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ORIGINAL STUDY

Cost analysis of managing paediatric femoral shaft fractures : Flexible intramedullary nailing versus non-operative management

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This retrospective study aimed at comparing the cost of operative treatment versus non-operative treatment in the management of isolated paediatric femoral shaft fracture, in a single Trauma and Orthopaedic unit in a district general hospital in South East England. Patients were divided into three groups according to their treatment, and the cost was analysed depending on their requirements for hospital stay, theatre, physiotherapy, radiographs and plaster cast.

Sixty-two children were admitted to our trauma unit with an isolated femoral shaft fracture from January 2001 to April 2005.

There is a significant variation in the cost between the 16 patients treated with operative flexible nailing in comparison with those treated non-operatively either by traction alone (31 patients), or by traction followed by cast (15 patients). Operative treatment was shown to reduce the inpatient stay by approximately 75% (mean of 9.8 days in the operative group in comparison to 39.3 days in the non-operative group). It has also reduced the overall cost for treatment by more than 60% in comparison to traction alone and by almost 30% in comparison to using traction followed by casting.

Keywords : paediatric trauma ; femoral shaft fractures ; cost.

INTRODUCTION

Fractures of the femoral shaft in children are caused by major musculoskeletal trauma and often result in a lengthy treatment process, which has a cost implication on the National Health Service as well as the child's family (*7, 8*). Treatment of such an injury varies according to the skeletal maturity of the child and to the surgeon's preference. Fortunately, this injury is known to have a generally good outcome regardless of the treatment options (*1, 10*). In our study we focused on the cost of different treatment modalities in treating femoral shaft fractures in children in order to analyse the cost. The following parameters were studied : the cost of the hospital stay, theatre running cost, radiographs expenses, physiotherapy and plaster cast costs.

METHODS

A retrospective cost analysis was performed of all children admitted to our trauma unit with an isolated femoral shaft fracture between January 2001 and April 2005. Patients were treated, either by Intramedullary

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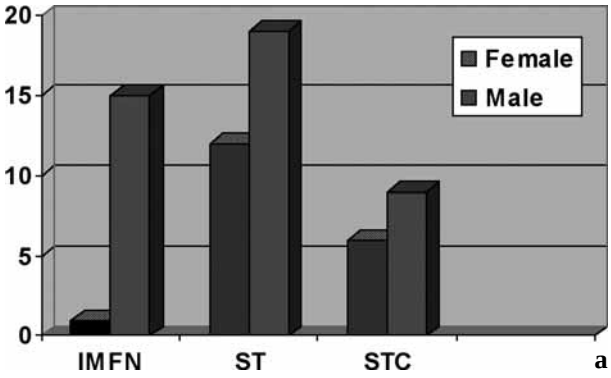

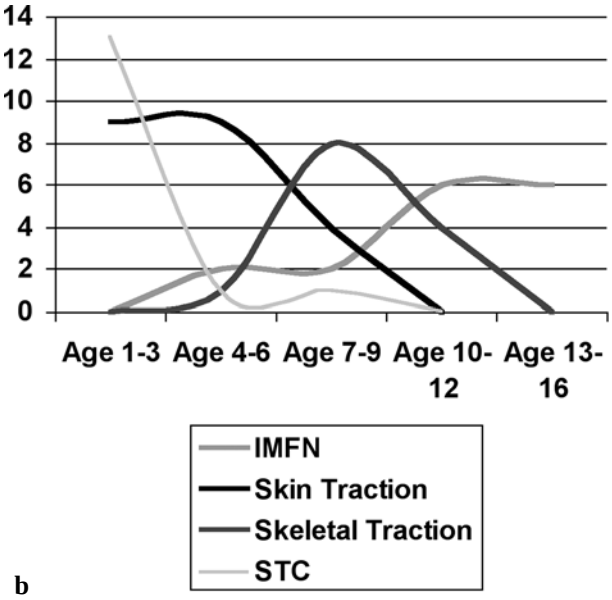

Fig. 1. — The demographic distribution of each group (fig 1a) and the breakdown of each treatment method in correlation with the age (fig 1b).
IMFN = intramedullary flexible nailing ; ST = skin traction ; STC = skin traction followed by hip spica.

Flexible Nailing (IMFN), Skeletal / Skin Traction (ST) or by skeletal traction followed by hip spica (STC). Sixty-two patients were identified and divided into three groups according to their treatment modality. We analysed the cost of their inpatient stay, theatre time, costs of the needed radiographs taken including intra-operative fluoroscopy, the physiotherapy needs, the out-patients visit and the plaster cost. Clinical data was retrieved from the patients' notes and theatre records. The hospital finance department and the physiotherapy unit as a best approximation supplied financial data to us.

RESULTS

Seventy-two children were admitted to our unit with isolated femoral shaft fractures in the time period that was evaluated. Ten were excluded from the study (five were below the age of one, two had incomplete data, two had initial traction which has changed to IMFN, and a 16-year-old girl was treated as a skeletally mature adult with an interlocking intra-medullary nail).

Sixty-two children with a mean age of 5.98 years (range : 1 to 15) were analysed. The female to male ratio was 19 :43. Patients were divided into three groups according to their treatment option (fig 1 a, b) :

Group A (IMFN) : 16 patients, one female and 15 male (fig 1).

Group B (ST) : 31 patients, 12 females and 19 male (fig 2).

Group C (STC) : 15 patients, 6 females and 9 male.

Hospital stay cost

Patients treated with nailing (IMFN) were required to stay in hospital for 3-24 days (including readmission for nail removal 3-6 months later) with an average of 9.8 days, costing £ 1864 per patient, based on the cost of a paediatric bed in our hospital as £ 190 per day.

Patients treated with traction only (ST) were required to stay 22-77 days with an average of 39.3 days, costing £ 7471 per patient.

Patients treated with traction followed by cast were required to stay 5-32 days with an average of 18.8 days, costing £ 3572 per patient.

Theatre cost

All patients in group A (IMFN) were readmitted in a 3-6 month period for nail removal and the cost of this was included. Patients treated with skeletal traction had a femoral pin inserted in theatre and five patients had skin traction applied in theatre, and the cost of this was included.

Fig. 2. — Antero-posterior and lateral radiographs of a femoral shaft fracture in an eight-year-old boy treated with IMFN. a : on admission, b : four months later, prior to nail removal.

Group A "IMFN"

We calculated the running cost on an hourly basis. The time for nail insertion varied from 35-75 minutes with an average of 57 minutes.

The cost was obtained as £ 389 based on two surgeons, three nursing staff and an anaesthetist, including the theatre equipment.

The cost for the flexible nail used in our institution is £ 76 per nail.

Nail extraction time was calculated as 25 minutes approximately.

Average theatre cost per patient for group A (IMFN) was calculated as follows : (£ 389 × 57/60) + (£ 389 × 25/60) + (£ 76 × 2) = £ 684.

2) *Group B "ST"*

Thirteen patients required the use of theatre, eight for insertion of the skeletal traction pin, and five for setting the skin traction under anaesthesia.

The average time consumed was 35 minