surgical treatment, we have noted an increasing number of amputations performed in this hospital. However, no study had been conducted to review the epidemiology of the major limb amputations in this hospital. The study was also aimed to identify the risk factors for major limb amputation in order to introduce preventive measurement in the future.

Materials and Methods

This is a retrospective study of 3 years duration beginning from the 1st January 1997 to the 31st December 1999 done in Seremban Hospital, a level one hospital in Negeri Sembilan. All patients who underwent major amputations during the period were included in the study. The inclusion criteria for major amputations of the lower limbs are transmetatarsal amputation, tarsal amputation, Syme's amputation, below knee amputation, above knee amputation, through knee amputation and hip desarticulation. Major upper limb amputations include transmetacarpal amputation, wrist amputation, below elbow amputation, above elbow amputation and forequarter amputation. Minor amputations such as ray amputation, finger or toe desarticulation were excluded from the study.

Data were collected from the patients record traced from the medical record office using a standard form. The socio-demographic data includes the race, age group and gender. Causes of amputations were classified into traumatic and non-traumatic causes. The traumatic causes were further sub classified into road traffic accident, industrial accident or domestic injuries. The non-traumatic causes were divided into infectious and non-infectious causes. The infective causes include diabetic ulcer and osteomyelitis while the non-infective causes include vascular gangrene, malignancy and congenital deformity. For those who underwent more than one major amputation, each amputation was accounted as individual amputation.

Results

There were 204 major limb amputations performed during this period. The number of amputations increased from 48 cases in 1997 to 64 cases in 1998 and 92 cases in 1999. Male patients constituted 134 of the cases while female 70 cases. The Malays constitute 43.5% of the amputees followed by the Chinese (24%) and the Indians (25%). The mean age of amputees was 39.7 years old. Eighty four percent of the amputations were performed on patients older than 40 years old of age, out of which 50% were those in the age group above 60 years old. The remaining 16% were below the age of 40 years old, out of which 75% belongs to the age group between 20 - 40 years old.

Non traumatic amputations represent 84.8% of the major amputation, with 87.5% of the cases in 1997, 89% in 1998 and 82.6% in 1999. Diabetic ulcers and gangrenes was the major contributor for non-traumatic amputations (91%) followed by peripheral vascular diseases (7%) and malignancy (2%). Traumatic amputations constitute 15.2% of the cases with majority of the cases caused by motor vehicle accident (83%) followed by industrial accident (17%). The number of traumatic amputations also increased from 12.5% in 1997 to 17.4% in 1999.

Sixty percent of amputations done in patients above 40 years old were due to complications of diabetes mellitus, which was absent in patients below the age group. In the latter, trauma was found to be the major cause of amputation, where it accounted for 72% of the cases. There was male preponderance for traumatic amputations. Twenty two percent of male had amputation done for traumatic causes compared to only 5.7% in female. Non traumatic amputations involved

94.3% of the female gender compared to only 78% of the male gender. As far as the races are concern, the Indians represent 41% of the traumatic amputations followed by the Chinese (24%) and the Malays (21%).

Lower limb amputations represent 97.5% of the cases out of which 64% were due to diabetic causes. Below knee amputations were performed in 72% of the cases, followed by above knee amputations (27%) and Syme's amputations (1%). There were only 5 cases of upper limb amputations. Four of them were below elbow amputations done following traumatic industrial accident. One patient had fore quarter amputation done of the left shoulder for malignancy.

In our study, we encountered three cases of amputation due to malignancy. These were patients who had a forequarter amputation done due to rhabdomyosarcoma of the left shoulder and two cases of below knee amputation for squamous cell carcinoma and osteosarcoma.

Discussion

It was found in this study that the majority of major limb amputations in Seremban Hospital were due to non-traumatic causes. This corresponds to other studies done in England, Wales and Finland where it was found that more than 75% of the amputations were due to non-traumatic causes[1]. As with the other studies, our study also showed that diabetes and peripheral vascular diseases were the main underlying causes leading to these amputations[2].

The increasing number of amputations over the three years can partially be attributed to the poor diabetic control and late consultation to physician necessitating limb amputations. Increasing the awareness of the diabetic patients on the possible complications of the disease and taking appropriate preventive measurements can improve this condition. The patients and family member should be trained to look after the foot hygiene while the general practitioner should also be aware of the earliest signs of diabetic foot changes.

The increasing number of traumatic amputations, from 12.5% in 1997 to 17.4% in 1999 was also alarming. Similarly, Narang et al also reported an increasing percentage of traumatic amputations in India, representing 67% of all amputations between 1954 to 1978[3]. Daily statistics on road traffic accident are clear evidence of the magnitude of the problems we are facing. Installing individual awareness on road safety together with stringent traffic law are two major steps to be taken. Industrialization also paid a significant toll. All patients who had below elbow amputations done were caused by crushed injury to the hand. Among possible predisposing factors are inadequate training in handling the machines, loss of concentration after long working hours and lack of safety measurements at the working site. Further study should be done to clarify this matter.

The mean age of amputees in Seremban Hospital were 39.7 years old. In most developed countries the mean age of amputees were reported as 75.3 years old. Whereas in the third world countries the average age is much lower. For example, in Burma, a mean age of 31 years was reported[4], in Hong Kong it was 39 years[5], in India 25 years old[6] and in Australia 53 years old[7]. In other words, a developed country has a higher mean age of amputation whereas the less developed countries have a lower mean age of amputation. This could possibly relate to the advances in the health services present in that particular country.

Our study also showed that the male gender constituted almost two third of the total amputations. This correlated with other part of the world where male amputees are more compared to female amputees. The reported male to female ratio from the United Kingdom, United States of America and Scandinavia are 2:1, and this has not altered over the last 20 years. The significant percentage of male amputees in

traumatic amputations (22% compared to 5.7% in female) might suggest the susceptibility of the male gender to trauma.

We also noted the difference between the numbers of lower limb and upper limb amputations. The upper limb to lower limb ratio in the United Kingdom was 1:11 and in the United State of America was 1:6 in year 1961. In our study the ratio was 1:10. However, in the under developed world, the ratios were said to be the opposite. For example in India, the ratio was 2:1[6] and in Burma the figure was 4:1[4].

Many factors influence the level of amputation selected. In the case of trauma or dysvascularity, viability of the tissue is a major concern. Although a number of objective tests that can help predict healing rates, such as the segmental laser Doppler studies and the transcutaneous oxygen measurements, have been investigated, at present there is no universally acknowledge 'gold standard' which will guarantee a good outcome. In general the surgeon must combine the clinical judgement based on experience together with available objective data in determining the specific amputation levels.

It was found that most of the lower limb amputations were below knee amputation. This pattern was found to be similar with the western countries. In the United States of America, it was reported that below knee amputation contributes 54% while above knee amputation 33% of the total amputations. This can particularly be attributed to the early decision making to perform an amputation before the pathology ascends to a higher level. Preservation of a functional knee joint has been demonstrated to significantly reduce the energy expenditure required walking with prosthesis.

Conclusion

Our study showed that there is increasing numbers of major limb amputation during the past three years. Non traumatic causes particularly diabetes mellitus still constitutes the majority of the cases. However, there is an alarming increasing trends of traumatic amputations especially those involving the road traffic accident. Diabetic complications were found to be a risk factor for those above 40 years of age, whereas male gender and road traffic accident were the risk factor for those below the age group. Below knee amputations were found to be the commonest type of amputation performed in this hospital.

It is our hope that this information will initiate further detailed study on the functional outcome of the amputees and at the same time become a catalyst for both the healthcare providers and the patients in preventing the risk factors and improving the management of the disabling condition.

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TRAUMA

Plate Osteosynthesis of the Humerus Shaft Fracture and its Association with Radial Nerve Injury - A Retrospective Study in Melaka General Hospital

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Summary

Over a seven-year period, 170 cases of humerus fractures were plated in Hospital Melaka. Of these, 131 cases were successfully traced for this study. Besides looking at fracture epidemiology, its relationship with radial nerve injury was examined. The incidence of post-traumatic wrist drop in closed and compound fractures were 14.9% and 35.3% respectively. In relation to the site of fracture, lower third fracture had the highest incidence of wrist drop (29%). The recovery from post-traumatic wrist drop was 83%. The average duration taken for recovery was 11.8 weeks. The incidence of post-operative wrist drop was high at 17.6% but all recovered during follow-up.

Key Words: Humerus shaft fracture, Osteosynthesis, Radial nerve injury

Introduction

Humerus shaft fractures are common in orthopaedic practice. They form three to five percent of all fractures[1]. While the management of humerus shaft fractures is conservative in many uncomplicated injuries, there is a definite and growing role for operative treatment. The indications for surgery include unacceptable fracture reduction, multiple trauma, ipsilateral forearm injuries, compound fractures and vascular injury. In multiply injured patients, internal fixation provides a mobile, pain free extremity thus avoiding prolonged recumbency and facilitating rehabilitation[2]. We know that radial nerve injury is commonly associated with humerus shaft fractures and that it also a complication of internal fixation of these fractures, yet relatively few large papers look specifically at this issue. A seven year retrospective study on the results of 131 cases of humerus shaft plating performed at Melaka General Hospital was done. In this study the incidence and outcome of radial nerve injury associated with humerus shaft fracture or their plating were specifically looked into.

Materials and Methods

From 1990 to 1996, plating of 170 cases of humerus shaft fractures were entered into the operation theatre record books. Of this

number 131 cases or 76% could be entered into this study based on the complete availability of the following:

1. Admission notes.
2. Surgical notes.
3. Pre and post operative X-rays.
4. Follow up out-patient cards.

Patients who defaulted follow up prior to bone union or nerve recovery were excluded from the study. The data obtained included the patients age, sex, cause and date of injury, site and type of humerus shaft fracture, indication for surgery, surgical approach, type of plate, findings at nerve exploration together with period taken for bone and nerve recovery.

A humerus shaft fracture is defined as one occurring below the surgical neck and above the supracondylar ridge of the humerus. This was divided into upper, middle and lower thirds. A vast majority of the fractures were plated with narrow DCP 4.5.

Nerve recovery was defined as the return of at least grade 4 power in wrist and finger extension.

Results

Patient Profile

(i) Sex
Looking at the patient profile we find that 85 percent were male and 15 percent were female.

(ii) Age
As for the age distribution, we found that most of the patients are active young adults in the 21 to 40 year old age group.

Cause of Humeral Fracture

Motor vehicle accidents contributed to 86% of the fractures. Falls caused 11.5% of the fractures.

Industrial Accidents (1.5%) and assault (0.8%) accounted for the other cases.

Indications for Surgery

Indications for plating of the humerus were

i) Unacceptable reduction 74.8%
ii) Non union 13.7%
iii) Nerve injury 3.8%
iv) Compound fracture 2.3%
v) Polytrauma 2.3%
vi) Others 3.1% (including vascular injury, allergy to plaster or wool)

Fracture Description

For the purpose of this study, the humeral shaft was divided into upper, middle and lower thirds. The majority (63%) of fractures were at the middle third. Twenty-seven percent were at the lower third while only 10% were at the upper third. Eighty-seven percent of the fractures were closed as opposed to 13% which were compound.

Relationship with Radial Nerve Injury

Looking specifically at the relationship between radial nerve injury and humerus shaft fractures, we found that the annual incidence of post traumatic (or pre operative) wrist drop varied

Table I
Humerus Plating:
Number of Cases Done Versus Number of Cases Traced

Year	No. of Cases Done	Traced
1990	14	11
1991	16	11
1992	36	33
1993	29	18
1994	23	19
1995	23	17
1996	29	22
Total	170	131
%	100	76

from 5% to 27% with an average of 17.6% or 23 out of 131 cases. In compound fractures, the incidence was 35.3% while in closed fractures the incidence was 14.9%. The figures are generally consistent with those in literature which suggest an incidence of between 15 and 30 percent[5,8].

In relation to the site of fracture, we found that lower third fractures had a 29% incidence of wrist drop, middle third fractures had an incidence of 16% wrist drop while there were no cases of wrist drop in upper third fractures. Of the 23 cases of post traumatic wrist drop, exploration was done in 13 cases. (9 cases were explored within 3 weeks of the fracture, while 4 cases were explored after 3 weeks).

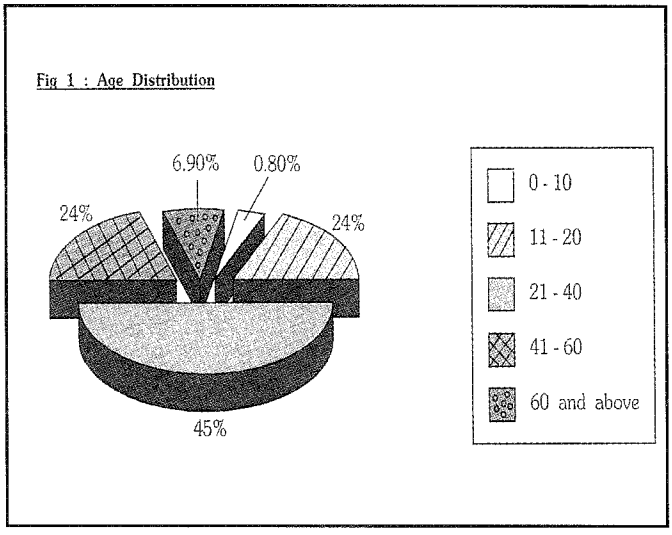

Fig 1: Age Distribution.

Table II
Sex Distribution

	1990	1991	1992	1993	1994	1995	1996	Total	%
Male	9	10	27	16	14	15	20	111	85
Female	2	1	6	2	5	2	2	20	15

Table III
Site of Humeral Shaft Fracture

	1990	1991	1992	1993	1994	1995	1996	Total	%
Upper third	1	1	5	2	1	0	4	14	10.7
Middle third	6	9	19	12	10	10	16	82	62.6
Lower third	4	1	9	4	8	7	2	35	26.7
Total	11	11	33	18	19	17	22	131	100

Table IV
Types of Fracture (Closed Versus Compound)

	1990	1991	1992	1993	1994	1995	1996	Total	%
Closed	11	11	28	14	18	13	19	114	87
Compound	0	0	5	4	1	4	2	17	13

Table V
Number of Cases of Pre-Operative Wrist Drop

	1990	1991	1992	1993	1994	1995	1996	Total
No. of Wrist drop	3	3	7	4	1	3	2	23
Total cases plated	11	11	33	18	19	17	22	131
%	27.3	27.3	21.2	22.2	5.3	17.6	9.1	17.6

Table VI
Number of Cases of Post-Op Wrist Drop

	1990	1991	1992	1993	1994	1995	1996	Total
No. of Wrist drop	2	0	6	3	3	4	1	19
Total cases plated	8	8	26	14	18	14	20	108
%	25	0	23	21.4	16.7	28.6	5	17.6

The findings at exploration were that 2 nerves were transected, 2 were trapped in between the fracture fragments, 1 was in callus, 3 were recorded as contused or stretched and 5 nerves looked normal.

Nerve Recovery

For this study, recovery from wrist drop was defined as the return of wrist and finger extension power of at least grade 4. Recovery from post traumatic wrist drop occurred in 19 out of 23 cases. Of these, 18 recoveries occurred within 5 months and one case took 1 year to recover.

The average duration taken was 11.8 weeks. Seen from a different perspective, it is important to emphasize that 17 percent did not recover and one should not assume that all post traumatic wrist drops recover. Of the four cases that did not recover, two had radial nerves that were totally cut, one nerve had been reported as contused in the surgical notes. One patient refused exploration. The duration taken for nerve recovery is important in that it helps us decide on the length of time for observation before deciding to intervene surgically.

Post Operative Wrist Drop

The next part of the study was to look at the relationship between radial nerve injury and plating. In this part of the study, the 23 cases of preoperative wrist drop were excluded. Out of the 108 remaining cases, wrist drop occurred post operatively in 19 cases (17.6%).

The figure of 17.6% is higher then most figures quoted in literature (which varies from 0 to 15 percent[2,6,8]. In this study, surgical approach (whether anterolateral or posterior) did not affect the incidence of wrist drop. All the post operative wrist drops recovered and we can assume that the temporary impairment of nerve function was due to stretching or contusion during surgery. The duration taken for recovery from post operative wrist drop varied from 1 day to 24 weeks.

Discussion

The occurrence of radial nerve injury pre and post-operatively were coincidentally identical at 17.6%. The recovery rate of wrist drop following trauma was 83 percent. This is generally comparable to figures by Bell in 1985 (87.5%).

Seventeen percent of wrist drops following trauma did not recover and this non-recovery occurred both in closed fractures and in compound fractures. This suggests that all cases of humerus fracture with wrist drop be operated on, as it facilitates identification of the cause of palsy, which also tells us the prognosis. Repair and protection of the injured nerve is also facilitated.

In this study the average duration taken for nerve recovery was 8 weeks. Also, in 18 out of 19 cases which recovered, the recovery occurred within 5 months. As such, we suggest that if the initial treatment of a fracture humerus with wrist drop is conservative, exploration should be considered after three to five months, if there is no sign of recovery.

Conclusion

1. Humerus fractures with wrist drop should be explored because seventeen percent of the wrist drops following trauma did not recover.
2. Radial nerve palsy following plate ostcosynthesis will usually recover. It this study, all recovered within a period of 24 weeks.
3. Plating of the humorous, if indicated, is a safe and effective way of managing humerus shaft fractures.

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Functional Outcome of Proximal Humeral Fractures

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Summary

The functional outcome of 27 patients (16 males, 11 females) with a proximal humeral fracture was evaluated using the Simple Shoulder Test. Fifteen patients were also assessed using the Constant system. The mean age of the patients was 46.3 years (range 16 - 90 years) and the mean follow-up was 14 months (range 6 - 29 months). There were ten 2-part fractures, eight minimally displaced fractures, two 3-part fractures, three 4-part fractures, three 1-part fracture-dislocations and one 3 parts fracture-dislocation. Twenty-four fractures were treated conservatively and 3 surgically.

Thirteen patients (48%) regained full function on the simple shoulder test and almost all regained range of movement sufficient for activities of daily living. Six patients were not able to return to their previous job. All patients were pain free at rest and were able to sleep on the affected side comfortably, although 9 patients had pain with activity, even though most pain were mild in nature. The mean Constant scores for the fractured arm and the normal arm were 72.5 points and 91 points respectively. The strength of shoulder abduction was reduced by a mean of 34%. Although the outcome was generally satisfactory, there was nevertheless a statistically significant deterioration of function following the fracture.

Key Words: Proximal humeral fracture, Functional outcome, Simple shoulder test, Constant score

Introduction

In Western countries, proximal humerus fractures in adults are largely a fracture of elderly postmenopausal women, and is often the result of simple falls[1-3]. Minimally displaced fractures form up to 85% of all fractures[4]. Conservative treatment is therefore the mainstay of treatment, and outcomes have been generally satisfactory.

On the other hand, the mean age of patients sustaining a proximal humeral fracture in Malaysia may be significantly lower than those reported in the literature. Most fractures may be the result of severe trauma rather than simple falls (unpublished observations[5]). The outcomes may therefore be different and this study aims to investigate the functional outcome of proximal humeral fractures in Malaysia.

Materials and Methods

All primary fractures occurring at or proximal to the surgical neck of the humerus with the exception of epiphyseal fractures, treated at the Institute of Orthopedics and Traumatology, Hospital Kuala Lumpur between January 1997 and December 1998 were included in this retrospective study. This period was chosen because it gave a minimum follow-up period of 6 months for all patients at the time of the study and may reduce the number of patients that are lost to follow-up.

A total of 40 patients were identified. The case notes and radiographs of 3 patients were not available for review, leaving 37 patients. From these, 10 patients were not contactable by telephone and did not respond to the postal questionnaire and were excluded from the study. Twenty-seven patients had a functional outcome evaluated using the Simple Shoulder Test[6] (see Fig. 1). Fifteen patients were also evaluated with the Constant system[7] (the scoring for individual parameters were 15 points for pain, 20 points for activities of daily living, 40 points for range of motion and 25 points for strength). The scores from the fractured arm can be expressed as a percentage of the normal arm. This percentage was then classified as an excellent outcome if between 85 - 100%, good between 70 - 84%, fair between 55 - 69% and poor if below 54%.

Radiographs of the fractures before treatment were reviewed and the fractures were classified using Neer's classification criteria (a segment is displaced if displacement is greater than 1cm or angulated greater than 45°)[4]. However, only the following fracture types were used to avoid an excessive number of small groups; minimally displaced, two part, three part, four part, one part fracture-dislocation and 3-part fracture-dislocations.

Statistical testing was performed using Statistical Packages for Social Sciences (SPSS), version 8.0.

Results

The age of the patients ranged from 15 to 90 years (mean of 46.3 years) and the age distribution is shown in Fig. 2. Sixteen (59%) were males and 11

1.	Is your shoulder comfortable with your arm at rest by your side?	Yes/No
2.	Does your shoulder allow you to sleep comfortably?	Yes/No
3.	Can you reach the small of your back to tuck in your shirt with your hand?	Yes/No
4.	Can you place your hand behind your head with elbow straight out to the side?	Yes/No
5.	Can you place a coin at the level of your shoulder without bending your elbow?	Yes/No
6.	Can you lift 0.5kg to the level of your shoulder without bending your elbow?	Yes/No
7.	Can you lift 4.0kg to the level of your shoulder without bending your elbow?	Yes/No
8.	Can you carry 10kg at your side with the affected extremity?	Yes/No
9.	Do you think you can toss a softball underhand 10 yards with the affected extremity?	Yes/No
10.	Do you think you can toss a softball overhand 20 yards with the affected extremity?	Yes/No
11.	Can you wash the back of your opposite shoulder with the affected extremity?	Yes/No
12.	Would your shoulder allow you to work full-time at your regular job?	Yes/No

Fig. 1: The simple shoulder test used to evaluate the functional outcome.

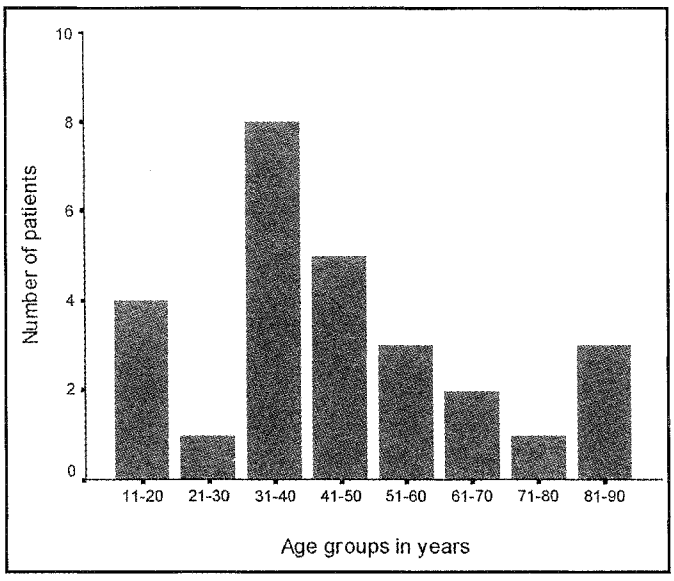

Fig. 2: Distribution of the age groups of the patients.

(41%) were females. The racial distribution was 48% Malays, 37% Chinese, 11% Indians and the other races 4%. The right arm was the dominant arm in 93% of the patients and 55% of the fractures affected the right side. Fifty-four percent of the fractures involved the dominant arm.

There were 10 (37%) 2-part fractures, 8 (30%) minimally displaced, 2 (7%) 3-part fractures, 3 (11%) 4-part fractures, 3 (11%) 1-part fracture-dislocations and 1 (4%) 3-part fracture-dislocation. Only one fracture was an open fracture. One patient had a concomitant ipsilateral humeral shaft fracture, one an ipsilateral scapula fracture and one had an ipsilateral radius and ulna and contralateral clavicular fracture. Sixty-three percent of the fractures resulted from severe trauma and only 37% from moderate trauma.

Of the 24 patients (89%) treated conservatively, one patient had a close manipulative reduction under general anaesthetics. Of the 3 patients (11%) treated surgically, one had a shoulder hemiarthroplasty and two had an open reduction and fixation. The U-slab was the commonest method (44%) of treatment, followed by strapping (22%), a hanging cast and collar and cuff (11%), collar and cuff (7%) and a broad arm sling (4%).

The mean follow-up was 14 months (range from 6 - 29 months). It was not possible to determine the time to radiological union from the radiographs available because most patients did not have a regular radiographic assessment since they were not clinically warranted. None developed avascular necrosis or non-union from the radiographs reviewed. CT scans to further evaluate the fractures were not performed in any patients.

Simple Shoulder Test

The result of the functional outcome as evaluated using the Simple Shoulder test is shown in Fig. 3. Forty eight percent of the patients regained full functional recovery. The mean positive responses for the fracture types were; undisplaced fractures 9.6, 2-part fractures 10.8, 3-part fractures 12, 4-part fractures 5.7, 1-part fracture-dislocations 12 and 3-part fracture-dislocation[9]. Other than being

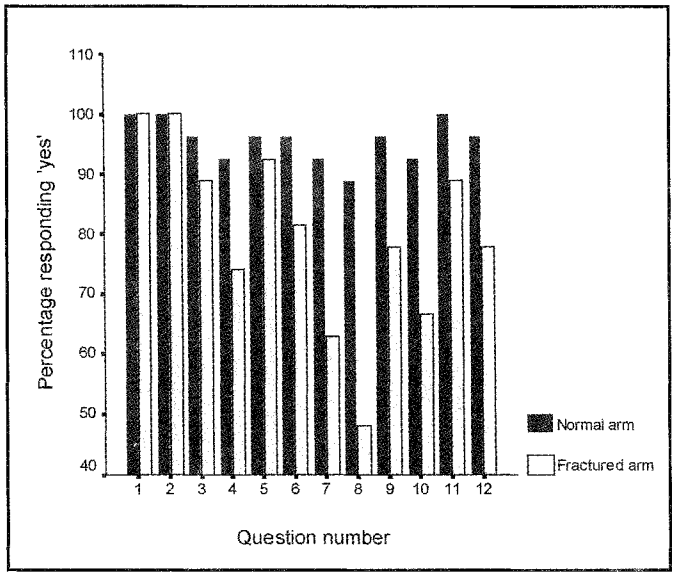

Fig. 3: The overall results of the simple shoulder test expressed as the percentage of 'yes' responses for each question.

comfortable at rest and being able to sleep comfortably, 2 patients (one minimally displaced and one 4-part fracture) were not able to perform all the other functions assessed by the simple shoulder test. The other 2 patients with 4-part fractures were also unable to continue full-time with their regular jobs.

Constant Shoulder Assessment

The scores for each patient are shown in Fig. 4. The mean Constant score for the fractured arm was 72.5 points while the mean score for the unaffected arm was 91 points. Excluding a patient who had cerebral palsy and pre-existing weakness in the non-fractured arm, the difference in the scores between the fractured and non-fractured arms was statistically significant at the level of $p<0.05$ ($p=0.046$ using the paired t test). Excluding this patient, when the scores of the fractured arm are expressed as a percentage of the non-fractured arm, the percentages ranged from 42-95% (mean of 76%). The patient who had the lowest percentage score had a shoulder hemiarthroplasty for a 3-part fracture. The outcomes stratified according to fracture groups is shown in Table I.

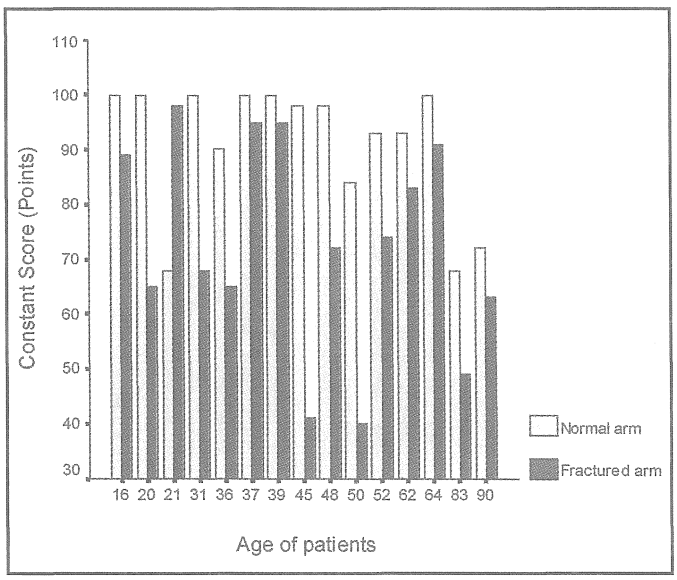

Fig. 4: The distribution of the Constant scores according to the age of the patients.

Table I
Outcome of Fractures According to Fracture Types

Fracture Type (Number)	Outcome Excellent	Good	Fair	Poor
Undisplaced (4)	1	2		1
2-part (6)	4		2	
3-part (1)		1		
4-part (1)				1
1 part fracture-dislocation (2)	2			
3 part fracture-dislocation (1)		1		

Discussion

Young and Wallace[8] found that internal rotation took 3 months and abduction 6 months for recovery to reach its maximum. Therefore, even though the duration of follow-up in this study was not long, the patients are likely to have reached their maximum level of function at the time of the study[9]. All patients did not experience any pain at rest and were able to sleep on the affected side comfortably. However, evaluation of pain using the Constant score showed that 9 patients continued to have pain with activity, even though most pain were mild in nature and analgesics requirements were minimal. This is in keeping with the findings of other studies[8,10].

Internal rotation to the level of the waist sufficient to tuck in the shirt was achieved by 24 of 27 patients, but the full range of internal rotation when assessed with the Constant system was not surprisingly reduced compared to the normal arm in most patients. Functional external rotation, sufficient to place the hand to the back of the head with the elbow straight out to the side, was

achieved by 20 of 25 patients. Elevation of the arm to 90° was achieved by 25 of 26 patients but the range was reduced in 6 of 14 patients when evaluated using the Constant system.

The fracture appears to have significant effect on the ability to carry weights. Only 13 of 24 patients were able to carry 10kg on the side and 17 of 25 patients were able to lift 4kg to the level of the shoulder without bending the elbow. Using the Constant system, only one patient scored maximum points on strength assessment. The strength of the fractured arm in percentage terms of the normal arm ranged from 33% to 100% (mean 66%).

Six patients did not think that they were able to return to their regular full-time work. They included all 3 patients of working age who had sustained a 4-part fracture. One of the 2 patients with a 2-part fracture was aged 90 years, while the patient with a minimally displaced fracture also had other medical problems, which affected his ability to work.

In assessing the outcomes using the simple shoulder test, we made an assumption that the right and left arms have a similar level of function, although this may not necessarily be true. With this in mind, the functional outcome as evaluated using the simple shoulder test following a proximal humeral fracture appears to be satisfactory. However, the difference in scores between the two arms using the Constant system in fact averaged nearly 20 points, a quite considerable difference. This was statistically significant. This therefore suggests that following a proximal humeral fracture, the function of the arm for activities of daily living may be satisfactory but recovery of function is far from complete. And as most of the patients in this study were younger than 50 years and are thus still active, the true extent of functional impairment has still not been properly evaluated. It is worth noting that many patients did not attend supervised rehabilitation from physiotherapists. The overall outcome may be improved if all patients attended physiotherapy as part of their management at the appropriate time.

The severity of the fracture has been reported to affect the outcome[10-12]. Other factors that may affect outcome, such as the duration of immobilisation and physiotherapy[10] were difficult to ascertain from the notes and the patients. Because of this and the small number of cases in each group, we were not able to make any firm conclusions on how the severity of the fracture affected the outcome. We did note that all the 3 patients with 4-part fractures had poorer outcomes, responding positively to only 7, 2 and 8 out of the 12 questions. All 3 patients with a 1 part fracture-dislocation responded positively to all 12 questions.

The Constant scoring system is a more sensitive method of functional evaluation than the simple shoulder test. However, the Constant scores are age dependent, and as the distribution of scores for our population has not been defined, we have tried to express the results as a percentage of the normal arm where possible, as it may make the results a more accurate reflection of function. Despite the simple shoulder test's limitations as a method of evaluating the outcome of fractures, we chose this method because we felt that many of the patients would not return for a clinical examination, but may respond to a simple questionnaire. This proved to be the case, with only 15 of the 37 patients returning for a clinical examination. Although the results of this study have to be interpreted with caution because 32% of patients were lost to follow up, we now have some information on the expected outcomes of proximal humeral fractures treated conservatively. This would enable any surgical treatments to be critically evaluated in future studies.

Conclusions

Conservative treatment when assessed using the simple shoulder test, appeared to be a satisfactory treatment for most proximal humeral fractures.

Pain does not appear to be a significant problem and most patients regained a functional range of movement. However, there is a statistically significant difference in Constant scores between the 2 arms, suggesting that function remains considerably poorer on the fractured arm and there is often a significant loss of strength and ability to carry weights.

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Intraarticular Fractures of the Distal Radius in Young Adults - A Review of the Outcome of Treatment

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Summary

A retrospective review of 30 intraarticular fractures of the distal radius in 27 patients was done. Only young adults aged between 18 and 40 were included. Road traffic accidents accounted for 25 of the cases (23 motorcyclists). Fourteen fractures were treated by closed reduction and a plaster cast. Sixteen fractures were treated by open reduction with internal fixation using a buttress plate or multiple Kirschner wires. At a mean follow-up of 17 months, 63% of the wrists had a satisfactory result and 37% unsatisfactory result. The main adverse factor was intraarticular congruity. The grip strength on the injured side averaged 56% of that of the uninjured side and the pinch strength averaged 73%. Most of the patients were able to return to their former occupation in an average of four months.

Key Words: Outcome, Intraarticular fracture distal radius, Young adults

Introduction

Intraarticular fractures of the distal radius remains a problem fracture as they are innately unstable; are difficult to reduce anatomically and to immobilise and are associated with a high incidence of complications. These severe articular fractures were found to occur most frequently in physically active men whose wrists had been exposed to severe compression forces; in particular, motorcycle accidents and falls from a height. When faced with an intraarticular fracture of the distal radius, questions would arise in the mind of the attending doctor: "How should I treat this fracture? In the course of the treatment, what are the indicators that could guide me in achieving the optimum result?" Similarly, questions would arise in the minds of the patient: "How will this injury affect the function of my hand? To what degree will I be disabled? How will it affect my work?" The purpose of this study is to answer these questions in young adults (18 to 40 years) in terms that can be quantified.

Materials and Methods

The records of 27 patients aged between eighteen and forty years with intraarticular fractures of the distal radius were reviewed. The patients were recalled to the clinic for a physical examination and were asked the same questions. An antero-posterior and lateral X-ray of the injured wrist was also taken at the same time. Thirty fractures in the twenty-

seven patients were thus available for study. The length of follow-up ranged between four and forty-eight months with a mean of seventeen months.

The average age of the patients was twenty-seven years. There were twenty-five men and one woman. Fifteen fractures (53%) involved the dominant limb.

Motor-vehicle accidents caused twenty-five fractures, twenty-three of which involved motorcyclists. One was a car front seat passenger and one (the only woman in this study) a back seat passenger. Four fractures occurred as a result of a fall from a height of between four and twenty-five feet. One was due to an industrial accident when a cement mixer fell on him. Ten fractures were associated with other injuries and four fractures were open. Fourteen fractures were treated by closed reduction and immobilization in a plaster cast alone. Due to difficulties in obtaining general anaesthesia, reduction was done under intravenous analgesia and sedation followed by immobilisaton in a below elbow plaster-of-paris cast for a period of six weeks.

The other sixteen fractures were treated by open reduction, twelve of which were fixed by a buttress plate and four by Kirschner wires reinforced by a plaster cast backslab. Surgery was performed within two weeks of the injury except for one patient with an open fracture where surgery was done at one month post trauma. Ten of the fractures treated by buttress plates were displaced volarly and all the plates were placed on the volar surface of the radius. Where Kirschner wires were used, they were removed at six weeks post fixation. At surgery, only the fracture site was exposed; the wrist joint was not visualized.

The decision to treat either by closed or open reduction and the method of fixation used was decided upon by the individual surgeon in charge of the patient. No standard policy was followed. External fixators were not available during the period of study. The fractures were classified according to the system advocated by Frykman[1]. Twelve (40%) were Type VIII; eight (27%) Type VII; three (10%) Type VI; two (7%) Type IV; and five (16%) Type III.

At the follow-up examination, subjective, objective and radiographic evaluations were made. Each patient was asked on subjective factors such as pain, functional limitations, appearance, disability and occupational considerations. Objective examination included inspection of the wrist for deformity; measurements of the range of motion of the wrist using a goniometer; grip and pinch strength testing using a Preston dynamometer and evaluation of sensibility. The contralateral limb was similarly evaluated and served as a control.

Antero-posterior measurements of the radial length, radial angle and volar tilt (Van der Linden)[2] (Fig. 1) were made from the radiographs obtained at the time of injury, immediate post-reduction and at follow-up. Radiographic evidence of non-union of the ulnar styloid process, residual incongruity and post-traumatic arthritis were recorded.

The subjective, objective and radiographic findings were quantified by the demerit point system as described by Gartland and Werley[3]. (Fig. 2) Each fracture was graded as excellent, good, fair or poor.

Results

By the criteria of Gartland and Werley, six (20%) of the wrists were rated as excellent; thirteen (43%) as good; and eleven (37%) as fair; no wrist received a poor rating. Thus, nineteen (63%) of the wrists had a satisfactory result (excellent or good) and eleven (37%) had unsatisfactory result.

Of the thirteen wrists with dorsal displacement, 64% were satisfactory compared with the seventeen wrists with volar displacement in which the result was 53% satisfactory. There was

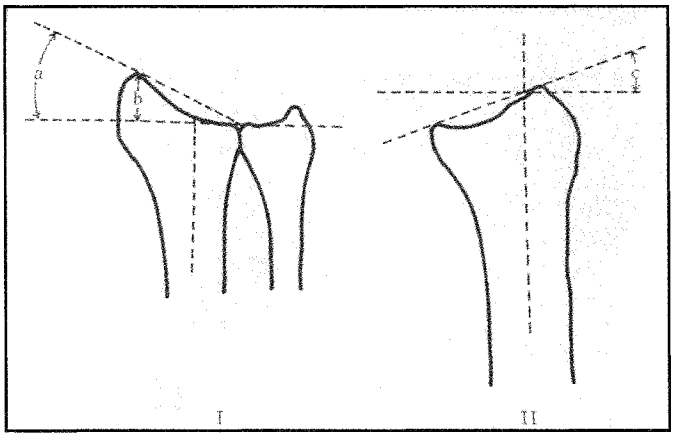

Fig. 1: (I) Measurements on anteroposterior radiographs. The radial angle (a) is the angle between a line perpendicular to the long axis and radial articular surface, as indicated by a line joining its radial and ulnar margins. Radial height (b) is the distance (in millimetres) that the tip of the radial styloid projects distally to a perpendicular line to the long axis of the radius drawn at the distal margin of the radioulnar joint. Radial shorterning is the change in radial height occurring between two radiographs.
(II) Measurements of the lateral radiograph. The volar angle (tilt) is the angle between a line perpendicular to the long axis and the articular surface as indicated by a line joining its volar and dorsal margin of that surface[2].

no difference in the final result of those treated by closed reduction and plaster cast and those treated with a buttress plate. Sixty percent of the fifteen wrists treated by closed reduction and plaster cast and 58% of the twelve wrists treated with a buttress plate had a satisfactory result. However, four of the six wrists with excellent results were treated with a buttress plate.

The use of a buttress plate showed that it was more able to maintain radial length and radial angle[2] than a plaster cast alone. 64% of those treated with a buttress plate did not show any loss of radial length or radial angle from the time of treatment till the final follow up compared with 43% of those whose reduction was held by a plaster cast alone. The ability to maintain the normal volar tilt was more similar; 55% in the group with buttress plating and 50% in the group with plaster casts.

In terms of intraarticular congruity, with open reduction and buttress plating it was possible to achieve reduction without any incongruity in only 36% of wrists. Maintenance of congruity was obtained in 82% of wrists. With closed reduction and plaster casting, there was no incongruity in 43% and maintenance in 71%.

The average loss of radial length in the wrists with excellent and good results was 3.3mm and 4.3mm whereas those with fair result, the average loss was 8.3mm. There was no difference in the loss of radial angle and volar tilt in those with good and fair results. However, those with excellent results had a lesser degree of loss. All six wrists with excellent result did not have any incongruity. (Fig. 3) In those with a good result, 5 wrists (38%) did not have any incongruity and 8 (62%) had an incongruity of 1mm. All the wrists (11) with fair result had incongruity; 29% 1mm; 62% 2mm and 15% 3mm.

All patients reported that they were able to return to their former occupation except two patients who also had severe associated injuries. The length of absence from work ranged from two to

	Points
Residual deformity (range, 0 to 3 points)	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2 or 3
Subjective evaluation (range, 0 to 6 points)	
Excellent - no pain, disability, or limitation of motion	0
Good - occasional pain, slight limitation of motion, and no disability	2
Fair - occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful, and activities slightly restricted	4
Poor - pain, limitation of motion, disability, and activities more or less markedly restricted	6
Objective evaluation* (range, 0 to 5 points)	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Loss of circumduction	1
Pain in distal radio-ulnar joint	1
Grip strength - 60% or less than on opposite side	1
Loss of pronation	2
Complications (range, 0 to 5 points)	
Arthritic change	
Minimum	1
Minimum with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications (median)	1 to 3
Poor finger function due to cast	1 or 2
Final result (ranges of points)	
Excellent	0 to 2
Good	3 to 8
Fair	9 to 20
Poor	> 20

** The objective evaluation is based on the following ranges of motion as being the minimum for normal function: dorsiflexion, 45 degrees; palmarflexion, 30 degrees; radial deviation, 15 degrees; ulnar deviation, 15 degrees; pronation, 50 degrees; and supination, 50 degrees.*

Fig. 2: Demerit Point System Used to Evaluate End Results.

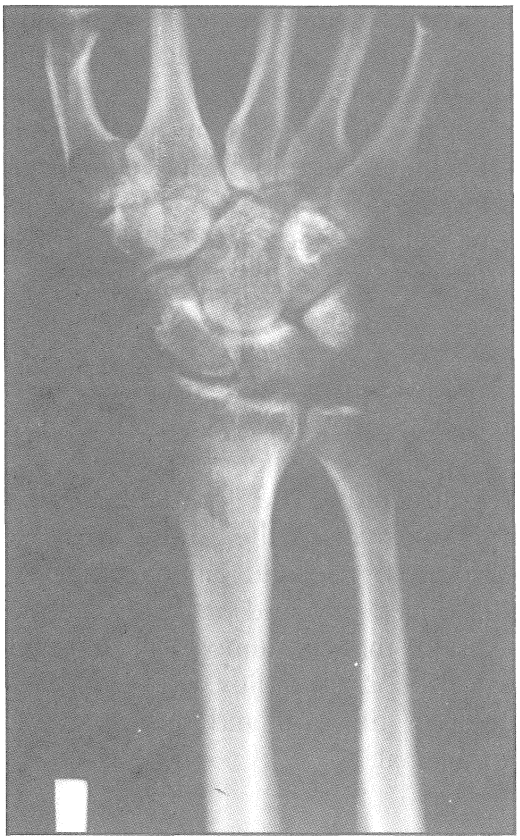

Fig. 3a and 3b: Intraarticular step (incongruity) seen in the radiographs of 2 patients.

seven months with an average of four months. To the question as to whether there was anything they could do before the injury that they could now not do at the time of follow-up, the single most common answer was the inability to carry heavy weights (52%). Most said that they had a feeling of weakness in the wrist while others said that they felt an aching sensation at the wrist when attempting to carry weights. Another common complaint was difficulty in turning door knobs and similar activities requiring a simultaneous gripping force with supination or pronation at the wrist.

There was no pain in eight wrists (26%) and occasional pain after activity in twenty wrists (64%). In three wrists (10%) there was occasional pain even when the wrist had not been in use. The grip strength on the injured side averaged 56% of that on the uninjured side and the pinch strength averaged 73%. The range of motion of the wrist at the latest follow-up had been recorded for all patients. Again comparing the injured with the uninjured side, dorsiflexion averaged 76%; palmarflexion 76%; supination 91%; pronation 83%; ulnar deviation 74% and radial deviation 55%.

Discussion

Published reports on the results of treatment of intraarticular fractures of the distal radius are far from satisfactory[4,5,6,7,8]. In young adults it is almost always due to high energy trauma with considerable disruption of the articular surface and crushing of the cancellous bone. In consequence it is not easy to obtain perfect

reduction even with open methods. Having achieved reduction, it is yet another uphill task to maintain the reduction. These difficulties are borne out by the findings in this study. The 36% fair or poor result is similar to that of Knirk and Jupiter[6] (39% fair to poor) whose patients also comprised young adults below forty years of age.

Twenty-three fractures (74%) occurred in motorcyclists. This would have resulted upon impact on the hand gripping the handlebar or the rider could have been thrown off the machine, landing on the outstretched hand, both indicating the tremendous amount of energy transmitted onto the wrist joint. In a country with widespread use of motorcycles, it is to be expected that the incidence of this problem fracture would remain high.

It is of note that there was no difference in the final overall result of the wrists that were treated by closed reduction and plaster cast and the wrists that were treated by open reduction and fixation with a buttress plate. In a hospital with severe bed and theatre time shortage it would seem unnecessary to use primary internal fixation as the main method of treatment. Not only is the hospital stay longer but two separate operations are needed for fixation as well as for removal of the plate. If not properly done, complications would ensue, as in two of the patients where screws inadvertently placed into the joint caused almost constant pain. It should be pointed out that the wrist joint was not exposed during surgery. Melone[9], in his description of the surgical technique of open reduction and internal fixation, emphasised the need to expose the joint with meticulous replacement of each fragment. This is in fact difficult, with adherent ligament attachments on comminuted pieces of bone. However, a buttress plate is more able to maintain the reduction especially the radial length and radial angle compared with just a plaster cast[10].

To achieve an excellent result it is necessary to obtain and maintain reduction with minimum loss of radial length, radial angle and volar tilt. Maintenance of a certain degree of radial length is also necessary for a good result. Maintenance of radial angle and volar tilt has no bearing on a good or fair result. The most important parameter is intraarticular incongruity which has a direct and clear relationship with the overall result. This is in agreement with the findings of Knirk and Jupiter[7] and Bradway[4].

All the wrists, except one, had some loss of range of motion in one direction or other when compared with the normal contralateral wrist. Radial deviation was the most commonly and severely affected. The particular wrist in exception was also the only wrist which regained normal grip and pinch power. All the rest had reduced grip and pinch strength. It can thus be said that in almost all intraarticular fractures of the distal radius, there will be some impairment of function and the wrist will not return to normal.

Conclusion

The prognosis of intraarticular fractures of the distal radius remains guarded, whatever the treatment. The eponymns used to describe the fractures are confusing in that they have not been uniformly used by all authors. The available classifications are cumbersome to use in the clinical setting and do not adequately indicate the treatment nor the prognosis. It is simplest to describe the fracture in anatomical terms as a "closed/open intraarticular fracture of the distal radius with dorsal/volar/no displacement".

Firstline treatment with closed manipulative reduction followed by a plaster cast is still acceptable. The most important parameter to look for is intraarticular congruity. Radial length, radial angle and volar tilt should also be restored though a certain amount of loss is compatible with a good result. Where it is not possible to reduce the fracture by closed manipulation, open reduction and internal fixation should be considered, using a buttress plate for fractures with volar displacement and

Kirschner wires for dorsally displaced fractures, supplemented by a plaster cast. It is stressed that external fixators were not used during this period of study.

Patients should be informed that they will lose range of motion of the wrist as well as grip and pinch strength to a certain degree but that in most cases they should be able to return to their former occupation within an average of four months.

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SPINE

The Need for Scoliosis Screening in Malaysia

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Summary

Conflicting recommendations exist on the issue of scoliosis screening in the general population. Worldwide, opponents cite the relative inaccuracy of screening tests, cost-ineffectiveness and psychosocial effect of 'labelled' patients but advocates quote the successes in many centres and the advantages of timely intervention. We studied 205 patients with idiopathic scoliosis and found they presented at relatively later ages and with curves that showed rapid annual progression. We suggest that screening in Malaysia may identify patients early for treatment besides promoting health awareness.

Key Words: Screening, Idiopathic scoliosis, Late presentation

Introduction

Screening tests for scoliosis aim to identify patients early for treatment. Such programmes are significant because patients may have morbidity like back pain, pulmonary disease and cardiac decompensation in scoliosis[1].

There is no scoliosis screening programme in Malaysia. Conflicting recommendations exist regarding this matter. Countries like the United States, Greece and the Netherlands practise screening on their pre-pubertal population. Conversely, the British and Canadians do not screen after running feasibility studies by their respective health bodies while many developing nations like Russia and China have not implemented screening due to sheer logistics[2].

Proponents of screening argue that these programmes are run efficiently and well, enabling early intervention besides serving as a tool of health education. Critics feel that such tests have inherent weakness in positive predictive value, scar patients mentally, cause complications after early treatment and are not cost-effective.

In our practice in Malaysia, we often encounter patients who present late. We audited the patients of the Scoliosis Clinic at the Institute of Orthopaedics & Traumatology, Hospital Kuala Lumpur - the National Referral Centre - to assess the need for such a screening programme in Malaysia.

Materials and Methods

We studied the clinical records and radiographs of 205 patients with idiopathic scoliosis seen at the Scoliosis Clinic of the Institute of Orthopaedics and Traumatology, Hospital Kuala Lumpur from 1985 till 2000. All patients with a diagnosis of Idiopathic Scoliosis who presented with a history of curve detection at age 10 years and above were included in our study. Spinal radiographs at the time of presentation and at subsequent visits were

measured. For post-menarche patients, we included only those with a minimum of two years follow-up after first presentation. We also included patients who resumed clinic visits after an interval of defaulting treatment.

We specifically excluded all cases which had no diagnosis, those who defaulted follow-up beyond the first year after presentation, and patients who had strong family history of neurological disease, connective tissue defect or congenital deformity.

Curves were measured by Cobbs method on the standing frontal spinal radiographs in all cases. No inter or intraobserver errors were estimated. Data was analysed using SPSS v 9.05.

Results

There were 21 males and 184 females; 95 Malays, 92 Chinese, 17 Indians and 1 Orang Asli.

There was no difference in the mean menarcheal age between races (Table I).

Table I
Mean Age at Menarche

RACES	MEAN
Malay	12.3478
Chinese	12.4348
Indian	13.0000

Anova Test p = 0.3

Table II
Age at Presentation of the Patients according to Ethnic Group

Ethnic Group	Number	Mean Age (Years)	sd
Malay	95	17.43	5.94
Chinese	92	14.77	4.38
Indian	17	14.68	4.94

Malay patients were seen at a mean age of 17.43 years old at 44.85 degrees. Chinese presented at a mean age of 14.77 with a mean of 39.87 degrees (Table II and III). Across all races, the mean age was 16.27 with a standard deviation of 5.95. Thoracic curves were most common, followed by thoracolumbar. Overall, there were 182 cases bearing single curves and of these, 34 progressed to double curves within 2 years after first presentation. Females had a mean of 5.66° progression rate per year in the pre-menarche group and 2.94° in the post-menarche group (Table IV).

We operated on 47 patients, the majority of whom (40 cases, or 19.5%) had curves exceeding 50°. Forty six patients with Cobb angles exceeding 50° chose to be observed (Table V). More Chinese patients (24, or 51% of all operated cases) chose surgery, compared to 17 (36.17%) Malay patients.

Discussion

The Scoliosis Research Society defines scoliosis as a three-dimensional deformity having a coronal curve of 11° or more[2]. Weinstein reported an adolescent idiopathic scoliosis prevalence of 2 to 3% in peri-pubertal children, with up to 0.2% of these having curves exceeding 45°[3]. We do not have Malaysian equivalents although both Koukourakis and Panayotis have independently reported Greek figures of 1.5 to 1.7%[4,5]. Wang obtained a prevalence of 1.06% in a survey involving 21,759 adolescents in Beijing, China[6].

Our patients presented at a mean of 16.3 years old when other multicentre findings usually do not exceed 14 years of age. The mean curve size was 42.3° at presentation, approaching the threshold many centres recognise as that requiring surgical intervention. Where our patients may not require surgery, they still fall within the risk group for significant curve progression. Bunnell reported 18% of his patients progressed 10° or more despite attaining

Table III
Curve Size at Presentation, Categorised into Different Age Brackets. Where There are Double Curves, the Major Curve is Tabulated

Age bracket	Ethnic Group	Mean Curve Size	N	Std Deviation
0 - 4.99	Chinese	37.0000	2	12.7279
	Total	37.0000	2	12.7279
5 - 9.99	Malay	45.0000	1	-
	Chinese	36.5000	6	15.6557
	Indian	43.0000	2	24.0416
	Others	70.0000	1	-
	Total	42.0000	10	17.5752
10 - 14.99	Malay	46.4865	37	26.2092
	Chinese	39.9592	49	17.8313
	Indian	32.5000	6	14.3910
	Total	42.0978	92	21.6150
15 - 19.99	Malay	42.6857	35	20.1929
	Chinese	32.7273	24	16.2486
	Indian	39.2500	6	14.6373
	Total	40.6721	65	18.4352
Above 20	Malay	47.1427	22	21.7736
	Chinese	44.5500	11	13.3239
	Indian	43.5000	3	32.8805
	Total	45.0642	36	22.6593
TOTAL	Malay	44.8511	95	22.9351
	Chinese	39.8681	92	16.9406
	Indian	39.2353	17	18.9589
	Other Races	-	1	-
	Total	42.2709	205	20.2186

Table IV
Curve progression in premenarche and post menarche patients

	Pre-menarche progression rate (degrees/year)	Post-manarche progression rate (degrees/year)
Malays	6.21	2.46
Chinese	5.88	2.99
Indian	4.89	3.37
Average	5.66	2.94

Table V
Treatment Given according to Curve Size

	Curves <30°	30° to 50°	>50°	Total
Observation (includes those who were advised brace* or surgery# but did not comply)	33	55*	46#	134
Bracing (includes those who were advised surgery! but did not comply)	8	13	3!	24
Surgery	-	7	40	47
Total	41	75	89	205

Risser IV iliac apophyseal ossification[7]. It is important to detect deformity early when progression rates are significant.

We surmise that a combination of factors led to our present findings. In the absence of screening programmes, juvenile-onset idiopathic curves may not be detected at primary school level. Without personnel trained to clinically detect or suspect spine deformity, early diagnosis is missed. Lacking health awareness in a setting where scoliosis is not publicised as a considerable but manageable deformity, the public fail to appreciate its impact and consequentially, do not present their children to relevant health providers.

The basic premise behind screening is the assumption that such tests are accurate and reliable in detecting deformity. It is also assumed that early detection improves health outcomes. The principal screening test for scoliosis is the physical examination of the back. This includes visual inspection of the standing patient and the Adams forward bending test[10]. Suspected cases are then referred for thorough physical examination by doctors, which may include a radiograph.

In a 10-year follow-up evaluation of screening efficacy, Karachalios challenged the reliability of forward bending test, more so when used alone[11]. Most researchers, however, continue using this test citing good interobserver consensus and sensitivity with positive prediction value approaching 80%[12,13]. Combining this with the inclinometer offers theoretical enhancement although there is no consensus on a cut-off point[14].

In 1997, Koukourakis estimated that the Cretian programme involving 21,220 children cost US$10 per child in the first year, reducing to US$5.80 in the 2nd year[4]. Prujis proposed that the annual Greek programme be downstaged to have longer intervals between screening when his study found meagre returns[15]. Lately, Yawn and Yawn's population-based, longitudinal retrospective study in Minnesota yielded figures of US$24.66 per child screened rising to US$10,836 when surgically treated[16]. Similar models would apply to Malaysia should we adopt such screening. Initial expenditure is increased by many factors; the mobilisation of resources and logistics for the first time, early problems with familiarity and lack of confidence in performing clinical tests leading to unnecessary radiographs, training of school nurses and medical officers, increasing the availability of tertiary-level hospitals to buffer an expected increase in referred cases and the potential cost of surgery in patients detected to have severe curves. These factors may not pose a problem in developed nations that have established screening[17,18,19].

Conclusion

Our review of the of Idiopathic Scoliosis patients at the scoliosis service at Hospital Kuala Lumpur show that patients present late, with large curves. We recommend the consideration of school screening to detect these curves earlier. School screening may be able to identify patients early before curves progression, and should prevent the late referrals of large curves.

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An Audit of the Scoliosis Service at Hospital Kuala Lumpur

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Summary

This is a study of patients referred to the Scoliosis Service of Hospital Kuala Lumpur. Three hundred and thirty five (335) consecutive patients who were seen between 1985 and 2000 were reviewed to determine the presentation of scoliosis, the treatment received and the compliance to follow up. Data were determined by measuring the frontal spinal radiographs. Two hundred and ninety eight (298) patients met inclusion criteria. Idiopathic scoliosis accounted for 203 patients (68.1%), 31 (10.4%) were neuromuscular scoliosis; and 44 (14.8%) had congenital scoliosis. Twenty-five point five percent of patients had surgery, 10.4% were treated with brace, while the remaining 69.1% of patients were observed, or had no treatment at all. Congenital scoliosis patients had better compliance compared to idiopathic or neuromuscular scoliosis patients.

Key Words: Audit, Scoliosis, Presentation

Introduction

The Scoliosis service at Hospital Kuala Lumpur was started in the early 1980's. It has evolved to be a comprehensive service providing total care for patients who require treatment for spinal deformity. It is run under the aegis of the Orthopaedic Service and always had a multidisciplinary facet to its services; intergrating well with Orthotics, Radiology, Paediatrics and Neurology. The patients that are seen at the service are referred from all parts of the country. Although it is one of the larger services in the country, it is not the only service; HUKM and UHKL also have Scoliosis services and it is correct to say that all 3 services compliment each other in providing care to the community. The objectives of this study were to determine the presentation of scoliosis, the treatments received and the compliance to follow up in Hospital Kuala Lumpur.

Materials and Methods

The medical records and radiographs of all patients diagnosed as having scoliosis, and presenting between 1985 and 2000 to the scoliosis service of Hospital Kuala Lumpur were reviewed. Specific data on curve size at presentation, treatment received and compliance to follow up in each patient was recorded by means of a performa sheet. The method we used is the standard method of investigation used in previous natural history studies[1,2,3,4,5,6].

Curve size was determined by standing coronal radiographs measured by Cobb's method. This method makes use of the end vertebrae of the most tilted vertebrae to the curve. A line is drawn at the cranial end plate of the cranial end vertebra. Similarly, a line is drawn at the caudal end plate of the caudal end vertebra.

Perpendicular lines to these end plates are drawn and the angle at the intersection is measured. Radiographs at first presentation and the last follow up were measured. Each curve was described by its magnitude and apex location. There was no estimation of intra observer and inter observer errors. All curves were measured by the same protractor by the same investigator. The aetiology of each curve was classified according to the classification of the Scoliosis Research Society. For patient with more than one curve, the larger structural (major) curve was selected in this study.

Data were analysed using t-test and ANOVA test on SPSS 9.05.

Results

Two hundred and ninety eight patients out of the total of 335 (89%) met the inclusion criteria of having complete records.

Presentation of scoliosis by diagnostic group and demographics

Idiopathic scoliosis was the commonest among all different etiologic groups, accounting for 68.1% (n=203) of the 298 patients. Neuromuscular scoliosis accounted for 10.4% (n=31); while 14.8% (n=44) had congenital scoliosis. The remaining patients (6.7%) had scoliosis due to neurofibromatosis, Marfan's syndrome, infection, and other miscellaneous causes.

Of the 131 patients; (44.0%) were Malay, 133 (44.6%) were Chinese and 28 (9.4%) were Indian. Table I shows the distribution of ethnic groups for different etiologic groups of scoliosis. There were 60 male (20.1%) and 238 female (79.9%). Table II shows the distribution of gender for different etiologic groups of scoliosis.

There were 236 patients with curve size more than 30°. Of these, only 83 (35.2%) had received any treatment (either brace or surgery). The remaining were managed conservatively; either due to the inability to afford a brace or surgery, or reluctance to accept treatment.

Mean age and mean curve at time of first presentation to service for different aetiologic groups

Of the 203 patients with idiopathic scoliosis, 191 (94.1%) presented the curve after age of 10 years old. Table IIIA shows comparison of mean age and mean curve size at first presentation for different etiologic groups.

Table I
Distribution of Ethnic Groups for Each Aetiologic Group of Scoliosis

Type / Ethnicity	Idiopathic Scoliosis	Neuromuscular Scoliosis	Congenital Scoliosis	Others
Malays	94 (46.3%)	14 (45.2%)	17 (38.6%)	6 (30.0%)
Chinese	91 (44.8%)	14 (45.2%)	19 (43.2%)	9 (45.0%)
Indians	17 (8.4%)	2 (6.5%)	7 (15.9%)	2 (10.0%)
Others	1 (0.5%)	1 (3.1%)	1 (2.3%)	3 (15.0%)
Total	203 (100.0%)	31 (100.0%)	44 (100.0%)	20 (100.0%)

Table II
Distribution of Gender in Each Aetiologic Group

Gender \ Type	Idiopathic Scoliosis	Neuromuscular Scoliosis	Congenital Scoliosis	Others
Female	183 (90.1%)	18 (58.1%)	24 (54.5%)	13 (65.0%)
Male	20 (9.9%)	13 (41.9%)	20 (45.5%)	7 (35.0%)
F: M ratio	9:1	1.4:1	1.2:1	
Total	203 (100.0%)	31 (100.0%)	44 (100.0%)	20 (100.0%)

Table III A
Mean Age and Mean Curve Size at Presentation for Different Aetiologic Groups

	Mean Age at Presentation	Mean Curve Size at Presentation
Idiopathic scoliosis	16.25	42.27^0
Neuromuscular scoliosis	13.31	45.16^0
Congenital scoliosis	9.00	46.55^0
Other	20.41	53.55^0
ANOVA TEST	$F = 16.82$ $P < 0.05$	$F = 1.79$ $P > 0.05$

Presentation according to location of curves

Table IV shows the mean curve size and frequency of curves at different location for the different aetiologic groups of scoliosis.

Treatments received

Table V shows the frequency of treatment by observation, brace and surgery for different etiologic groups of scoliosis.

Table III B
Comparison of Mean Age of Presentation of Scoliosis of Various Aetiologies
Student T Test Used

Idiopathic and neuromuscular scoliosis	$P=0.12$
Idiopathic and congenital scoliosis	$P < 0.05$
Neuromuscular and congenital scoliosis	$P < 0.05$

Compliance to follow up

Of 134 untreated idiopathic scoliosis patients, 53 patients (39.6%) had defaulted follow up after the first visit and the remaining 81 patients (60.4%) continued their follow up. Twenty-four patients were braced; 8 (33.3%) were braced soon after the first visit and 16 were braced after a period of observation. Of the 45 operated patients, 11 patients (24.4%) had surgery soon after the first visit and 34 (75.6%) had surgery after a period of follow up.

There were 23 neuromuscular scoliosis patients who were treated with observation; 13 patients (56.5%) had defaulted their next follow up after their initial visit, and only 10 patients (43.5%) were compliant to the scheduled follow up. Of the 4 patients treated with brace, two were braced soon after the first visit, and the remaining 2 patients were braced after a period of observation. All four of the operated patients were operated after a period of observation.

Table IV
Mean Curve Size and Frequency of Curves at Different Locations for Different Etiologic Groups of Scoliosis*

Location \ Type	Idiopathic Scoliosis	Neuromuscular Scoliosis	Congenital Scoliosis	Others
Cervical	17.50° (2)	NA	NA	NA
Cervico-thoracic	NA	NA	50.00° (1)	NA
Thoracic	43.89° (132)	52.21° (14)	50.30° (23)	52.23° (17)
Thoraco-lumbar	39.97° (36)	37.83° (12)	49.18° (11)	76.5° (2)
Lumbar	39.82° (33)	43.00° (5)	33.33° (9)	31.00° (1)
Total	42.27° (203)	45.16° (31)	46.55° (44)	53.55° (20)

**Value in parenthesis is frequency of the category*

Table V
Type of Treatment in the Various Aetiologic Groups

Treatment \ Type	Idiopathic Scoliosis	Neuromuscular Scoliosis	Congenital Scoliosis	Others
Observation	134 (66.0%)	23 (74.2%)	34 (77.3%)	15 (75.0%)
Bracing	24 (11.8%)	4 (12.9%)	1 (2.2%)	2 (10.0%)
Surgery	45 (22.2%)	4 (12.9%)	9 (20.5%)	3 (15.0%)
Total	203 (100.0%)	31 (100.0%)	44 (100.0%)	20 (100.0%)

Of the 34 congenital scoliosis patients, 9 (26.5%) were patients who defaulted subsequent follow up after the first visit, and 25 (73.5%) continued their follow up. There was 1 patient who was braced soon after the first visit. Of the 9 patients who underwent surgery; one (11.1%) had surgery soon after the first visit, while the remaining 8 patients (88.9%) had surgery after a period of observation.

Discussion

Idiopathic scoliosis was the most common type of scoliosis seen, followed by congenital scoliosis and neuromuscular scoliosis. This is a fairly uniform distribution that seen in many scoliosis services[1,2,3,4,5,6,7,8,9]. Utilisation of the scoliosis service was evenly matched for all ethnic groups. (Table

I). The sex difference of 9:1 female to male ratio for idiopathic scoliosis is also within expected range[1,5,6]. We also found a slight female preponderance in the neuromuscular and congenital groups[3,4,9] (Table II).

An interesting factor we noted was that the mean size of curve at presentation of all curve types was the same (ANOVA $p>0.05$), even though the mean age of presentation was different (Table IIIA). Further testing for difference in age of presentation showed that while neuromuscular and idiopathic scoliosis presented at similar age ranges, congenital scoliosis were statistically different from both the other groups (Table IIIB).

We feel this evidence proves that the size of the curve is the most predominant factor that influences initial attendance to the scoliosis service. Put simply, the attendance to the scoliosis service is when the curves are at a mean of 40 degrees, irrespective of the diagnosis or age of patient. If the assumption is made that treatment should begin at a curve magnitude of 30 degrees; then most attendances are at a time when treatment should be initiated, with little or no place for observation. Only 35.2% of patients whose curve size more than 30^0 had received any treatment, the remaining refusing treatment or not being able to organize resources for procuring the implants for surgery or orthosis.

The thoracic spine is the location of most of the curves in all diagnostic groups, and also the site of the largest curves[2,5,6] (Table IV). Two small idiopathic curves were recorded in the cervical spine, but this may represent compensatory curves or postural tilts during radiography.

Of the 206 patients treated with observation, 39.3% had defaulted follow up after the first visit. We are unable to report on duplication of visits to other services in the Klang Valley, as there is no centrally coordinated referral body. It is quite likely that these represent patients who had come from another scoliosis service for a second opinion. The non-compliance rate of clinic attendance for idiopathic scoliosis, neuromuscular scoliosis and congenital scoliosis was 39.6%, 56.5% and 26.5%, respectively. Congenital scoliosis has the highest compliance rate, probably due to the fact that parental care is most attentive during this period. The lowest compliance rate was for neuromuscular scoliosis. This is also partly due to fact that this is a group of already ill patients.

Idiopathic scoliosis patients had a very low rate of brace wear[1,2,5,6,7]. We could not assess compliance of this, but note that there is a higher rate of surgery than orthotic brace wear. The treatment success depends very largely on the willingness of the patients to accept treatment.

When assessed as proportion of patients who underwent any form of treatment (total who underwent surgery and orthotic brace); the rates of treatment are, 34.0% for idiopathic scoliosis, 25.8% for neuromuscular scoliosis, and 22.8% for congenital scoliosis (Table V). This again, reflects the difficulty of surgery in the neuromuscular diagnostic group due to co morbid factors; while the low rates of surgery in congenital scoliosis reflects the reluctance of both parents and care givers to consider surgery for this group.

Conclusion

This study has shown that curve size is the predominant factor that causes patients or their care givers to seek treatment for scoliosis, irrespective of age or diagnostic group. It also has shown that only 35.2 % of patients whose curves are more than 30 degrees actually receive appropriate treatment (orthotic support or brace). Compliance of follow up visits were best with congenital scoliosis and worse in neuromuscular scoliosis. Idiopathic scoliosis has the best rates of compliance to treatment.

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The Natural History of Scoliosis: Curve Progression of Untreated Curves of Different Aetiology, with Early (mean 2 year) Follow Up in Surgically Treated Curves

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Summary

We studied the curve progression of untreated curves presenting to the Scoliosis Service of Hospital Kuala Lumpur. One hundred and fifty-two (152) patients were included in this study. The median rate of curve progression of idiopathic scoliosis curves was 7.03 degrees per year, for neuromuscular scoliosis curves was 17.39 degrees per year; and congenital scoliosis curves were 3.67 degrees per year. These rates are similar to the reported rates in the literature. Data for sixty-one (61) surgically treated patients were reviewed to determine the early curve correction of the curves of different aetiology. The mean age of surgery was 14.15 years old, the mean preoperative curve size was 71.61 degrees; and the mean postoperative curve size was 43.78 degrees. The mean duration of follow up after surgery was 2.44 years. The revision and removal of instrumentation rate was 8.3%.

Key Words: Scoliosis, Natural history, Curve progression, Surgery

Introduction

It is important to know the natural history of any condition before deciding to treat, and even more so when deciding on what treatment to give. This is most evident in spinal deformities, where evidence on the natural history of curve progression is lacking in most countries[1-3]. There have been no prior published data on the progression of untreated curves in Malaysia. We decided to study the progression of untreated curves in the patients who presented to the Scoliosis Service of Hospital Kuala Lumpur, and also the early curve correction in patients who underwent surgical correction of their curves in the major aetiological groups.

Materials and Methods

The medical records and radiographs of all patients diagnosed as having scoliosis, presenting between 1985 and 2000 to the scoliosis service of Hospital Kuala Lumpur were reviewed. Specific data on curve details were collected by the standard method of investigation used in previous natural history studies by the Scoliosis Research Society[1-8].

For the study on progression of untreated curves, all patients who presented to the service and was treated by observation or refused treatment are included. Also included were patients who were observed until treatment was performed. The

median curve progression rate was utilized rather than the mean to minimise the influence of outlying data[3-7].

The early curve correction was studied in all patients who presented to the Scoliosis Service and had surgery performed. This was assessed in the diagnostic groups, with only the pre operative and final post operative radiograph evaluated. The aetiology of each curve was classified according to the classification of the Scoliosis Research Society[4].

All measurements on the radiographs were measured by the standard Cobb's method. There was no estimation of intra observer and inter observer errors. All curves were measured by the same protractor by the same investigator. Data were analysed using t-test and ANOVA test on SPSS 9.05.

Results

One hundred and fifty-two (152) patients were included in the untreated curve progression study. All patients with static or progressing curves were included. Curve regressions were excluded. Table I illustrates the aetiology breakdown; and Table II shows the median progression rate of the untreated curves. Table III shows the mean age and mean curve size at presentation for the untreated curves. There was no difference in curve size of presentation, but a difference was noted in the age of presentation.

Table I
The Number and Percentage of Untreated Patients with Idiopathic, Neuromuscular and Congenital Scoliosis

Aetiology	Number	Percentage
Idiopathic Scoliosis	112	74%
Neuromuscular Scoliosis	13	8%
Congenital Scoliosis	27	18%

Table II
The Median Rate of Progression of Untreated Scoliosis According to Aetiology

Aetiology	Median Rate of Curve Progression (Degrees per Year)
Idiopathic Scoliosis	7.03
Neuromuscular Scoliosis	17.39
Congenital Scoliosis	3.67

Table III
The Mean Age of Presentation and Mean Curve Size at Presentation for Untreated Curves

Aetiology	Mean Age at Presentation (With Range) in Years	Mean Curve Size at Presentation (With Range) in Degrees
Idiopathic Scoliosis	15.5 (3.7-29.9)	41.6 (5-110)
Neuromuscular Scoliosis	12.6 (3.1-23.2)	49.5 (12-87)
Congenital Scoliosis	9.1 (0.1-33.5)	51.4 (20-130)
ANOVA test	$P < 0.05$	$P = 0.08$

Sixty-one patients underwent surgery. Fifty- five (90.2%) surgeries were performed in Hospital Kuala Lumpur. Six patients (9.8%) had their procedures in Hospital Seremban; with their preoperative assessment and postoperative follow-up at Hospital Kuala Lumpur. Table IV shows the distribution of aetiology undergoing surgery; while Table V illustrates the curve details according to aetiology. There were 2 congenital scoliosis patients without documentation of postoperative curve size.

There were 4 cases of removal or early revision of instrumentation. Three were done for complications of the surgery, and one had

Table IV
Patients who Underwent Surgery According to Their Aetiologic Groups

Aetiology	Number (Percentage)
Idiopathic Scoliosis	45 (73.8%)
Neuromuscular Scoliosis	4 (6.6%)
Congenital scoliosis	9 (14.8%)
Other types	3 (4.8%)
Total	61 (100.0%)

removal to reinsert a longer rod. Of the 4 patients, 2 were idiopathic scoliosis, 1 was a neuromuscular scoliosis and 1 had congenital scoliosis. Of the 61 operated cases, one patient had to be braced after surgery at 3.08 years old. This patient had a congenital curve and surgery with fusion only of the vertebral anomaly. This curve progressed. Three patients of the total were braced before surgery. The mean duration of follow-up after surgery was 2.44 years (range from 0.08 to 9.0 years).

Discussion

The patterns of progression of the untreated curves and the early correction by surgery can be understood by examining the results of this study. The progression rates of the untreated curves are similar to the reported rates in the literature[1-8].

The curves of untreated idiopathic scoliosis occurred most frequently, and progressed at a median rate of 7.03 degrees per year. They usually presented untreated at a mean age of 15.5 years; at a mean curve size of 41.6 degrees. Surgery was most frequently performed in this group at a mean age of 15.69 years at a mean preoperative curve of 66.42 degrees. Mean post operative curve was 36.82 degrees. The best correction was seen in this group of curves, with a mean correction of 43.7%. These were the most flexible curves seen, and the most amenable to surgical treatment.

Neuromuscular curves were the least frequently seen, but progressed the fastest at a median of 17.39 degrees per year. They usually presented untreated at a mean age of 12.6 years; with a mean curve size of 49.5 degrees. This group had the least rate for surgery done. If surgery was done, it was in curves which presented at a mean age of 11.21 years, and a mean preoperative curve of 83.50 degrees. The mean post operative curve was 50.25 degrees, with a mean correction of 39.8 %. Surgery in this group was limited by health and life expectancy of the patients; despite being very flexible curves for treatment.

Table V
Mean Age at Surgery, Mean Preoperative and Mean Postoperative Curve Size; with Percentage Correction of Curves of Different Aetiology

Aetiology	Mean Age of Surgery (With Range) in Years	Mean Preoperative Curve (With Range) in Degrees	Mean Postoperative Curve (With Range) in Degrees	Percentage Correction (of Means)
Idiopathic Scoliosis	15.69 (7.25-43.92)	66.42° (37°-130°)	36.82° (15°-79°)	43.7%
Neuromuscular Scoliosis	11.21 (4.92-15.92)	83.50° (72°-102°)	50.25° (35°-79°)	39.8%
Congenital Scoliosis	8.57 (2.25-15.67)	88.11° (54°-130°)	67.80° (38°-100°)	23.0%

Congenital curves accounted for 18% of the untreated cohort. These curves progressed at a median of 3.67 degrees per year. They were 14.8% of the surgical group. These curves usually presented untreated at a mean age of 9.1 years. The untreated curves progressed at 8.57 degrees per year, with a mean preoperative curve of 88.11 degrees. The mean post operative curve was 67.80 degrees, with the least mean correction as a group, at 23.0%. These curves are due to vertebral anomalies and are usually rigid, accounting for the least early correction seen. The success of surgery in these curves can only be assessed at maturity when the growth of the vertebral end plates have ceased.

Conclusion

Idiopathic and neuromuscular curves are the most flexible and have the best correction at surgery. The rate of surgery is highest in idiopathic scoliosis. Congenital scoliosis has the least progression rate but have larger curves at presentation. The correction rates in these curves are the least, but the results of the procedures in this group can only be assessed at the cessation of skeletal growth.

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Dynamic Measurement of Axial Vertebral Rotation and Rotational Flexibility in Scoliosis by Flouroscopic Method

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Summary

The Pedriolle torsion meter is an established method of vertebral rotation assessment in scoliosis[1]. However, the assessment of scoliosis by this method is static and indirect. The objective of this study is to compare the accuracy of a direct method of assessing scoliosis rotation by fluoroscopy compared to the Pedriolle torsion meter. Secondly, to determine that vertebral body rotation changes with supine posture compared to erect position.

Eight volunteers with idiopathic scoliosis were assessed for the apical vertebral rotation with this method and the Pedriolle torsion meter. These patients were also assessed in the supine and erect position with the fluoroscopic method to determine if the apical vertebral rotation would change with posture.

The mean Cobb angle of the curves was 62.8° (range 45° to 86°). The mean apical vertebral rotation in a standing position was assessed to be 21.5° by Pedriolle torsion meter and 29° by the fluoroscopic method. This difference was not statistically significant by the student t-test. In most patient, the rotation of vertebrae improved by a varying degree ranging from none to 24° in the supine position.

In conclusion, the fluoroscopic method is an alternate mean of measuring vertebrae rotation in idiopathic scoliosis, with comparable accuracy to the Pedriolle torsion meter method. The amount of vertebral rotation changes with posture of the patient.

Key Words: Fluoroscopy, Idiopathic scoliosis, Pedriolle torsion meter, Rotational flexibility, Vertebral rotation

Introduction

Scoliosis is a three dimensional deformity of the spine. Some author has indicated that a scoliotic spine is an incomplete torsion[2] and not just coronal deformity. Cotrel and Dubosset[3] had popularized the use of derotational maneuver to correct rotational deformity in addition to coronal plane correction. This maneuver has resulted in report of truncal decompensation following selective thoracic fusion[4]. Determination and analyzing vertebral rotation has assume a greater

importance[5]. Currently, the most popular method is by the Pedriolle torsion meter technique. However, Birchall *et al*[6] reported that radiological examination is inaccurate because difficulty in determining the radiological landmarks. They found that the mean difference of MRI measurement and radiological method is only 3.29 degree. However, CT Scan and MRI Scan are costly and cannot be used to measure rotation when the patient is erect or when the patient bends forwards.

Flouroscopy is a commonly available operating theatre equipment that is cheap and adjustable in many plane hence allowing measurement of vertebrae rotation in many postures. The aim of the project is to determine the accuracy of this method compared to the accepted method of assessment and to determine if rotation of the vertebrae changes with posture.

Materials and Methods

Eleven apical vertebrae in 8 patients were assessed. All the patients had idiopathic scoliosis and were scheduled for operation. The fluoroscopic assessment forms a part of preoperative assessment for this group of patient. Patient not going for operation was excluded because of ethical consideration avoiding unnecessary radiation exposure to patients. Other exclusion criteria include patients with non-idiopathic scoliosis, postoperative patients, adult-onset scoliosis and patients who had been exposed to excessive radiation recently.

Two patients had King I, 1 had King II, 2 had King III and 3 had King IV curves. All patients were girls with the mean age of 13.3 year-old (range = 11.4 to 15.6 year).

These patients were investigated in the x-rays department before their surgery. The standard preoperative workout were PA whole spine x-rays and fulcrum bending films. The vertebral rotation, on the standing PA film, was measured by the Pedriolle torsion meter. Two independent observers were asked to participate in this study. The mean value of the two measurements was recorded as P.

Following this, the fluoroscopy of the spine was performed with the patients standing and laying supine on the same day. During fluoroscopy, the patients were placed in the middle of the gantry. The apical vertebral was localized by palpation and the gantry of the fluoroscopy was rotated until both pedicles of the vertebra was seen. This will align the fluoroscope to the vertebral rotation (see Figure 1). The angle of rotating can be read from the marking on back surface of the gantry. The intervals of the markings were by 5 degrees but the accuracy was improved by a specially-made ruler, made from transparency, so that the interval was by 0.5 degrees. Two readings were taken (denote as F1a and F1b) by one examiners and two readings by a second examiner (denoted as F2a and F2b) as shown in Table I. The average of these readings were recorded as F (see Table II).

The patients were asked to lay supine in the radiolucent table and four measurement of the vertebral rotation were repeated as shown in Table I (denoted by S1a, S1b, S2a, S2b).

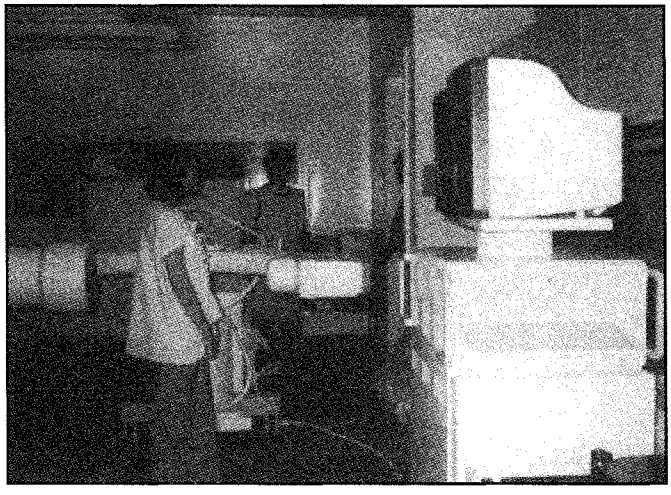

Fig. 1: The fluoroscopic method of rotational assessment.

Table I
Intra-observer and Inter-observer Reliability of the Fluoroscopic Method

Case	Apex	1st Observer		2nd Observer		1st Observer		2nd Observer	
		F1a	F1b	F2a	F2b	S1a	S1b	S2a	S2b
1	T8	43	41	36	38	42	47	40	42
	L2	37	37	40	38	21	19	20	20
2	T11	27	27	28	25	19	18	21	23
3	T9	36	36	38	38	14	16	18	17
4	T9	15	16	15	12	6	6	5	6
	L2	14	11	15	11	10	15	18	20
5	T11	52	49	50	50	27	26	27	24
	L3	20	24	21	19	21	21	23	24
6	T9	17	17	15	13	16	13	14	13
7	T12	29	28	31	33	18	23	20	20
8	T11	34	33	30	31	15	9	10	7

Table II
Mean Value of Rotation Measurement using the Pedriolle Meter and Fluoroscopy

Patient no.	Cobb's Angle		Cobb Angle on Bending		Rotation-P		Rotation-F		Rotation-S	
	Thorax	Lumbar	Thorax	Lumbar	T	L	T	L	T	L
1	45°	55°	20°	24°	15°	25°	40°	38°	43°	20°
2	75°	-	42°	-	30°	-	27°	-	20°	-
3	85°	-	38°	-	25°	-	37°	-	16°	-
4	50°	52°	23°	20°	10°	15°	15°	13°	6°	16°
5	86°	48°	46°	25°	25°	16°	50°	21°	26°	22°
6	60°	-	40°	-	25°	-	16°	-	14°	-
7	50°	-	28°	-	36°	-	30°	-	20°	-
8	85°	-	42°	-	20°	-	32°	-	10°	

P- Mean value of measurement of rotation by Pedriolle torsion meter (degrees).
F- Mean-value of rotation measurement by fluoroscopic method in the Erect position.
S- Mean-value of rotation measurement by fluoroscopic method in the Supine position.

Results

The mean preoperative Cobb angle of the patients were 62.8° (range = 45° to 86°). The flexibility of the curve was variable (see Table I) and ranged from 33% to 62%. There is no correlation between Cobb angle size and fulcrum bending flexibility.

The intra-observer and the inter-observer variability in the readings were not significantly different (p=0.544 and p=0.324 respectively by paired student t-test) when using this fluoroscopy method of apical vertebral rotation assessment.

The mean apical vertebral rotation in the standing position was 21.5° (range = 21° to 30°) as measured by the Pedriolle torsion meter and was 29.0° (range = 13° to 50°) as measured by the fluoroscopic method. The difference between the erect measurement by Pedriolle torsion meter and the fluoroscopic method was not statistically significant.

When the patients were placed supine, the mean apical vertebral rotation measurement by the fluoroscopic method was 17.6° (range 6° to 43°). The difference in vertebrae rotation measurement in the thoracic spine between erect and supine position of the patients were statistical significant (Student t-test, p=0.013).

Discussion

The pathogenesis of idiopathic scoliosis is controversial. However, it is well established that the deformity is three-dimensional[7]. Ascher *et al*[2] has proposed that the spine deforms as an incomplete torsion. The ability of the vertebrae body to derotate in relation to each other and in relation to coronal curve correction is controversial[5].

The clinical problem of idiopathic scoliosis is three fold[8]. Firstly, large curve more than 110 degrees has a higher risk of respiratory impairment. Secondly, a young immature patient with curve more than 60 degrees has an increased risk of progression. Finally, cosmesis and self-image may be a clinical and social problem. Cosmetic effects can be due to a variety of factors such as rib hump, truncal shift, prominent buttock and head shift from the pelvis.

Many surgeons believe that correction of vertebral rotation may improve the rib hump. Cotrel and Dubosset[3] developed a "new segmental spinal system" and suggested that derotational maneuvers are important. However, Arlet *et al*[4] has shown that for selective fusion, improper derotation may cause the truncal balance to worsen. The precise relationship between coronal deformity and rotational deformity of the vertebral is unknown. An accurate preoperative assessment of vertebral rotation and the knowledge of how much derotation is safe should ideally be determined.

Current modalities of vertebral rotation assessment include the Moe radiological method, Pedriolle torsion meter and CAT Scan assessment. The Pedriolle meter is the most commonly used method. It is an indirect method, relying on superimposing a three dimensional structure onto a two dimensional line. The accuracy of this method is limited as the line markings are by intervals of 5 degrees. Furthermore, when measuring larger vertebral rotation, there is difficulty in defining the edge of the vertebrae.

CAT Scan of the axial view of the vertebrae body is an accurate method of measuring vertebral rotation. However, the plane of the vertebrae cut is difficult to align with the index vertebrae. It is costly and the patient is usually supine when the deformity is improved. These disadvantages prevent CAT Scan from being commonly used to measure vertebrae rotation.

The aim of the study is to examine the use of fluoroscopic method of assessing vertebrae rotation. There are some theoretical advantages that this technique offers. Firstly, the method is cheap, using equipment available in many hospitals. Secondly, assessment can be done in many postures that the patient is asked to adapt. The disadvantage is that there is increased exposure to radiation. Hence we have limited the study to those patients who require surgery. We located the apical vertebral clinically by palpation and direct the gantry by the aid of a laser beam that is built in the fluoroscopy unit to reduce the radiation so that only one or two shot per level or per reading is required.

The technique involves adjusting the gantry until the pedicles lies symmetrically in relation to the vertebral body. This corresponds to the longitudinal axis of the vertebra. The degree of rotation can be obtained from the measurement at the back of the gantry. Hence,

this is a direct measuring method allowing the measurement to be done in many positions of the trunk.

Possible sources of inaccuracies include human error in identifying the symmetry of the pedicle and difficulty of patient maintaining a stationery posture. The intra-observer variability was and the inter-observer variability was not significantly different in this study in using the fluoroscopic method.

In this study, the vertebrae rotation measurement by fluoroscopy (29^0) was bigger than that measured by Pedriolle torsion meter (21.5^0). This difference is not statistically significant. There is a reduction of vertebral rotation when the patient adapts a supine posture by 11.4^0 compared to the vertical position. Whether this is a result of Cobb angle improvement or primary derotation of the vertebral body is not known.

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SPINE

Predictive Factors in the Evolution of Neural Deficit in Tuberculosis of the Spine

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Summary

This study was conducted to determine the factors involved in predicting the onset of paraplegia in tuberculosis of the spine. A cross-sectional, case control review of 85 cases of spinal tuberculosis was conducted at the National Tuberculosis Centre in Kuala Lumpur. Sixty-nine of these cases were normal neurologically, whilst 16 cases experienced neural deficit. The data was analysed using backward logistic regression and Fishers exact probability test. The factors studied included symptoms and signs of spinal tuberculosis, common investigations for tuberculosis, and physical factors of the disease. Only the erythrocyte sedimentation rate (ESR) showed a significant difference between the neural deficit and neurologically normal groups. This suggests that the ESR may be a factor in predicting evolution of paraplegia in spinal tuberculosis. In addition, it was noted that a low proportion of patients had positive sputum smear results and bacterial culture growth for *mycobacterium tuberculosis*; suggesting these tests are of limited value for tuberculosis of the spine.

Key Words: Spinal tuberculosis, Neural deficit

Introduction

Tuberculosis is a disease as old as recorded history[1]. Its clinical characteristics were originally described by Hippocrates[2], long before Percival Pott provided the first modern description of spinal tuberculosis in 1779. Throughout known history, its main causative agent, *Mycobacterium tuberculosis*, has been ranked as one of the most deadly human pathogens[3]. Tuberculosis of the spine is one of the various manifestations of tuberculosis in the human body. This condition, also formerly known as Pott's disease, is the most common and dangerous form of skeletal tuberculosis. This is due to its ability to produce varying degrees of paraparesis and paraplegia, as well as serious spinal deformities.

Spinal tuberculosis occurs when *Mycobacterium tuberculosis* spreads from the respiratory passageways to the vertebral column through either the lymphatic or haematogenous route. Once in the spine, the bacterium sets off a typical granulomatous inflammatory reaction with caseous necrosis and bony destruction; thus, destroying the infected vertebral bodies and their intervertebral discs. This leads to vertebral collapse and deformity, as well as the possibility of compression or infection of the spinal cord. Involvement of the spinal cord may cause neural deficit. Generally, there are two types of deficit in spinal tuberculosis - early onset or active disease, and late onset or deficit in healed disease. Neural deficit of early onset usually occurs within two years of onset of tuberculosis, while late onset deficit occurs anytime after two years from the

onset of disease[4,5,6]. Regardless of the type of deficit, the effects remain the same e.g. loss of productivity and self-esteem.

Not all cases of spinal tuberculosis result in neural deficit. A study of the literature indicates that between 5 to 20% of spinal tuberculosis will eventually develop deficit[1-6]. It would be advantageous if we could identify predictive factors that could indicate the development of neural deficit in cases of tuberculosis of the spine. This is of special importance for patients who may develop neural deficit of healed disease, when anti tuberculosis chemotherapy has already stopped; and vigilance is reduced. The purpose of this study is to describe the factors contributing to tuberculosis of the spine; and to determine predictive factors contributing to the evolution of neural deficit in tuberculosis of the spine.

Materials and Methods

This study was conducted at the National Tuberculosis Centre, Kuala Lumpur; using a cross-sectional, case control study design. Eighty-five

Table I
Summary of Common Symptoms of Spinal Tuberculosis

Symptoms	Neurologically Normal			Neurological Deficit			Odds Ratio	95% CI	p value
	Present	Absent	Total	Present	Absent	Total			
Backache	52 (75.4%)	17 (24.6%)	69	9 (56.3%)	7 (43.7%)	16	0.4203	0.1359 - 1.3004	0.1325
Pain (other than backache)	20 (39%)	49 (41%)	69	1 (6.3%)	15 (93.7%)	16	0.1637	0.0203 - 1.3209	0.0894
Weakness	21 (30.4%)	48 (69.6%)	69	2 (12.5%)	14 (87.5%)	16	0.3265	0.0681 - 1.5161	0.1618
Numbness	10 (14.5%)	59 (85.5%)	69	0	16 (100%)	16	0.0004	0 - 2.449E + 23	0.8021
Sphinter disturbance	7 (10.1%)	62 (89.9%)	69	1 (6.3%)	15 (93.7%)	16	0.5913	0.0676 - 5.1723	0.6349
Decrease in sensation	4 (5.8%)	65 (94.2%)	69	2 (12.5%)	14 (87.5%)	16	2.3212	0.3864 - 13.9435	0.3573
Loss of appetite	25 (35.2%)	44 (63.8%)	69	5 (31.3%)	11 (68.7%)	16	0.8001	0.2494 - 2.5663	0.7076
Loss of weight	31 (44.9%)	38 (55.1%)	69	6 (31.3%)	10 (68.7%)	16	0.7376	0.2406 - 2.2494	0.5903
Fever	12 (17.4%)	57 (82.6%)	69	1 (6.3%)	15 (93.7%)	16	0.3167	0.0781 - 2.6324	0.2873
Cough	17 (24.6%)	52 (75.4%)	69	2 (12.5%)	14 (87.5%)	16	0.4370	0.0900 - 2.1205	0.3043
Night sweats	5 (7.3%)	64 (92.7%)	69	1 (6.3%)	15 (93.7%)	16	0.8534	0.0928 - 7.8525	0.8887
Lethargy	2 (2.9%)	67 (97.1%)	69	0	16 (100%)	16	0.0031	0 - 3.623E + 19	0.8239

Table II
Summary of Common Investigations for Spinal Tuberculosis

Investigations	Neurologically Normal			Neurological Deficit			Odds Ratio	95% CI	p value
	Abnormal	Normal	Total	Abnormal	Normal	Total			
Mantoux test	13 (81.3%)	3 (18.7%)	16	3 (75%)	1 (25%)	4	0.6923	0.0520 -9.2106	0.7807
Sputum direct smear sample	3 (5.8%)	49 (94.2%)	52	0	7 (100%)	7	0.0020	0 - 4.636E +33	0.8840
Sputum bacterial culture	8 (17.4%)	38 (82.6%)	46	0	6 (100%)	6	0.0060	0 - 6.174E + 26	0.8340
Chest radiograph	27 (39.1%)	42 (60.9%)	69	3 (18.7%)	13 (81.3%)	16	0.3590	0.0935 - 1.3782	0.1355
ESR ≥ 70 mm/h	25 (46.3%)	29 (53.7%)	54	9 (90%)	1 (10%)	10	10.4395	1.2356 - 88.2050	0.0312
Full blood count	42 (85.7%)	7 (14.3%)	49	6 (75%)	2 (25%)	8	2.000	0.3342 - 11.9692	0.4477
Liver function test	46 (83.6%)	9 (16.4%)	55	7 (77.8%)	2 (22.2%)	9	1.4603	0.2599 - 8.2061	0.6672
Renal profile	47 (87%)	7 (13%)	54	9 (90%)	1 (10%)	10	1.3404	0.1466 - 12.2596	0.7953
Urine microscopy	34 (73.9%)	12 (26.1%)	46	4 (66.7%)	2 (33.3%)	6	1.4167	0.2294 - 8.7477	0.7077

Table IIIA
Summary of Physical Factors in Spinal Tuberculosis

Physical Factor	Neurologically Normal			Neural Deficit			Odds Ratio	95% CI	P value
	Present	Absent	Total	Present	Absent	Total			
Visible spinal deformity	21 (30.4%)	48 (64.6%)	69	2 (12.5%)	14 (87.5%)	16	0.3265	0.0681-1.5661	0.1618
Abnormal Cobbs angle	32 (68.1%)	15 (31.9%)	47	7 (70.0%)	3 (30.0%)	10	0.9429	0.2138-4.1578	0.9289
Concurrent illness	49 (75.4%)	20 (24.6%)	69	13 (81.3%)	3 (18.7%)	16	1.7669	0.4542-6.8734	0.4115

consecutive cases of tuberculosis of the spine between 1995 to 2000 inclusive were identified. Sixty-nine of these cases (81.2%) were normal neurologically, whereas 16 cases (18.8%) had developed neural deficit. The medical records of these 85 patients were examined retrospectively, and 26 possible predictive factors of neural deficit were identified. These factors were grouped under three categories; symptoms (Table I), investigations (Table II); and physical factors (Table IIIA, IIIB and IIIC). The data was analysed using *backward logistic regression* and *Fisher's* exact probability test using SPSS v9.05, with significance set at p=0.05.

Table IIIB
Levels of Vertebral Involvement

Vertebral Segments \ Neurological Status	Neurologically Normal	Neurological Deficit	Percentage with Deficit
Cervical	4	1	25.00%
Cervicothoracic	2	0	0.00%
Thoracic	15	5	33.33%
Thoracolumbar	10	3	30.00%
Lumbar	35	6	17.14%
Total	66	15	

Fishers Exact test p=0.862, df =4

Table IIIC
Number of Vertebrae Involved in Disease

	Neurologically Normal	Neurological Deficit	Percentage with Deficit
One	13	5	38.5%
Two	40	7	17.5%
Three	6	1	16.7%
Four	5	1	20.0%
Five	2	1	50.0%
Total	66	15	

Fishers Exact test p=0.742, df=4

Results

There were 61 males (71.8%) and 24 females (28.2%), with 10 male and 6 females with neural deficit. Their mean age was 40.4 years, with a range of 1 - 78 years. Summarised results of symptoms are in Table I, investigations in Table II; and physical factors in Table IIIA, IIIB and IIIC.

Discussion

Symptoms (Table I)

Backache was the most common symptom for spinal tuberculosis, followed by loss of appetite, weight loss and weakness. Also reported were pain (other than backache), cough, fever, numbness, sphincter dysfunction, sensation disturbance, night sweats and lethargy in order of descending frequency. These findings are in agreement with previous workers[7,8]. No weakness or lethargy was reported in the neurologically normal patients. A recent study from India reports a higher incidence of fever and cough compared to this study[9]. There was no difference between both groups.

Investigations (Table II)

Of the 20 patients whose Mantoux test results were available, 16 (80%) had positive results that were ≥10mm. This percentage is slightly higher than published results in other studies[7,8]. It is, however, well within the expected range of results for the Mantoux test in tuberculosis of the spine[10]. The Mantoux test remains an important diagnostic tool for tuberculosis in Malaysia. This is because the majority of afflicted patients with this disease are born before 1961 - the year compulsory BCG vaccination was implemented; or were not vaccinated at all. Sputum direct smear and sputum bacterial culture growth were overwhelmingly negative. This is probably due to the low loads of bacteria in tuberculosis of the spine, and is similar to a previous study at the same institute[7]. We query the usefulness of these tests as routine in the investigation of spinal

tuberculosis. An elevated ESR of ≥70 mm/h in spinal tuberculosis were reported by several workers[7,8,11]. We observed 90% of neural deficit patients compared to 46.3% normal neurology had this finding. This was statistically significant. This suggests that the elevated ESR could be used to predict the development of neural deficit in spinal tuberculosis. Full blood counts, liver function tests, renal profiles and urine microscopy; while were noted to have a high proportion of abnormal results in both groups, did not exhibit any significant difference.

Physical factors (Table IIIA, IIIB and IIIC)

Tuli states that by the time a patient reports for specialised treatment in developing countries, 95% already show a clinically detectable kyphos or reversal of the normal lordosis[12]. We found only 27% of patients to have a clinically detectable spinal deformity; while 68.4% presented with an abnormal kyphosis on radiograph. Contradicting reports exist on the presence of pulmonary tuberculosis in spinal tuberculosis. Boxer and associates report 11.5%[13]; while Sayi and Mlay report 9%[8]. We find 66.1% of our patients with pulmonary tuberculosis; this is in agreement with Rezai and associates[2]. Levels of vertebrae involved in this study are similar to previous studies in Malaysia[7] and Hong Kong[14]. We noted the "two-vertebra disease with the destruction of the intervening intervertebral disc" of ur-Rahman[15] to be the commonest, followed by single level disease. While this finding is corroborated by Jalleh and associates at the same institute[7], other workers report single level disease to be a rarity[7,8,9,14,15]. In all the physical factors studied we found no significant difference between neurologically normal and neural deficit patients.

Conclusion

From our study, we conclude that the raised ESR could be a predictive factor in the development of neurological deficit in spinal tuberculosis. We also find that sputum smears and sputum cultures have a very low positive rate in spinal tuberculosis, and recommend reviewing the significance of this routinely performed tests.

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TUMOURS

Pattern of Primary Musculoskeletal Sarcomas Referred to Institute of Radiotherapy and Oncology, Hospital Kuala Lumpur, 1995-1999

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Summary

An epidemiological study of 101 consecutive musculoskeletal sarcomas seen at the Institute of Radiotherapy and Oncology between 1995 and 1999 inclusive was carried out. The commonest sarcomas seen were osteosarcoma, rhabdomyosarcoma, Ewing's Sarcoma, liposarcoma, leimyosarcoma, malignant fibrous histiocytoma and chondrosarcoma; which collectively accounted for 84.2% of the group. Thirty patients (29.7%) presented with metastases. The commonest site of occurrence was lower extremity with 47.5%, followed by 34.7% in the trunk and peritoneum/axial skeleton, 9.9% in the head and neck region; and 7.9% in the upper extremity. We found no apparent relationship between race and incidence osteosarcoma and Ewing's sarcoma, as was reported by previous workers.

Key Words: Epidemiology, Musculoskeletal, Sarcoma

Introduction

To date there are 5 studies on the epidemiology or pattern of musculoskeletal sarcomas in Malaysia, three from the University of Malaya[1,2,3], one from National University of Malaysia[4] Hospital; and the National Childhood Cancer Report[5]. Bovil[1] at UHKL suggested that the incidence of osteosarcomas was least in Malays; while Peh[2] of UHKL and MN Sundari[3] at HUKM suggested that Chinese had the lowest incidence of Ewing's sarcoma. Lin's[5] National Childhood Cancer Study has shown Chinese to have the highest crude rate for osteosarcoma and the lowest for Ewing's Sarcoma. In a survey of 101 newly referred primary musculoskeletal sarcomas at the Institute of Radiotherapy and Oncology of Hospital Kuala Lumpur between 1995 and 1999 inclusive, osteosarcomas comprised of 21 cases, followed by Ewings (12) Liposarcoma (10) and MFH (8), 48 tumours was found in lower extremely and 45 in trunk and exial skeleton. Most tumours showed no racial inclination except Ewing's Sarcoma which was less common in Malays.

Materials and Methods

All patient records with histologically confirmed diagnosis of a primary musculoskeletal sarcoma, referred to the Institute of Radiotherapy and Oncology, Hospital Kuala Lumpur between 1995 and 1999 inclusive; were reviewed. Metastatic disease to bone from non-musculoskeletal source; and marrow tumours (plasmacytomas and lymphomas) were excluded. A total of 367 patients (old and new cases) were recorded at the Institute's registry, of which 330 (89.9%) complete

notes were retrievable. To reflect the incidence, only newly diagnosed tumours which were referred are included in the study. This amounted to 101 cases. Age at diagnosis, gender, site, ethnicity and histology type were recorded. Data was analysed with SPSS v 9.05.

Results

A total of 101 patients were available for study. Fifty-five (54.5%) were males and forty-six (45.5%) were female. Forty-one (40.6%) were bone sarcomas and sixty (59.4%) were soft tissue sarcomas (See Table I). The 7 most common types (constituting 84.2% of the total) are discussed.

Osteosarcomas n=21

Mean age of diagnosis was 24.1 years, median was 19.0 years, with range from 7 to 56 years. Peak incidence was seen during second decade of life (11 - 20 years) with 10 cases (47.6% of 21 cases). We did not see the 2 age peaks described by other workers. Male to female ratio was 1.1:1. Sixteen cases (76.2%) occurred in the lower extremities, three cases (14.3%) in the mandible, and two cases in the pelvis and sacrum. There was none reported in the upper extremity. Seven (33.3%) had metastasis at presentation. Fourteen (66.6%) were seen in Malay patients, four (19.1%) in Chinese and three (14.3%) in Indian patients.

Table I
The Frequency of New Primary Musculoskeletal Sarcomas at HKL between 1995-1999

Type of Sarcoma	Number of Cases	Percentage (%)
1. Osteosarcoma	21	20.7
2. Rhabdomyosarcoma	18	17.8
3. Ewing's sarcoma	12	11.9
4. Liposarcoma	11	10.9
5. Leimyosarcoma	9	8.9
6. Malignant Fibrous Histiocytoma	8	7.9
7. Chondrosarcoma	6	5.9
8. Fibrosarcoma	5	5.0
9. Synovial sarcoma	3	3.0
10. Neurofibrosarcoma	3	3.0
11. Giant Cell Tumour	2	2.0
12. Angiosarcoma	1	1.0
13. Other sarcomas	2	2.0
Total	101	100

Rhabdomyosarcoma n=18

Patients ranged from 2 to 84 years, with mean age of diagnosis at 18.6 years and median of 9.5 years. Peak incidence was at first decade of life (0-10 years) with 10 cases (55.6%). Male to female ratio was 1:1. Four cases (22.2%) were in the femur, three (16.7%) in the pelvis and three (16.7%) in the head and neck region. Four cases (25.0%) presented with metastases. Eleven (61.1%) were Malay, five (27.8%) were Chinese, and two (11.1%) were Indian patients.

Ewing's sarcoma n=12

Mean age of diagnosis was 18.1 years with median of 17.0 years; and range from 6 to 33 years. Five cases were each seen in the second (11 - 20 years) and third decades (21 - 30 years) of life, accounting for 83.4% of the total. Male to female ratio was 2:1. Five cases were in the upper extremity (41.7%), four cases (33.3%) in the pelvis, and 3 cases (25%) were in the lower extremity. Seven (41%) had metastases at presentation. Malays accounted for three patients (25%), five (41.7%) were Chinese, and four (33.3%) were Indian patients.

Liposarcoma n=10

Mean age of diagnosis was 54.6 years with median of 58.0 years. Range was 20 to 70 years. Peak incidence was at sixth decade of life (51+ years), accounting for seven patients (70.0%). Male to female ratio was 1.5:1. Five (55.5%) occurred in the lower extremity, two (22.2%) in the upper extremity and two (22.2%) in the

gluteal region. Three patients (30.0%) presented with metastases. Six (60.0%) were in Malays, and two (20.0%) each were in Chinese and Indian patients.

Leimyosarcoma n=9

Patients ranged from 45 to 75 years with mean age of diagnosis at 57.4 years and median of 58.0 years. Peak incidence occurred after the fifth decade (51+ years) with eight cases (88.9%). Male to female ratio was 1:1.25. Four cases (44.4%) each were seen in the abdomen and perineum, with a single case (11.1%) occurring in the head and neck region. Five patients (55.6%) presented with metastases. Six (66.7%) were in Malays, one (11.1%) in a Chinese patient and two (22.2%) in Indian patients.

Malignant Fibrous Histiocytoma n=8

Mean age of diagnosis was 40.9 years with median at 41.5 years. Patients ranged from 7 to 85 years. Most cases occurred in the 51+ age group with three (37.5%) cases. No definite peak incidence in age was seen. Two (25.0%) cases were seen below 20 years of age. Male to female ratio was 7:1. Six cases (75.0%) occurred in the lower extremity, with one (17.5%) case each in abdomen and upper extremity. Three (37.5%) presented with metastases. Six (75.0%) were in Malay patients with two (25.0%) in Chinese patients, while none were seen in Indian patients.

Chondrosarcoma n=6

Patients ranged from 20 to 64 years of age with mean age of diagnosis of 39.9 years and median of 36.5 years. They were evenly distributed throughout the age groups with two occurring in the 51+ age group. None were seen before 20 years of age. Male to female ratio was 2:1. Five cases (83.3%) occurred in the lower extremity with one (16.7%) in the spine. None had metastases at presentation. Malays accounted for three (50.0%), one Chinese (16.7%) and two Indian patients (33.3%).

Discussion

From this study, the pattern of commonest musculoskeletal sarcomas seem to be consistant with reported series both in Malaysia[1-5] and internationally[6,7] with osteosarcomas and Ewing's sarcomas being the commonest of bone forming sarcomas; and rhabdomyomas, leimyosarcomas and liposarcomas being the commonest soft tissue sarcomas [Table I]. Some variation exists in the ranking of these tumours, but this is probably due to referral patterns of the various institutions. Giant cell tumours were not reported in this series because of the referral pattern at this hospital, these being entirely treated by Orthopaedics, except in histologically high grade cases.

The provision of oncology services is highly concentrated in the Klang Valley region, with three major tertiary referral institutes, UHKL, HUKM and HKL[5,8]. In our study only thirty-eight (37.6%) of the patients were from Selangor and Federal Territory, the rest being referrals from the central and southern states of Malaysia. Four of the five previous studies were institute based[1-4], but no information was available on referral patterns. The fifth was a national study reporting the incidence between 1993 - 1995, and is probably a more true reflection of the incidence in racial groups; but is limited by the short time period of study[5].

The lower extremity was involved in 47.5% of cases, with the upper extremity only involved in 7.9% of cases. Trunk and peritoneum / axial skeleton was involved in 34.7% while head and neck was involved in 9.9%. This is consistent with other reported series[9]. The most number of cases seen in the upper extremity was Ewing's sarcoma (37.5%); Trunk and axial skeleton had high incidence of rhabdomyosarcoma (20.0%) and leimyosarcoma (22.9%). Ewing's was seen in 17.9% of axial skeleton tumours. Commonest head and neck musculoskeletal sarcoma were rhabdomyosarcoma (40.0%) and osteosarcoma (30.0%) [Table II].

Table II
The Site of Occurrence of the Sarcomas

Type of Sarcoma	Lower Extremity	Upper Extremity	Trunk & Peritoneum / Axial Skeleton	Head & Neck	Total
1. Osteosarcoma	16	-	2	3	21
2. Rhabdomyosarcoma	6	1	7	4	18
3. Ewing's sarcoma	3	3	6	-	12
4. Liposarcoma	5	2	4	-	11
5. Leimyosarcoma	-	-	8	1	9
6. Malignant Fibrious Histiocytoma	6	1	1	-	8
7. Chondrosarcoma	5	-	1	-	6
8. Fibrosarcoma	2	-	1	2	5
9. Synovial sarcoma	2	-	1	-	3
10. Neurofibrosarcoma	1	1	1	-	3
11. Giant Cell Tumour	1	-	1	-	2
12. Angiosarcoma	1	-	-	-	1
13. Other sarcomas	-	-	2	-	2
Total	48	8	35	10	101

Table III
Summary of the Demographic Pattern of the 7 Commonest Sarcomas in This Study

Sarcoma	Median Age (Years)	Male: Female Ratio	Metastases Present at Diagnosis	% Malay	% Chinese	% Indian	Total
1. Osteosarcoma	19.0	1.1 : 1	33.3%	66.6	19.1	14.3	21
2. Rhabdomyosarcoma	9.5	1 : 1	25.0%	61.1	27.5	11.1	18
3. Ewing's sarcoma	17	2 : 1	41.7%	25.0	41.7	33.3	12
4. Liposarcoma	58.0	1.5 : 1	30.0%	60.0	20.0	20.0	10
5. Leimyosarcoma	58.0	1 : 1.25	55.6%	66.7	11.1	22.2	9
6. Malignant Fibrous Histiocytoma	41.5	7 : 1	37.5%	75.0	25.0	0.0	8
7. Chondrosarcoma	36.5	2 : 1	0%	50.0	16.7	33.3	6

As a whole, there was a male: female ratio of 1.2: 1. This was consistent throughout with the exception of Malignant Fibrous Histiocytoma which had a 7 fold increase in males; and leimyosarcoma which had a slight female predominance. Thirty patients (29.7%) presented with metastases; these were ranging from 55.6% in leimyosarcoma to none in chondrosarcoma [Table III].

The racial pattern of tumour occurrence in this study does not suggest any racial predominance. We do not concur with Li[10], Peh[2], MN Sundari[4], and Lin's[5] finding of the relative resistance of Chinese to Ewing's sarcoma. To the contrary, in our study 41.7% of Ewing's sarcoma were in Chinese patients. We also do not concur with Bovill's[1] finding of low incidence of osteosarcoma in Malays compared to Chinese. Lin's[5] study and this study have shown the incidence of osteosarcoma to be not significantly different in Malay and Chinese patients [Table III]. Major bias exists in studies to determine the incidence of sarcomas. These require complete reporting and a standardized methodology to be used in all centres. This may explain the differences in the osteosarcoma incidence in Malays in the work of Bovill[1] and Lin[5]; accepting that there was considerable under reporting 30 years ago. With institution-based studies by Peh[2], Saw[3], MN Sundari[4], and this present study; the biggest bias is the referral pattern and referral practice of the medical fraternity in the region. We believe this to be a reason for the difference in the reported incidence of Ewing's sarcoma in Chinese patients. This may be solved by a combined analysis of all reported cases from the 3 major tertiary Oncology centers in the Klang Valley.

Conclusion

The pattern of primary musculoskeletal sarcomas that were seen at the Institute of Radiotherapy and Oncology at Hospital Kuala Lumpur between 1995 and 1999 are similar to those as in reported series in Malaysia and internationally. The occurrence of these sarcomas do not seem have any ethnic distribution.

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

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Summary

Sixty-seven primary THR surgeries in 57 patients between January 1992 and December 1998 were reviewed after a mean follow-up of 35.9 months. The rate of superficial and deep wound infections were 11.9% and 1.5% respectively. The most common organism in superficial wound infection was *Staphylococcus aureus*. The factors that were significantly associated with superficial wound infection were diabetes mellitus (p= 0.0230) obesity (p=0.0088). The patients who developed superficial wound infection have a significantly longer duration of surgery compared to patients without infection (p=0.014). However, there was no significant difference between the mean age among patients with and without superficial wound infection (p=0.814).

Key Words: Total hip replacement, Infection

Introduction

Total hip replacement (THR) surgery represents a major advance in the treatment of degenerative joint disease, providing dramatic pain relief and excellent restoration of hip joint function. However, infection in THR still poses as a challenge. Although the infection rate has decreased over the last few decades, post-operative infection remains a source of considerable morbidity[1]. Superficial infection may penetrate deep into the fascia and progresses to deep infection[2]. Deep infection is a catastrophic complication in THR and it is difficult and expensive to treat because of the subsequent need for revision surgery and the prolonged hospitalization often needed to eradicate the infection[1]. This study was carried out with the objectives of determining the crude rate of superficial and deep wound infection of THR done at Hospital Kuala Lumpur, and the factors associated with wound infection.

Materials and Methods

Data on THR surgery over a 7-year period between January 1992 and December 1998 were collected retrospectively from case records and recorded into a standard performa sheet. The factors associated with superficial wound infection in THR were evaluated by a case-control study design; comparing patients who underwent THR and subsequently developing superficial wound infection, against controls who underwent THR but did not develop superficial wound infection.

SPSS for Windows V9.05 was used for analysis. Post-operative superficial 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 (self reported), obesity and surgical approach. The statistical test applied for this was *backward logistic regression analysis.* 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 94 primary THR's, 67 (71.3%) were available for study; at a mean follow up of 39.4 months. All patients received pre and post operative prophylactic antibiotics. The rate of superficial wound infection was 11.9%; and deep wound infection was 1.5%. Organisms were identified in 6 cases of superficial infection. Of these, 3 cases yielded two organisms and 3 cases yielded single organism each. The results of bacterial culture in 2 cases were unavailable due to contamination of the specimens. The most common infecting organism identified was *Staphylococcus aureus* (4 cultures), with two being methicillin resistant (MRSA). The frequencies of organisms identified in the infections are shown in Table I. The indications for the surgeries are shown in Table II.

Backward logistic regression analysis showed factors that were significantly associated with superficial wound infection were diabetes mellitus (p=0.0230; OR=21.40), and obesity (p=0.0088; OR=20.22). The factors that were not significantly associated with superficial wound infection were previous surgery on the affected joint, rheumatoid arthritis, sex, usage of bone grafts, surgeon's glove perforation and surgical approach (Table III).

Table I
Organisms Identified in Superficial Wound Infections

Organism	Frequency
Staphylococcus aureus	4
Acinetobacter species	2
β-hemolytic Streptococcus group-D	1
Citrobacter species	1
Pseudomonas aeruginosa	1

Table II
Indication for Surgeries

Diagnosis	Number	Percentage (%)
Avascular necrosis	20	29.9
Osteoarthritis	17	25.4
Hip dysplasia	8	11.9
Inflammatory arthritis	8	11.9
Ankylosing spondilitis	6	9.0
Failed haemiarthroplasty	5	7.5
Perthes	2	3.0
Infected pseudoarthrosis of proximal femur	1	1.5

The mean duration of surgery for patients with and without superficial wound infection were 259.38 minutes and 196.95 minutes respectively. *Independent samples t-test* (Student's t-test) showed that the patients who developed superficial wound infection have a significantly longer mean duration of surgery compared to patients without infection (p=0.014), however, there was no significant difference between the mean age of patients with and without superficial wound infection (p=0.814) (Table IV).

Discussion

The rate of deep infection in this study was 1.5% and is comparable to the literature which is below two percent[3,4,5,6]. All patients in this study received pre and post-operative prophylactic antibiotics. Body-exhaust suits, ultraclean air and laminar airflow systems have been reported to be effective in reducing the rate of deep infection in THR[3,7]; however, prophylactic antibiotics alone in

Table III
Logistic Regression Analysis on Various Factors in Relation to Superficial Wound Infection in Total Hip Replacement

Variable	Sig	r^2	Odds ratio (95% CI)
Diabetes mellitus	0.0230*	0.065	21.40 (1.53, 300.21)
Previous surgery†	0.3923	0.000	0.23 (0.01, 6.86)
Rheumatoid arthritis	0.8713	0.000	0.00 (0.00,1.98E+4)
Sex	0.6443	0.000	0.60 (0.07, 5.37)
Usage of Bone grafts	0.6434	0.000	1.94 (0.12, 31.70)
Glove perforation	0.9614	0.000	0.88 (0.01, 140.93)
Obesity	0.0088*	0.099	20.22 (2.13, 191.53)
Surgical approach	0.2794	0.000	0.25 (0.02, 3.09)

†Previous surgery on the affected joint,
**p < 0.05 statistically significant*

Table IV
Independent Samples T-test (Student's T-test) for Age and Duration of Surgery

	AGE (Years)		DURATION OF SURGERY (Minutes)	
	Superficial Wound Infection		Superficial Wound Infection	
	Present	Absent	Present	Absent
N	8	59	8	59
Mean ± SD	51.38 ± 9.38	50.20 ± 13.56	259.38 ± 85.12	196.95 ± 63.14
P value	0.814		0.014*	

** p < 0.05 statistically significant*

the absence of these features in the orthopaedic operating theatres in Hospital Kuala Lumpur produced a deep infection rate comparable to the larger, dedicated centres which have these features incorporated in their operating theatres. This suggests that prophylactic antibiotics is probably the single most effective method to reduce the prevalence of infection as reported by Hanssen[8]; whereas the use of body-exhaust suits, ultraclean air and laminar airflow system produce only a modest decrease in the infection rate.

The most common infecting organism identified in superficial infection was *Staphylococcus aureus*, with two (50%) of them being methicillin resistant (MRSA). This has dire consequences if these progressed to deep in infections. In this study, diabetes mellitus and obesity are significantly associated with superficial wound infection. Diabetes is a well-known factor of poor wound healing and increased risk of subsequent wound infection. Obesity is also associated with poor wound healing. Inflammatory arthritis, previous operation on the affected joint, sex, usage of bone grafts, surgeon's glove perforation, surgical approach were not found to be significantly associated with infection in this study.

Conclusion

The rate of superficial and deep wound infection in THR procedures done in hospital Kuala Lumpur is 11.9% and 1.5% respectively. The most common organism in superficial wound infection was Staphylococcus aureus. The factors that were significantly associated with superficial wound infection are diabetes mellitus (p=0.0230) and obesity (p=0.0088). The patients who developed superficial wound infection have a significantly longer duration of surgery compared to patients without infection (p=0.0140). The use of prophylactic antibiotics in the absence of body-exhaust suits, ultraclean air and laminar airflow systems is sufficient to keep the infection rate at an acceptable level.

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BASIC SCIENCE

Intercostal Nerve Neurotization of the Femoral Nerve in Patients with Paraplegia - An Anatomical Feasibility Study

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Summary

Neurotization of the brachial plexus is an established procedure in the upper limb. However, neurotization of the lower limb remains experimental. Brunelli[1] reported the use of the ulnar nerve to neurotize the lower limb. Zhao *et al*[2] reported the use of intercostals nerve to neurotize the lower limb in rats.

The aim of the study was to determine the feasibility of using intercostals nerve to neurotize the femoral nerve in human cadavers and to ascertain the ideal intercostals nerve that has the anatomical course that suit this role.

Six fresh cadaveric dissection were performed through an extensile midline incision in the postmortem room and the lower six (T7-T12) were identified and traced from their origin. Their length and course identified and charted. T9 and T10 intercostal nerve was thought to be the most suitable nerve as the donor nerve, and the T11 and T12 intercostal nerve could not be free from its intra-muscular course sufficiently to be use as donor.

Key Words: Cadaveric dissection, Femoral nerve, Intercostals nerve, Lumbar plexus, Neurotization

Introduction

Thoracolumbar fracture is a common cause of paraplegia. The extent of spinal cord injury can be major or minimal. Much research into spinal cord regeneration is being conducted to determine the feasibility. Experimentally, spinal cord regeneration is possible in animal models but clinical application is not well-defined. In contrast, neurotization for brachial plexus is a well-proven technique. Samii *et al*[3] reported 76% successful reinnervation of musculocutaneous nerve in patients with brachial plexus injury.

Neurotization of lumbar plexus or individual nerve has not been widely practiced clinically. Zhao *et al*[2] reported that in a rat model where the intercostals nerve were anastomosed to the cauda equina nerves, most rats were able to move their leg in 9 months and histology showed well myelinated nerve.

The aim of this project is to study the feasibility of selectively neurotising the femoral nerve by using the intercostals nerves. This will form the

anatomical basis for later clinical application of this proposed concept of surgical restoration of lower limb function in paraplegics.

Material and Methods

Six fresh cadavers where obtained from the mortuary, University Hospital Kuala Lumpur. Fresh cadavers were used to avoid the problem of difficulty of dissection and the loss of elasticity caused by formalin preservation. There were five male and one female cadavers with an average age of 56.4 years (range = 49 to 64 year-old). Those with traumatic death were not included. The average height was 165.8cm and average weight was 66.7kg (see Table I).

Standard midline postmortem incision from the throat to pubis symphysis was made and routine autopsy was performed prior to the intercostals nerve dissection which was made through the muscle plane. The sternum was removed so that the rib cage did not need distract the rib cage. All the internal organs were removed carefully and hence the intercostal nerves were visualized to aid in dissection. The organs were sent for forensic examination.

The T7 to T12 intercostals nerves were found through the muscle wall and located in the subcostal groove just below the ribs. The dissection was aided because the nerves were differentiated from the vessels and seen through the layers of parietal pleura and intercostals muscles. T11 and T12 intercostals nerves were found to aborized very soon to innervate the abdominal muscles and could not be dissected despite the aid of loupe magnification. T7 to T12 intercostals nerve were dissected to the neuroforamen and freed from its bed. The branches were ligated and excised. The nerve is traced until it is not practical to keep the nerve intact i.e. aborizes. Measurement of the intercostals nerve length were made from the neuroforamen to the distal end of the dissected

Table I
Cadaveric Weight and Height in Relation Intercostals Nerve Length (I) and Distance of Intercostals Nerve to the Femoral Nerve (F)

Cadaveric		1	2	3	4	5	6
Sex		M	M	F	M	M	M
Weight (kg)		66	67	56	69	84.7	57.6
Height (cm)		162	169	152	177	165	170
				Length/Distance (cm)			
T7	I	25	26	25	26	30	26
	F	33	35	31	35	35	35
T8	I	26	26	26	30	31	28
	F	30	33	28	33	33	33
T9	I	29	29	25	30	30	29
	F	28	30	25	28	30	28
T10	I	32	28	29	25	28	29
	F	26	25	23	25	27	27

I-length of dissected intercostals nerves (from neuroforamen to detached ends)
F-distance from the neuroforamen to the proximal end of femoral nerve.

nerve (distance I) - see Table I. The dissected nerves were measured, still attached to the spinal nerve root but detached distally. It was laid on the measuring ruler, straighten without tension simulating the normal operative practice.

The lumbar plexus were dissected and the proximal end of the femoral nerve was identified. The distance from the proximal end of the femoral nerve to the neuroforamina of each intercostal nerves from T7 to T10 were measured (denote as distance F). A mark on the proximal end of the femoral nerve where the branches of the lumbar plexus joints together to form the nerve was made. This mark and the exit foramina of the intercostals nerve was connected by a string which lay straight on the psoas muscle without tension simulating the potential course of donor nerve. The string was then measured on a ruler.

Results

We explored the lower intercostals nerves and found that the length of intercostals nerves from T7 to T10 in most cadavers were between 25cm to 30cm. The length dissected increased fromT7 to T9 (by 26.3 at T7, 27.8cm at T8, 28.7cm for T9, 28.5cm for T10). The average length (I) of T11 and T12 intercostal nerves were 20.4 cmand 16.8cm respectively.

The distance F i.e. the distance of the neuroforamina to the proximal end of the femoral nerve to the proximal end of femoral nerve decreased, by a distance 2 to 5cm in succeeding level (decreased by an average of 2.3 cm from T7 to T8, 3.5cm from T8 to T9 level, 2.7cm from T9 to T10). The average distance of neuroforamina to the proximal end of the femoral nerve (distance F) were 23.0cm for T11 and 21.3cm for T12 respectively.

T9 and T10 intercostal nerve length (I) is longer than distance F for the corresponding nerve (see Table II). Hence direct suturing of these two nerves to the femoral nerve is possible without nerve grafting.

Table II
The Average Length of Intercostal Nerves and Length from Foramen to Proximal end of Femoral Nerve

Length/ Distance	T7 (cm)	T8 (cm)	T9 (cm)	T10 (cm)
F	34.0	31.7	28.2	25.5
I	26.3	27.8	28.7	28.5

Discussion

Paraplegia due to thoraco-lumbar spine injury is very common. In the USA, the annual incidence rate spinal cord injury requiring hospitalization is between 32 to 50 per million in a year[6]. The neurological deficit depends on the extent of initial injuries. There are evidence of potential for neurological recovery in most patient. However, the recovery may be partial and incomplete.

Research on cord regeneration showed that neuroglial regeneration appears to be possible in animal but it is far from clinical application in human[7].

Neurotization of selected nerves to restore limb function appears to a clinical possibility. Neurotization of important nerves in brachial plexus injury, such as the musculocutaneous, the axillary and supraspinatus nerve, has produced results. Sammii[4] demonstrated that in 345 patients with brachial plexus injury, direct repair and neurotization of the musculocutaneous nerve were beneficial to these patients. Songcharoen *et al* reported 72.5% of 216 patients regained MRC grade 3 of elbow flexion following spinal accessory-musculocutaneous nerve neurotization.

Zhao *et al*[2] proved in a rat model that neurotization of caudal equina nerve with intercostals nerve showed motor action potential across the anastomosis and has good reinnervation on histological examination. Brunelli and Brunelli[1] further demonstrate that ulnar nerve transfer or neurotization of the lower limb successfully helped three patients to walk.

However, concern about injury to the important ulnar nerve disadvantaged this procedure and hence not widely acceptable.

We propose that lower intercostals nerves may be a better donor nerves than the ulnar nerve in the aspect of donor morbidity. The loss of intercostals nerves normally does not affect breathing in these patients as the phrenic nerve is intact. The donor nerve should ideally be long enough so that nerve grafting is not required. However the technical and anatomical factors that affect the use of intercostals nerves as donor nerves need further investigation. Extensive literature search reveals sparse information on this subject. Hence the aim of this study is to determine the feasibility of using intercostals nerve to re-innervate the important lower limb nerves.

Potentially, selective neurotization can be performed to important lower limb nerves such as the superior gluteal nerve (for hip extension), femoral nerve (for knee extension) and sciatic nerve (for knee flexion and lower leg function). We chose to apply the concept to the model of intercostals nerve to femoral nerve. The sciatic nerve clinically a difficult nerve to neurotize because its size is much bigger than the donor and its ability to restore lower leg function is remote as the distance to the motor end plate is too far. The superior gluteal nerve is comparable in size to two or three intercostals nerve making neurotization possible but anatomically lays deep in the pelvic cavity hence making measurement difficult.

We explored the lower intercostals nerves and found that the length of intercostals nerves from T7 to T10 in most cadavers were between 25cm to 30cm. There is a tendency for the length dissected to increased from T7 to T9 and decreased tremendously between T11 and T12.

T9 and T10 fulfilled the condition of being the ideal donor as direct suturing to the recipient femoral nerve is possible with grafting. Using the T8 would require 4cm of graft and T7 would require 7.7cm of graft with the possible compromise to the success of the re-innervation.

There is no clinical study yet to determine the clinical usefulness of this procedure and further research to the axonal number of the femoral nerve and intercostals nerve is required. There are many ways to apply this concept, e.g. through two separate incisions for the donor and the recipient nerves and tunneling through muscle which need further clinical evaluation.

Conclusion

Our study would indicate that neurotization of femoral nerve by using intercostals donor nerve are anatomically possible. However, clinical efficacy is not yet proven.

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CASE REPORT

Compartment Syndrome of the Calf and Foot Following a Displaced Salter-Harris Type II Fracture of the Distal Tibia: A Review of the Literature and a Case Report

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Summary

A 14 year-old boy with an epiphyseal fracture of the distal right tibia and fibula developed compartment syndrome of the calf and foot. The diagnosis of compartment syndrome was delayed and a fasciotomy resulted in uncontrolled infection, which ultimately resulted in an above knee amputation. Constant vigilance is necessary in uncooperative or non-complaining patients to detect the signs and symptoms of compartment syndrome, even where the injury is not often associated with this complication. The difficulties in management, following a fasciotomy for delayed diagnosis of compartment syndrome, are discussed.

Key Words: Compartment syndrome, Foot, Calf, Epiphyseal fractures, Delayed fasciotomy

Introduction

There have been only 7 case reports in the literature of a deep compartment syndrome of the calf following an isolated fracture or injury to the ankle[1-7]. This rarity may lead to a lack of awareness amongst clinicians and nursing staff, that compartment syndrome may still occur after an ankle injury. We report on a case of compartment syndrome of the deep posterior compartment of the calf and of the foot, following a displaced close Salter-Harris Type II fracture of the distal tibia and fibula, to highlight the need for elevation of the injured limb and continued vigilance for compartment syndrome.

Case Report

A 14 year-old boy sustained displaced close Salter-Harris Type II fractures of the distal right tibia and fibula and of the distal left radius and ulna together with a closed fracture of the distal third of the right radius and ulna following a motorcycle accident. An attempt at reduction of the fractures under pethidine analgesics and diazepam sedation failed to achieve a satisfactory reduction and he was admitted for reduction and stabilisation of the fractures under general anaesthesia. The right leg was in a complete above knee cast and the limbs were to be elevated whilst he awaited surgery.

Due to a lack of emergency operating theatre time, surgery was cancelled on a few occasions. Whilst awaiting surgery, he had requested to be discharged on several occasions. He left the ward in a wheelchair on many occasions, either on his own or with his friends and would spend up to 10 hours a day with his foot in a dependent position in the wheelchair. He continued to use the wheelchair despite his foot gradually becoming more swollen and the cast becoming very tight, the increasing pain which was becoming very severe, and the sensation in his foot diminishing with increasing difficulty moving his toes. He did not ask for analgesics despite the severe pain nor seek any attention when he returned to the ward.

On the sixth day following his injury, the nurses noted blood on the cast and that the toes were swollen, discoloured and cold. The cast was removed and blisters were noted especially on the posteromedial aspect of the calf. Part of the skin on the dorsum of the foot was necrotic. The sensation from the ankle to the foot was markedly reduced. The dorsalis pedis pulse was weak and the posterior tibial pulse absent. Passive dorsiflexion of the toes caused pain. Capillary return was sluggish. A diagnosis of a compartment syndrome of the calf and foot was made and a decision was made to perform emergency fasciotomy and debridement of the calf and foot with stabilisation of the fracture.

Fasciotomies of the calf were performed using two incisions and the foot with a single medial incision. The muscles of the posterior compartment, especially the deep flexor compartment in the distal part of the calf was found to be necrotic. Pus was also noted to be present within this compartment. The muscles of the anterior and lateral compartments of the calf were contracting well. The muscles of the foot were pale and oedematous. The obviously necrotic muscles were excised and the fracture was stabilised with Kirschner wires. Tissue cultures and swabs were sent and patient was commenced on intravenous metronidazole and cefoperazone.

The postoperative recovery was stormy and complicated. He developed acute renal failure and required haemodialysis. The kidney function subsequently returned to normal. On the third day postoperatively, the creatine kinase level was 2752 U/l whilst a urine sample did not reveal the presence of myoglobin. The dressings on the leg were changed daily in the ward but the condition gradually deteriorated. The tissue cultures grew Proteus species and the swabs grew Staphylococcus Aureus and Streptococcus Pyogenes group A.

At the second debridement under general anaesthesia, all the muscles of the deep flexor compartment and part of the superficial flexor compartment were found to be necrotic. The lateral and anterior compartments were oedematous but showed only slight necrosis. There was also extensive necrosis of the muscles of the foot. All necrotic muscles were debrided.

Following this, he was transfused with 6 units of packed cells. The albumin level dropped to 12g/l and he developed generalised oedema. The above elbow casts had to be bivalved and forearms rested in a backslab. Despite fresh frozen plasma transfusions, there was continued bleeding. The infection remained difficult to control and he required another examination under general anaesthetics. Pus was noted to have tracked to the posterior aspect of the thigh at this time. The muscles on the anterior and lateral compartments of the calf were completely necrosed and foul smelling and an above knee amputation was performed. The wound was closed to control bleeding, as the patient was haemodynamically unstable during surgery.

Thereafter, his condition gradually improved with supportive therapy and intravenous antibiotics. He developed slight wound dehiscence of the amputation stump but this was closed secondarily without further complications.

Discussion

The higher the intracompartmental pressure, the more rapid is the loss of neuromuscular function[8]. Intracompartmental pressure was not measured preoperatively and it is therefore not possible to comment on the severity of the raised pressure. The patient's high pain threshold meant that he did not ask for any analgesics nor seek help and this inevitably contributed to the delay in the diagnosis.

We are not aware of any other case report that describes a concurrent compartment syndrome of the foot and leg following an isolated epiphyseal fracture of the distal tibia and fibula. Six case reports described compartment syndrome of the calf only following ankle fractures or injury[1-6] while Manoli *et al*[7] reported 8 patients with concurrent compartment syndromes of the foot and leg, 2 of which were due to tibial pilon fractures. None of the cases of compartment syndrome were due to epiphyseal fractures of the distal tibia and fibula. This rarity of compartment syndrome following an epiphyseal fracture, and the late development of the compartment syndrome may also have contributed to the delay in diagnosis.

At the time of the fasciotomy, pus was noted to be present in the deep flexor compartment. This suggests that secondary infection of the necrosed muscle may already be present and the markedly elevated pre-operative white cell count of 30.2 x 10^{-3}/uL would support this. An intact skin is the best barrier against contamination and infection[8] but in this case, there was extensive necrosis and blistering of the skin. Thus the breakdown of the normal barrier and protection against infection may have allowed contamination of the necrosed muscle.

This case also highlights the continued difficulties of management after fasciotomies where there has been a prolonged period of compartment syndrome. Fasciotomy increases the risk of infection and septicaemia by exposing necrotic and damaged muscles to the environment[9,10]. The muscles, which were viable during fasciotomy and hence were not debrided, may not survive. Antibiotics will not reach the necrotic muscles and these muscles will provide further nidus for uncontrolled infection. Shaw[11] suggested that persistent oedema and elevated creatine phosphokinase levels are indicative of continued pathology and that repeated examination under general anaesthesia is warranted.

Although compartment syndrome after ankle injuries is uncommon, constant vigilance is nevertheless required to detect early and subtle signs when they do develop. This vigilance must be heightened for patients who may be uncooperative, non-complaining or obtunded. Early fasciotomy remains the cornerstone towards a successful outcome following a compartment syndrome. The role of fasciotomy after compartment syndrome has been established for greater than 10 hours needs to be carefully considered and delayed excision of the dead muscle may be the safer treatment[9].

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CASE REPORT

Compartment Syndrome of the Foot in a Child

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Summary

We report a case of a 12-year-old boy with acute compartment syndrome of the foot following a road-traffic accident. Due to the rarity of the injury, there was a delay in diagnosing the injury. An emergency fasciotomy was performed 19 hours after the injury. The foot healed with a mild extension contracture of the second toe.

Case Report

A 12-year-old boy was seen at our emergency department with gross swelling of his right foot after his foot was run over by a bus. The injury had occurred two hours earlier. He was unable to bear weight on that foot. His right foot was swollen, tense and tender with the toes appearing dusky. There was pain on dorsiflexion of the toes. The popliteal pulse was palpable however, both the dorsalis pedis and posterior tibialis pulses were not palpable. The plain x-ray revealed a fracture of his right fifth metatarsal (Fig. 1). He was admitted for circulatory observation and elevation of the foot. Due to the rarity of the injury, a compartment syndrome was not considered initially. The next morning, the swelling had increased with blisters over the dorsum of the foot and cyanosis of the second to fifth toes (Fig. 2). An emergency fasciotomy (19 hours after the injury) of all the compartments of the foot was done using two dorsal incisions, one medial and one lateral incision. The fracture was stabilized with a 2mm K-wire. The fasciotomy wounds were covered with split skin-grafts after 15 days. At follow-up one year later showed a mild extension contracture of his second toe was seen (Fig. 3). He was able to wear normal shoes and was asymptomatic.

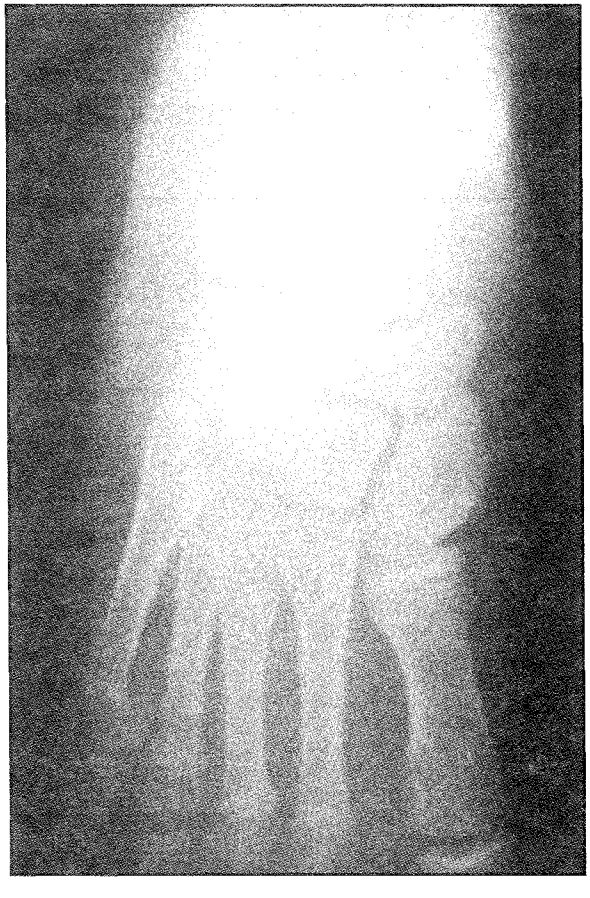

Fig. 1: Angulated fracture neck of the right fifth metatarsal.

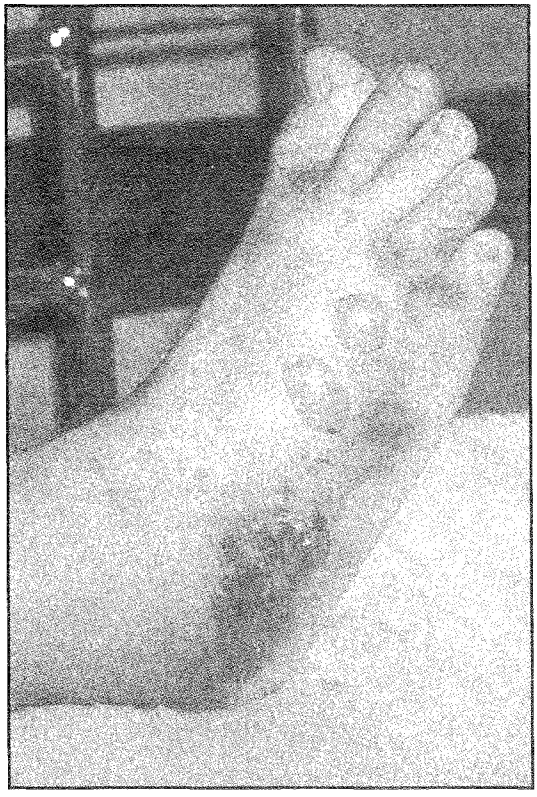

Fig. 2: Compartment syndrome with gross swelling, blisters over the dorsum of the foot and cyanosis of the second to fifth toes of the right foot.

Fig. 3: Mild extension contracture of the right second toe one year after the injury.

Discussion

Compartment syndrome of the upper and lower extremities are well recognized complications of trauma. However little is known about the manifestation and treatment of compartment syndrome of the foot as these injuries are often missed[1]. To the best of our knowledge, there have only been eight reported cases of compartment syndrome of the foot occurring in children[1].

Heckman and Champine stated that significant foot injuries must be identified and treated soon after injury by restoring the bony architecture, providing adequate soft tissue coverage and function and initiating early rehabilitation to ensure prompt restoration of the function of the foot[2]. The diagnosis of compartment syndrome of the foot is similar to other compartments of the body

In equivocal cases, tissue pressure monitoring aids in planning for treatment. Great emphasis is placed on early diagnosis to minimise ischaemic time and prevent long lasting consequences of ischaemia[3]. The foot serves a vital function such in weight bearing and locomotion. Ischaemic damage may lead to lead to a painful foot with stiffness and contractures of the toes. In our patient, there was ischaemic necrosis leading to the extension contracture of the second toe. At one-year follow-up he has remained asymptomatic. The contracture may require a release if it worsens and interferes with shoe-wear. Management of compartment syndrome includes complete decompression of all nine osseofascial compartments taking sufficient care of the soft tissue and skin of the foot. Wounds should be closed without tension either by secondary closure or by skin graft. The aim of this paper is to emphasize the importance of early recognition and immediate treatment of a compartment syndrome of the foot.

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CASE REPORT

Late Reconstruction of the Patellar Tendon

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Summary

A case of late reconstruction of the patellar tendon is reported. Besides partial loss of the tendon, the patient also had loss of the distal third of the patella. A rolled strip of fascia lata was used to reconstruct the tendon with tunnels through the patella. At the tenth month of follow-up, the result was deemed successful.

Key Words: Patellar tendon, Patella bone loss, Reconstruction

Introduction

Reports of late reconstruction of the patellar tendon are found for ruptures of the substance of the patellar tendon. It continues to be a rare and challenging procedure for orthopaedic surgeons[1]. This article describes the reconstruction of the patellar tendon using a rolled strip of fascia lata in a patient with loss of the patellar tendon substance and the distal third of the patella.

Case Report

A 45-year old man injured his right knee when the lorry he was driving was involved in an accident with another lorry. At the hospital he was found to have a comminuted fracture of the lower third of the patella (Fig.1). At surgery, the lower third fragments of the patella were excised through a transverse incision and tenodesis of the patella tendon to the remnant of the patella was done. A long leg cast was applied for six weeks, after which the patient was sent for physiotherapy. Physical examination at 14 weeks post trauma revealed that the right knee could be moved from zero to 130 degrees passively but active extension

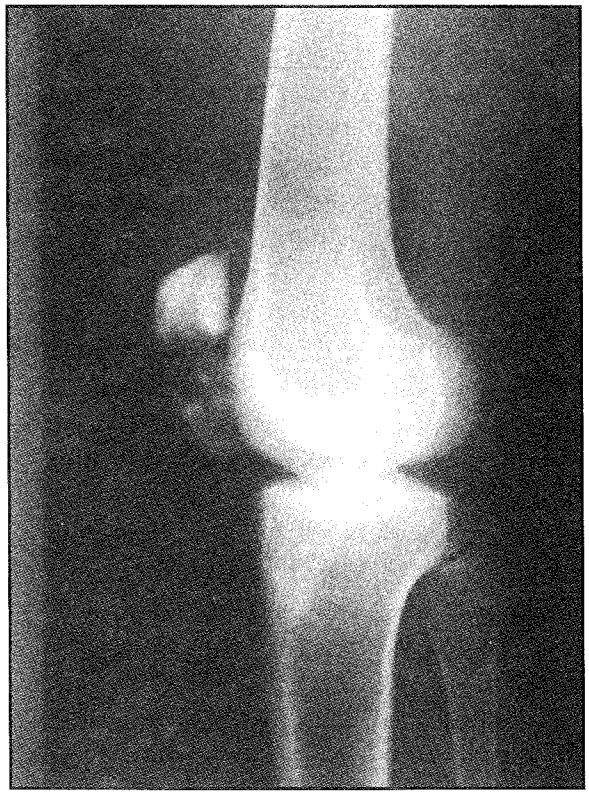

Fig. 1: Lateral radiograph of the initial fracture.

lacked the final 45 degrees. The patella was positioned two centimetres more proximally than on the normal side. There was severe thigh muscle atrophy. Further intensive physiotherapy was carried out but there was no further improvement. He complained of difficulty in climbing up and down steps and did not feel confident in driving his lorry as he was "slow on the brakes".

Eighteen months later, reconstruction of the patellar tendon was carried out.

Materials and Methods

A zigzag incision was done to accommodate the original transverse incision across the patella with the proximal limb medial to and the distal limb lateral to the patella. After excising the scar tissue at the previous surgical site, two-thirds of the proximal part of the patella and the distal half of the patella tendon remained. The defect between the two was 3 centimetres. A long strip of fascia lata was harvested from the contralateral thigh measuring 25 centimetres in length and 2 centimetres wide. This was then rolled onto itself and held with a series of absorbable sutures to make it into a long cylindrical cord.

A scalpel blade was used to create an opening through the remnant of the patellar tendon near its attachment to the bone. Next, a large oblique drill hole was made beginning slightly lateral to the centre of the inferior raw surface of the patella and exiting supero-laterally at 10 o'clock. Another similar drill hole was made slightly medial to the centre of the patella and exiting supero-medially at 2 o'clock. The ends of the fascia lata were threaded through the two holes. With the knee held in full extension, each end of the fascia lata was pulled taut, folded distally and sutured onto itself (Fig. 2).

A cerclage wire was threaded circumferentially through the quadriceps tendon and the tibial tubercle and tightened with the knee in extension. A plaster backslab was applied and

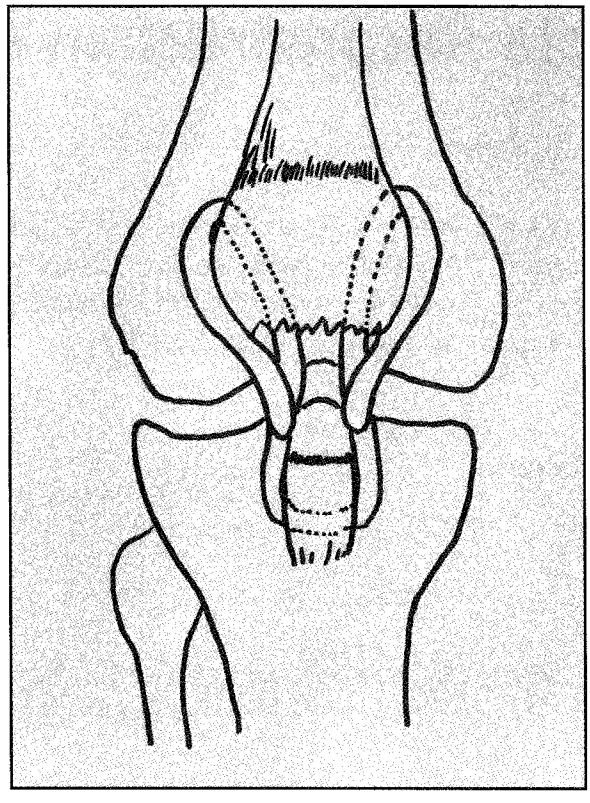

Fig. 2: Configuration of the fascia lata in the reconstruction.

intentionally broken while drying so as to allow a few degrees of immediate movement postoperatively. The cerclage wire and cast were removed at six weeks and a vigorous programme of physiotherapy started.

The patient was last seen ten months after the surgery. At that time, the passive range of motion was from zero to 130 degrees and the active range of motion was -5°-130° (extension lag of 5 degrees) (Fig. 3). He was pleased with the result and had returned to work as a lorry driver.

Discussion

Discontinuity of the patellar tendon is an uncommon occurrence. Most reported cases involve traumatic rupture or laceration of the substance of the tendon itself. It can also occur after surgery in which the insertion of the tendon

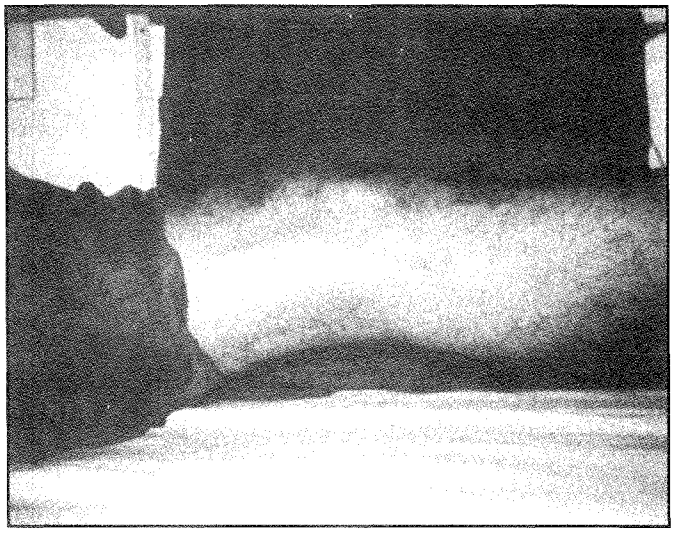

Fig. 3a+b: Range of movement in flexion and extension at 10 months.

has been disturbed. In our patient, there was loss of the proximal half of the tendon as well as the distal third of the patella, leaving a gap of 3 centimetres. We think that it is important to allow a few degrees of movement in the immediate postoperative period to prevent adhesions which might affect the active flexion of the knee later on. We did this by gently breaking the plaster-of-paris backslab while it was drying. It was easier to apply than a standard hinged cast brace; was lighter for the patient and allowed better monitoring of the long wound necessitated by a previous transverse incision. Various methods of repair of the patellar tendon have been described, using the gracilis muscle, the semitendinosus muscle, allografts and also Dacron grafts. External pins and wires have often been used to immobilise the knee[2,3]. Our method of using the fascia lata, cerclage wire and plaster backslab is simple and effective and can be done in any local hospital with an orthopaedic unit.

Acknowledgement

This study was done at the Faculty of Medicine, Universiti Kebangsaan Malaysia unit while it was still situated at the Kuala Lumpur Hospital. We thank the dean of the Faculty of Medicine, Universiti Kebangsaan Malaysia for permission to publish this paper.

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CASE REPORT

Delayed Decompression of Chronic C1C2 Subluxation in a Pediatric Patient with Tetraplegia - Is Recovery Possible?

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Summary

A 2 year-old Malay girl was admitted to our institution with a chesty cough and breathlessness but later found to have a chronic C1/C2 subluxation for one and half year with tetraplegia. Her cervical cord was decompressed and occipito-cervical fusion performed. Her neurological status improved significantly post-operatively and is able to care for her personal hygiene. The authors believe that the ability of the cervical cord to recover in the paediatric age group is remarkable that surgical option should be considered even when all seen lost. We believe that this is the first report in the literature to support this potential.

Key Words: Cervical spine, Delayed decompression, Posterior fusion, Subluxation, Tetraplegia

Introduction

Cervical spine trauma is relatively uncommon in the pediatric age group compared to adults. Patel *et al*[1] has found that upper cervical spine injuries is more common in children less than 8 year-old and that atlanto-occipital dislocation is more likely to result in mortality in this age group. There is a great need for doctor to be vigilant especially in children who cannot communicate. X-rays are difficult to interpret as the odontoid peg may be cartilaginous and occasionally a CT Scan may be necessary to confirm the clinical suspicion. Occasionally, some patients may present late and clinical decision as to the management is not clear.

Case Report

A 2 year-old Malay girl was brought to Pediatric Unit, University Hospital Kuala Lumpur from another hospital complaining of chesty cough and breathlessness for 3 days. She required mechanical ventilation support and could not been weaned from the ventilator. Subsequent x-rays by conscientious pediatricians detected the C1/C2 subluxation.

Two years ago, she accidentally fell from her father's arms and onto a piece of logwood at the age of 6 months. She was unconscious, not moving her limbs since then. She was sent to the hospital and found to subdural haematoma from

a fracture of the cranium. She was initially unconscious and had an emergency craniotomy at the occipital area. She was ventilated for one month in that hospital and later recovered consciousness. Before discharge, she was noted to be unable to move her limbs voluntarily with periodical leg spasms.

The clinical examination at this admission showed that she was completely quadriplegic with an indwelling catheter and was tachypneic from the broncho-pneumonia. She was conscious and responded to call. Her pupils were 3mm in diameter, equal and reactive to light bilaterally. A cranial defect in the left parieto-occipital region was palpable. Neurological examination showed hyper-reflexia, generalised hypertonicity and presence of clonus but no spontaneous voluntary movements. Rectal examination showed that the anal tone was lax.

The day after admission to the pediatric ward, she had a generalised seizure which required intubation and ventilation. There was problem of extubation due to persistent poor respiratory effort. The cervical x-rays showed a chronic irreducible C1/C2 subluxation (Fig. 1).

A MRI of the cervical spine confirmed atlanto-axial subluxation with compression of the spinal cord by the odontoid peg with adjacent syrinx formation (Fig. 2) CT Scan of the brain showed gliosis in the left parietal region with dilation of the ipsilateral lateral ventricle. A bony cranium defect in the left parietal region was seen.

The EEG showed high voltage slow wave discharges at the parietal region but no epileptiform waves were seen. Fluroscopy of the diaphragm showed right sided diaphragm paralysis.

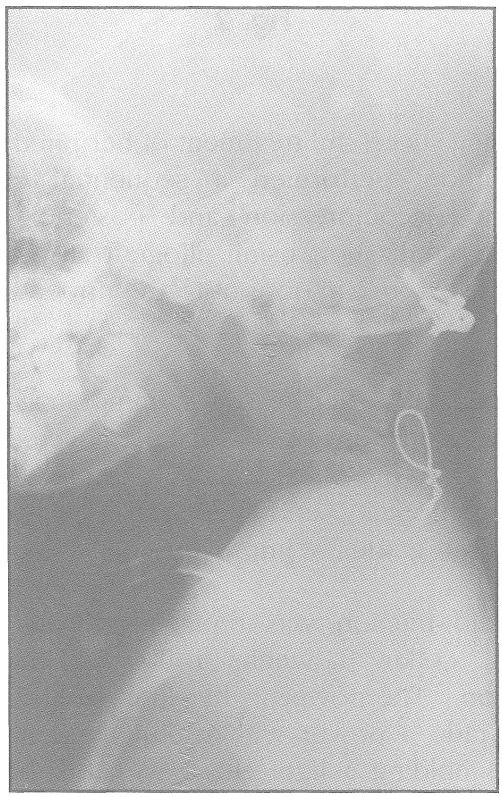

Fig. 1a &1b

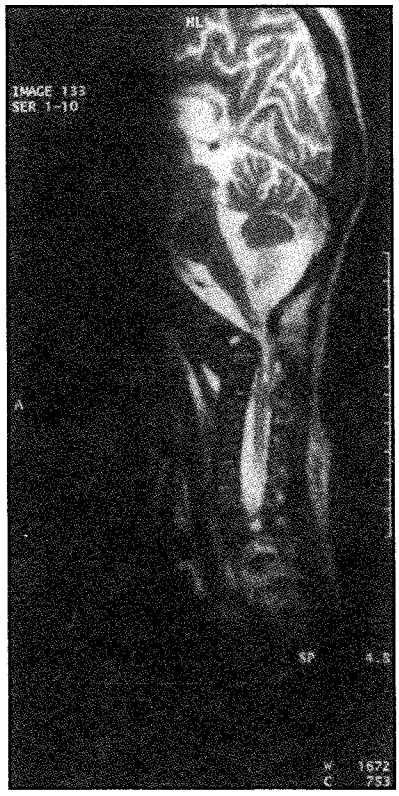

Fig. 2

Following successful treatment of her pneumonia, the authors performed a sequential anterior transoral decompression and posterior upper cervical stabilization using allograft strips which was wired from the occiput to the upper cervical vertebrae on the same day.

Post-operatively, her head was immobilized in an Halo-vest and was noted to have recovered some movement in her limbs with MRC grade 3 power. Her hypertonicity and hyperreflexia remained initially but gradually improved.

The Halo traction was replaced by an Aspen cervical collar 8 weeks following the first operation. The power in her limbs improved to MRC Grade 4 power with useful hand function such as holding a light children's story book in her hands. Real-time ultrasound revealed that her right sided diaphragm was moving well.

She continued to have neurogenic bladder and reflux nephropathy. However, her neurology suddenly deteriorated one week after the Aspen collar was removed and new x-rays showed that the subluxation had recurred and she was tetraparetic. Emergency exploration showed that the allograft had fractured and there was non-union of the occipito-cervical fusion. The fixation was replaced by a modified luque rectangle from 2mm diameter k-wires secured to the spine by spinous process wires. Autograft bone was harvested and applied.

Six month after revision surgery, she has regained MRC grade 4 power with ability to take care of her own personal hygiene. She still requires assisted ventilation via a tracheostomy at night even though the diaphragm function is present.

Discussion

Cervical Spine fracture is not a common problem in children compared to adults. Missed upper cervical spine fracture and dislocation is a frequent problem especially in young children who are too young to communicate[2].

In this case, the head injury had compounded the problem resulting in a missed C1/C2 injury. Sin and Ullman 3 had highlighted the association of head injuries and cervical trauma resulting in tragic consequences when missed.

The prognosis of a child with chronic complete quadriplegia especially one with chronic assisted ventilation needs is not known. To the best of our knowledge, there is no written article to guide us as to the result of surgery in this group of patients. There is a moral and ethical issue as to whether extensive surgery is warranted. It is known that the hypermobility of the cervical spine and the sensitive nature of the developing spinal cord in children increased the risk of neurological deficits even without radiological abnormally.

The chance of neurological recovery seemed remote in this case. However, we believe in the enormous potential for tissue to heal even neural tissues in young child and decided to performed anterior trans-oral decompression followed on the same day by posterior stabilization.

This proved to be an enormous task in a two-year old child. Intra-operative artificial ventilation via an endotracheal tube blocked access to the posterior pharyngeal wall and we decided on tracheostomy tube which at this age is very short and tend to dislodge during surgery especially when the patient is prone.

Posterior fixation is another problem where the spinous processes and laminae are fragile in the age-group. Despite the great osteogenic potential, the choice to use allograft is incorrect in a pediatric patient and autograft is highly recommended.

Conclusion

This is an anecdotal report of useful neurological recovery of a young child with complete quadriplegia for two years following surgical intervention. It demonstrates the remarkable ability for neural recovery at this age and provide and a useful lesson that extensive surgery even after such a long period of compression can be fruitful.

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CASE REPORT

Neurological Deficit After Surgery for Spinal Deformity - The Value of Normal Intra Operative Wake-up Tests in Large Sagittal Curves. A Report of Two Cases From an Institution

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Summary

Neurological deficit after surgery for spinal deformity is a rare but devastating complication. Factors that have been associated with a post surgical deficit are congenital curves, large curves, kyphotic deformities, anterior and posterior surgery, ligation of multiple anterior vessels and hypotension; controlled or otherwise. Intra operative wake up tests have been used alone or in combination with spinal cord monitoring; to detect evolving neurological deficit in spinal deformity surgery. Despite these checks, major neurological deficits still occur post surgery. This is a report of two cases with normal intra operative wake up tests, but developed neurological deficit twelve hours after the end of surgery.

Key Words: Wake up test, Neurological deficit, Kyphosis

Introduction

Neurological deficit after surgery for spinal deformity is a rare but devastating complication. MacEwen[1] reported an incidence of 0.72% neurological deficit without spinal cord monitoring. Forbes[2] reported an incidence of 0.27% neurological deficit with spinal cord monitoring, with a 10.2% detection of abnormalities in the SEP. Potenza and Weinstein[3] have reported early intra operative detection of an evolving deficit with SEP monitoring. However, many factors have been implicated in 'false positive' detection of neurological deficit where the SEP deteriorates in the absence of any clinical disturbance[4]. Since SEP monitor ascending pathways in the spinal cord, the question of motor pathway preservation in a spinal procedure has to be addressed; as motor deficit may also occur in normal SEP[5,6]. The well established wake up test[7,8,9,10] is the only effective way to monitor intra operatively; motor activity of the lower limb by reversing muscle relaxants and partially waking a patient during a spinal procedure. Two cases are reported where an intra-operative wake test was performed with good lower limb movement, but the patients developed major neurological deficit after surgery.

Materials and Methods

Two patients who developed major neurological deficit after surgery for spinal deformity at this institute are reviewed. They are from a cohort of 82 patients who underwent surgery for scoliosis (of various etiologies) at our institute from 1985 to 1998. The mean preoperative curve of the cohort was 70 degrees (range 37 degrees to 150 degrees) and the mean age of surgery was 14 years (range 2.5 years to 44 years). A wake-up test was performed routinely in all cases except in patients younger than 10 years, and in those who are unable to cooperate.

Results

Case 1

A 14 year old girl presented with a 5 years history of progressing spinal deformity. She appeared Marfanoid and had a right sided thoraco lumbar scoliosis with apex at T11, measuring 90 degrees between T8 and L2 on frontal traction radiograph (Fig. 1A); and 128 degrees on erect frontal radiographs. Lateral radiographs showed a smooth kyphosis measuring 90 degrees from T4 to L2 with apex at T9 (Fig. 1B). She was normal neurologically. A right transthoracic, intrapleural, transdiaphragmatic, retroperitoneal approach with release of the anterior longitudinal ligament and vertebrectomy of T11 was performed. She developed a pneumonia post operatively, and the posterior fusion with sublaminar wiring with partial correction of coronal plane to 58 degrees and sagittal plane to 60 degrees (Fig. 2A and 2B) was performed 28 days later when her pneumonia cleared. She had a normal intra-operative wake up test, moving both her lower limbs. However, 12 hours after surgery she developed painful spasms in her right thigh, which progressed to clonus[11] in the right ankle. She became paraparetic in both lower limbs the next day with power of Grade 2/5.

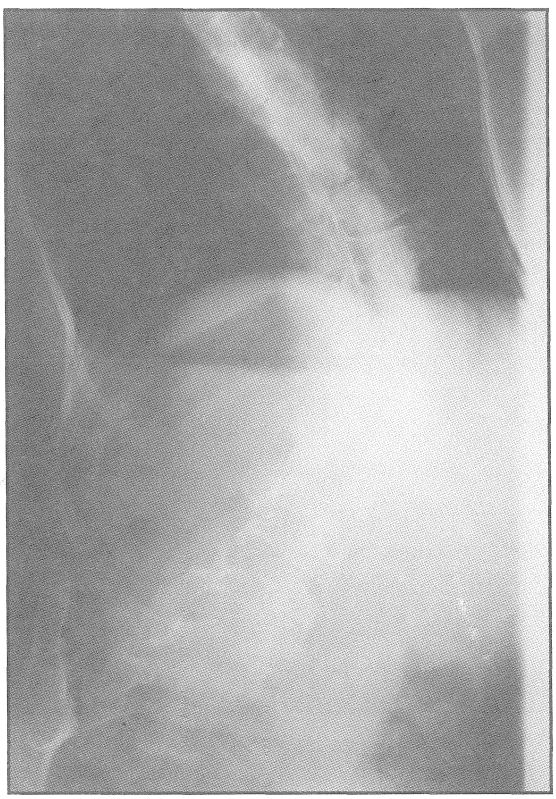

Fig. 1a: Case 1 Preoperative Frontal view.

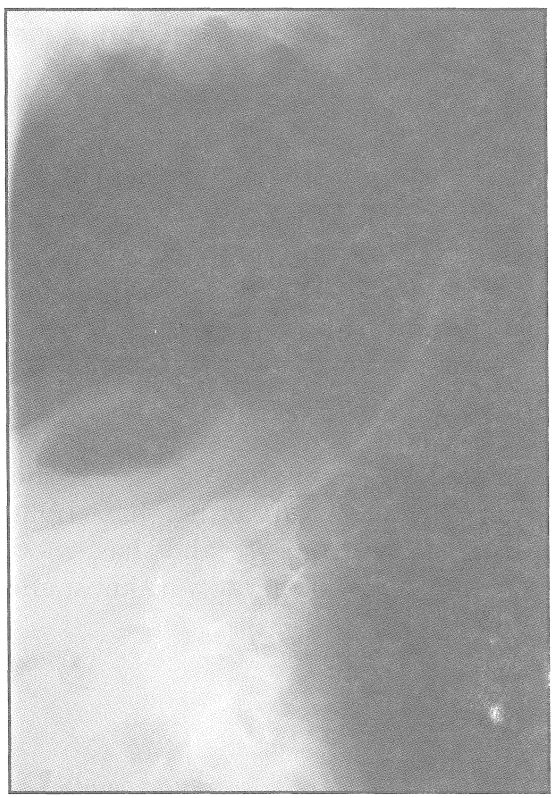

Fig. 1b: Case 1 Preoperative Lateral view.

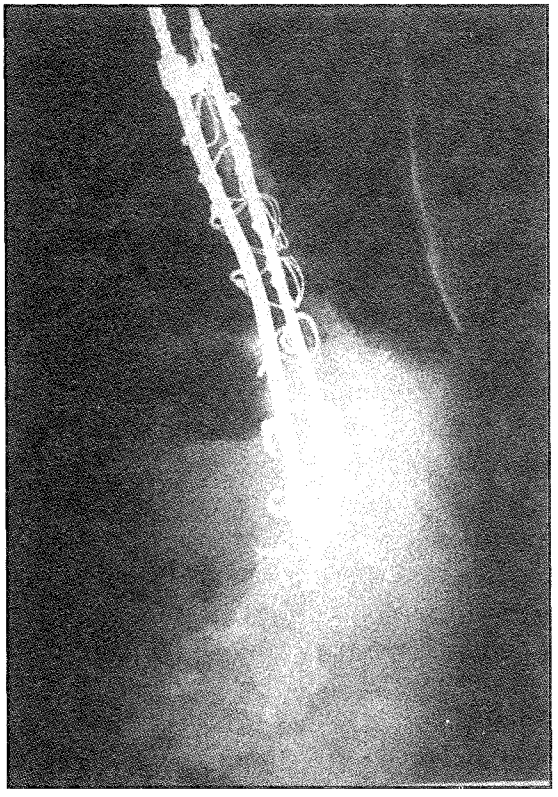

Fig. 2a: Case 1 Postoperative Frontal view.

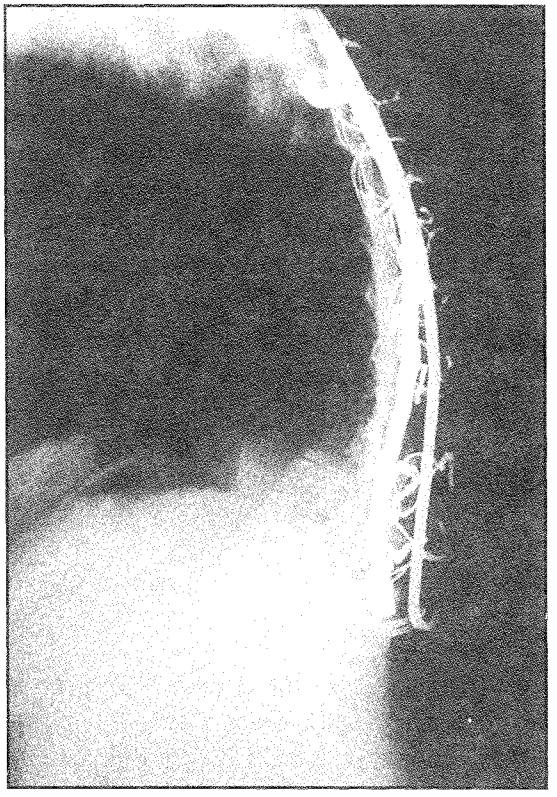

Fig. 2b: Case 1 Postoperative Lateral view.

A CT scan of the spine showed no mechanical obstruction to the cord at the apex (Fig. 3). An emergency exploration of the apex was performed via a posterior approach with direct inspection of the cord at the apex, the cord was noted to be pulsating normally, and not under tension. An intra-operative myelogram showed free flow of dye through the cord and confirmed no mechanical obstruction on the cord. She was walking unaided at 6 months, with a spastic gait. Six years post surgery, she has right leg weakness of grade 3+/5 and has moderate spastic contractures of her lower limbs, and can walk unaided.

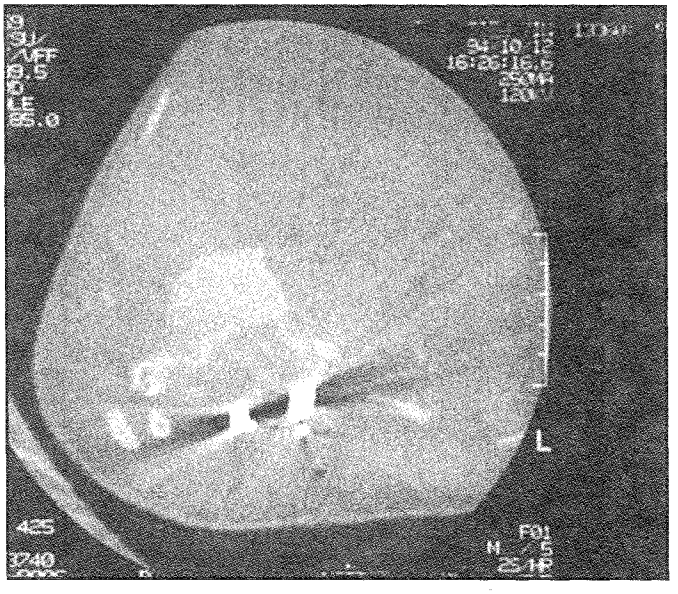

Fig. 3: Case 1 Axial CT scan of apex showing no mechanical obstruction on the cord.

Case 2

A 14 years old boy presented with a fast progressing right sided deformity of the back which was noted for 5 years. Radiographs showed a sharp, angular kyphoscoliosis with

apex at T10 and T11; measuring 150 degrees in the frontal plane from T9 to L1, 150 degrees from T9 to L1 in the sagittal plane erect, and 90 degrees in the sagittal plane with traction (Fig. 4). He was normal neurologically. Although not clearly visualized in imaging, a diagnosis of congenital vertebral anomaly due to failure of formation was made. MRI of the spine did not show any intradural anomaly or tethering of the cord, and could not elucidate the vertebral anomaly. A right transthoracic, intrapleural, transdiaphragmatic, retroperitoneal approach with release of the anterior longitudinal ligament and vertebrectomy of T11 was performed. Right convex postero-lateral closing wedge osteotomy of the apical region with mild distraction with rod in the concavity; was performed one week later. Wake-up test was normal with both limbs having full power. Twelve hours after surgery he developed weakness of the left foot; this progressed rapidly to paraparesis and sensation loss in both lower limbs and loss of anal tone. An immediate myelogram and post myelogram CT of the spine showed free flow of the dye in the cord (Fig. 5). Emergency exploration with removal of the rod was done. He was put on a TLSO for 6 months. There was return of muscle power to grade 2/5 in one week; with bladder and bowel control in 6 weeks. He was walking unaided with a spastic gait at 3 months. Thirty months after surgery he is walking with a spastic gait and had power of 4+/5 in the left lower limb.

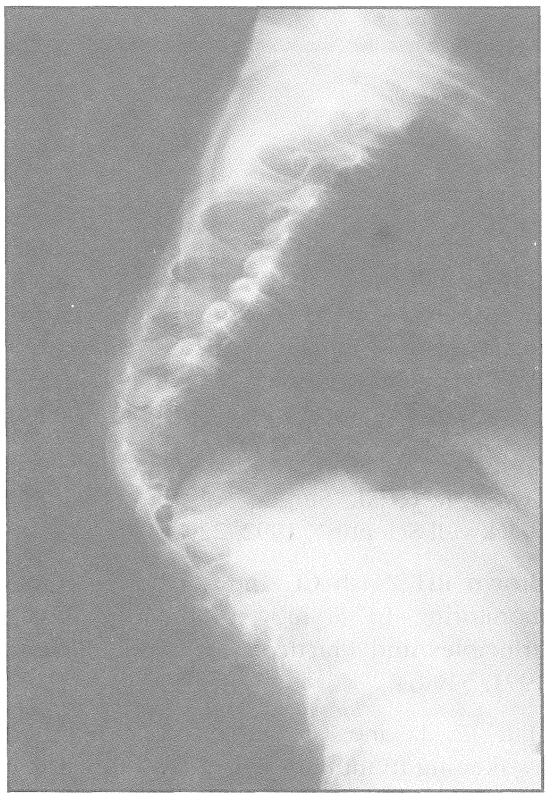

Fig. 4: Case 2 Preoperative lateral traction view.

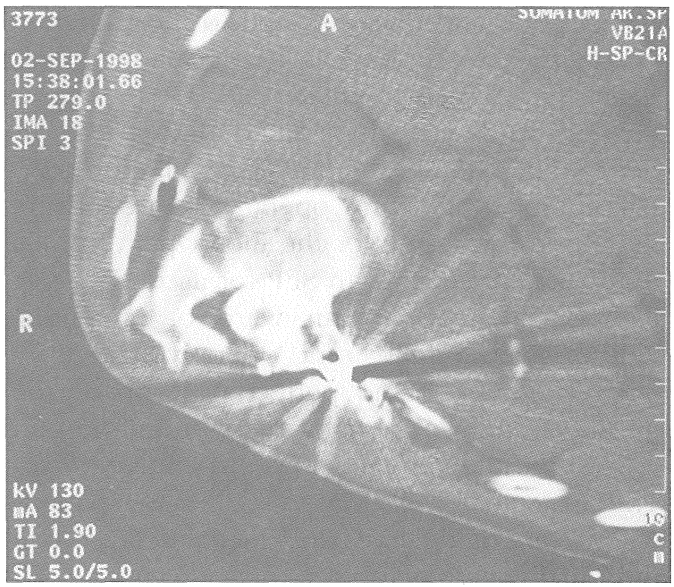

Fig. 5: Case 2 Post myelogram CT of apex showing no mechanical obstruction on the cord.

Discussion

Factors that have been associated with a post surgical neurological deficit are congenital curves[1,12,13,14], large curves[12,14], kyphotic deformities[12,13,14], anterior and posterior surgery[1,12,14], ligation of multiple anterior vessels[12,13,14,15] and hypotension[13,14,15,16,17], controlled or otherwise. Post operative neurologic deficits have been reported to occur despite unchanged intra operative SEP[5,6]. Ischaemia of the cord resulting in dysfunction; is also supported

widely[1,14,16,17], and demonstrated to most likely to occur in the low thoracic region of the cord[18]. Both the cases presented had all the above factors, and are considered high risk for neurologic injury in any spinal corrective procedure. While intra operative cord function monitoring, whether for the motor pathway like the wake - up test or an SEP for ascending tract function monitoring; can warn of impending neurological deficit intra operatively[2,3,7,8,9,15,19,20], there still remains no perfect way, apart from good clinical observation to monitor cord function in the immediate post operative period. This may not be good enough for the patients with severe rigid curves, in which a delayed cord dysfunction with major deficit can occur.

The rate of major spinal cord dysfunction in our center is 2.5 percent, which is very high compared to other centers[1,2]. This is despite the fact that surgeons, anesthetists and post operative care team at our center have a lot of experience with anterior spinal surgery as a consequence of our exposure to performing the same procedures for spinal tuberculosis. A major factor for this high incidence is that the majority of our spinal deformity patients present late for treatment, at a mean age of 14 years with rigid coronal and sagittal curves at a mean of 70 degrees, which makes surgery full of risks.

Conclusion

Major neurological deficit of the spinal cord can occur in the presence of a normal intra operative wake-up test. While this can be picked up as it gets worse in the immediate post operative period, there remains no effective way to monitor motor tracts in this period, except by good clinical care by the post operative team. High index of suspicion must still prevail even if intra-operative monitoring is normal.

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CASE REPORT

Ewing's Sarcoma of the Talus in a Four-Year-Old Child

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Summary

Ewing's sarcoma is a rare malignant tumor of the foot in children. We report a case of Ewing's sarcoma of the talus in a four-year-old Chinese girl to highlight the initial difficulty in diagnosis and the clinical course of the disease. She was initially diagnosed as osteomyelitis of the talus and died eight months after presentation with pleural and spinal metastases. To the best of our knowledge, Ewing's sarcoma of the talus in a young child has never been reported in Malaysia.

Case Report

A four-year-old Chinese girl was admitted to our hospital in June 1999, with a history of recurrent right ankle pain, swelling and low-grade fever of five months duration. In March 1999, she had a skin infection over her right ankle and was treated with antibiotics by a general practitioner. She had a normal perinatal history and had completed her immunization. There was a strong family history of malignancy. Her grandfather, grandmother and uncle had died from nasopharyngeal carcinoma, breast carcinoma and hepatoma respectively.

Clinically, she was a febrile and of average built. The gait was antalgic. There was a firm, mildly tender, diffuse swelling on the lateral aspect of the right ankle. The range of ankle movement was normal. The right inguinal lymph node was palpable and measured 1cm in diameter. The liver and spleen were not enlarged. Both lungs were normal. The total white count was normal and the erythrocyte sedimentation rate was 46 mm/hour. The plain x-ray was reported as osteomyelitis of the right talus (Fig. 1). She was treated empirically with antibiotics and analgesics and subsequently discharged. Her ankle swelling and pain were reduced at follow-up one week later.

One month later, she was readmitted in another hospital with a cough and progressive swelling of the right ankle. The CT scan of the thorax showed a metastatic lesion and an effusion in the left pleural cavity. A biopsy of the right ankle showed small synovial villous nodules consisting of local proliferation of endothelium. There were no malignant cells seen.

She was transferred to our hospital when the left pleural effusion worsened. A chest tube was inserted and her condition improved in the intensive care unit. A repeat biopsy of the talus and left pleural were done after a few days when her general condition improved. Intra-operatively, the right ankle showed a friable whitish tissue infiltrating the synovium and talus.

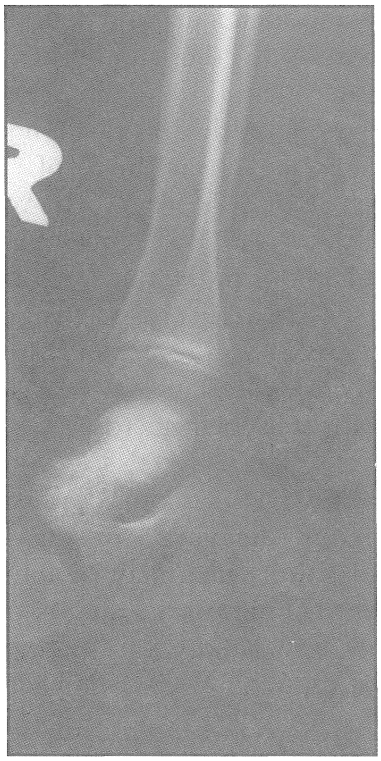

Fig. 1: X-ray of the right ankle showing sclerosis of the talus.

Histopathological examination confirmed an Ewing's sarcoma. Microscopically, the tumour consists of small round cells. The cells react with MIC2 antibodies. The leucocyte common antigen was negative and the actin, desmin and myoglobin markers were absent (Fig 2 a and b). She was referred to the oncologist for radiotherapy and chemotherapy. The pleural effusion resolved dramatically within 5 days of radiotherapy. Combination chemotherapy (consisting of ifosphamide, vincristine and adriamycin) was commenced.

During chemotherapy four months later, she developed an acute onset of paraplegia. A bone scan did not show any increased uptake in the spine but the MRI of the spine showed multiple metastases to the thoracic and lumbar spine with extradural compression of the spinal cord at the level of the second and third lumbar spine. She had radiotherapy to the spine but there was no neurological recovery.

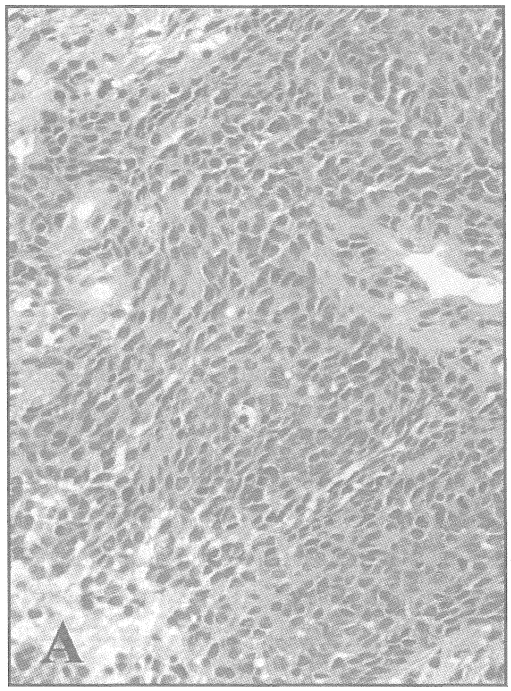

Fig. 2 A: Photomicrograph of the ulnar lesion showing small round cell infiltrate (hematoxylin and eosin x 200).

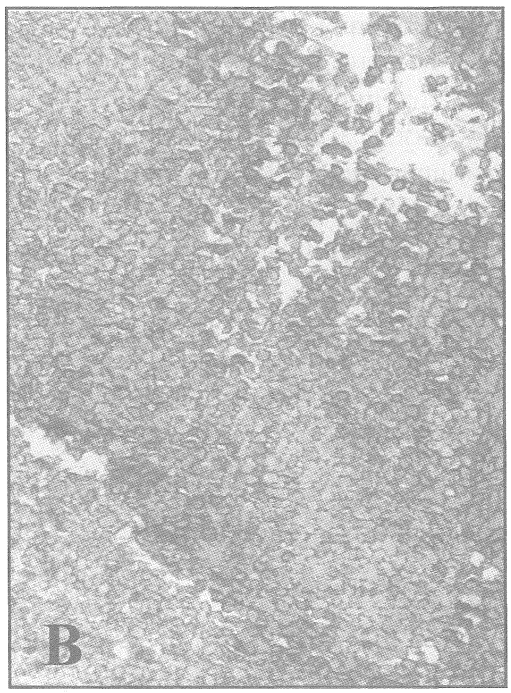

Fig. 2 B: Photomicrograph of the small round cells reacting positively with MIC 2 antibodies (immunoperoxidase x 200).

In February 2000 she received another course of chemotherapy. Adriamycin infusion was given over one hour, followed by ifosphamide infusion over 3 hours. After two hours of intravenous ifosphamide, she died suddenly, most probably due to a cardiac arrest.

Discussion

Ewing's sarcoma is a malignant, non-osteogenic primary tumor of bone. James Ewing in 1921 first reported a 14-year-old girl with a lytic lesion of the ulna that responded dramatically to radiotherapy (cited in Vlasak and Sim, 1996)[1]. Ewing's sarcoma in young children is rare, highly malignant, and when at an unusual site it is often difficult to diagnose. Because the prognosis of metastatic Ewing's sarcoma remains poor, early detection is the best hope for long-term survival. Durbin *et al*[2] noted that the delays in the diagnosis of Ewing's sarcoma in young children were due to several reasons.

Firstly, since most bony lesions in this age group are benign, malignancy would be low in the list of differential diagnosis. Secondly, only 8% of all childhood malignancies occur in the bones and Ewing's sarcoma accounts for only 25% of these bone malignancies, the remainder being mainly osteosarcoma or chondrosarcoma. Thirdly, only 3% of Ewing's sarcoma occurs below the age of three as the majority of patients are in their second decade of life. Fourthly, the diagnosis may be overlooked when the lesion occurs in an uncommon site as the talus, instead of the long bones, pelvis, or ribs.

Adkins *et al*[3] reported a marked delay in diagnosis when it occurs in the hind-foot (mean, 22 months) rather than in the forefoot (mean, 7 months). There is little information specifically addressing Ewing's sarcoma of the talus. Weissman et al in 1966 (cited in Adkins *et al*, 1997)[3] reported an 18-year-old girl with an osteosclerotic tumor in the talus that initially was treated for avascular necrosis. Pandey in 1970 (cited in Adkins *et al*, 1997)[3] similarly reported a patient with an osteosclerotic talar lesion who was treated for avascular necrosis.

In addition, Ewing's sarcoma can simulate an infection hence delaying the diagnosis. The symptoms of pain, which may be intermittent as in this patient is often misleading and especially so when it is associated with swelling and fever and could be mistaken for osteomyelitis[1,2].

A definite diagnosis of Ewing's sarcoma was made based on special staining and immunohistochemical studies. This was not done for the first biopsy. Our patient had metastases to the lungs and spine. Pritchard *et al.* (cited in Durbin *et al*, 1998)[2] found that 25% of Ewing's sarcomas have metastasized at the time of diagnosis. For non-metastatic Ewing's sarcoma the 5-year, disease free survival is 70%, whilst for metastatic disease, it is only 33%[2]. Adriamycin may have caused cardiac toxicity in our patient.

Acknowledgment

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CASE REPORT

Peroneal Nerve Palsy Secondary to Proximal Fibular Osteochondroma - A Case Report

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Summary

The author reports a case of a 11-year old child presented with peroneal nerve entrapment secondary to proximal fibular osteochondroma, with complete recovery of function following the excision of the tumor.

Key Words: Osteochondroma, Fibula, Peroneal

Introduction

Compressive neuropathy caused by osteochondroma is not a new phenomenon[1]. This is true especially in patients with multiple hereditary exostosis. However, reports of isolated peripheral compressive mononeuropathies secondary to osteochondroma are scarce, and involvement of the common peroneal nerve has not been reported in a sizeable group of patients.

Case Report

A 11-year old girl was first seen at the Orthopaedic clinic on the 11.11.1998. She presented with a swelling over the lateral aspect of the left knee since a month duration associated with weakness of the left foot. There was no history of trauma. Physical examination revealed a hard irregular mass arising from proximal part of the left fibula. There was sensory loss over the peroneal nerve distribution and the patient had a footdrop. Plain radiograph revealed a bony outgrowth arising from the neck of the left fibula (Fig 1). Patient underwent a surgical exploration and tumor excision on the 24.11.99. Intraoperatively, a huge cartilage capped mass arising from the metaphyseal region of the left fibula measuring 4cm x 2cm x 1cm was found compressing the common peroneal nerve. The histopathological report came back later as an osteochondroma.

Patient was started on an intensive physiotherapy after the surgery. Subsequent follow-up showed remarkable return of the left foot function. The compressive neuropathy was completely resolved one year after the surgery.

Discussion

Osteochondroma of the proximal fibula is relatively common, but reports of associated peroneal nerve palsy have been scarce[2]. Cardelia *et al* [3] in their review reported only six patients over 8 years period. Solitary osteochondromas are commonly first seen as painless masses with no

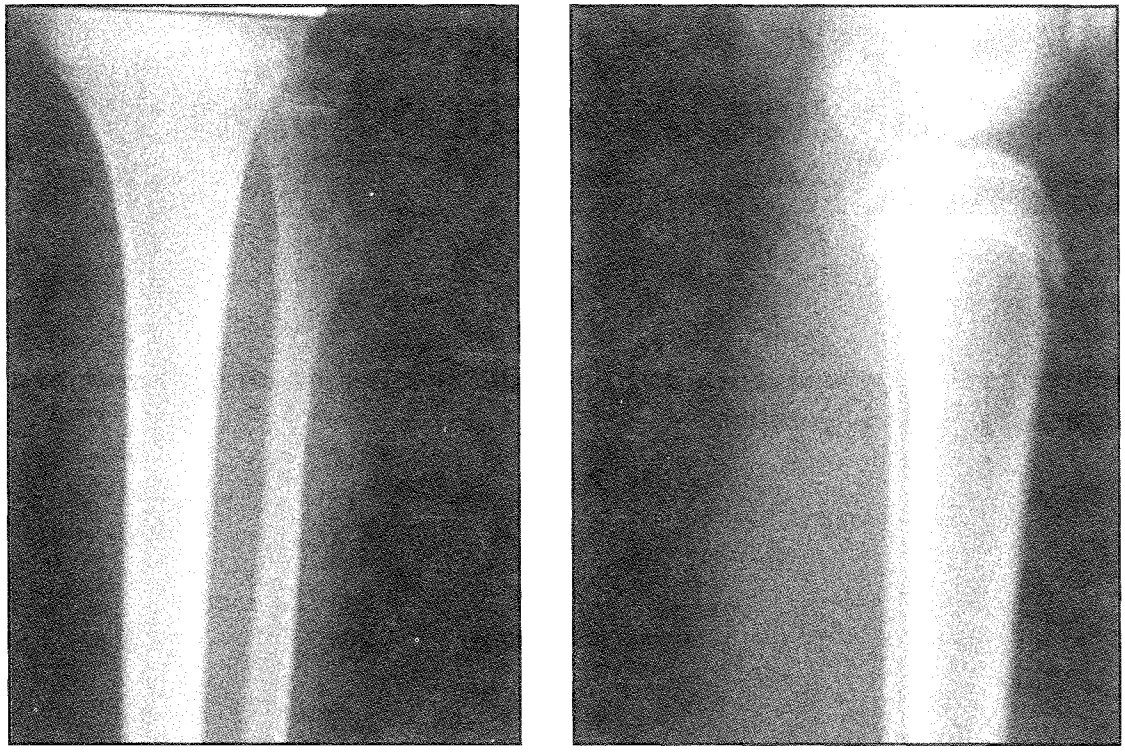

Fig. 1: Plain radiograph revealed a bony outgrowth arising from the neck of the left fibula.

associated symptoms. Symptoms, when present, may be due to impingement of contiguous tendons, major blood vessels or nerve, contusions, or impediments to joint movements. Malignant change have been reported in a few cases. Preoperative nerve conduction study can detect conduction delay at the fibular head despite the fact that only 50% of the patients showed only trace or no neurological deficits on physical examination[3]. Our patient presented with obvious common peroneal nerve palsy and nerve conduction study was not deemed necessary. Not all exostosis should be excised. Surgical intervention is usually indicated for cosmetic reasons or when producing symptoms. Intraoperatively, a direct attenuation of the nerve by the osteochondroma is commonly seen in reported cases and the gross appearance of the nerve is similar to changes observed in other forms of compressive peripheral neuropathy. Chronic compression might lead to the formation of a fibrous constrictive sheath around the nerve.

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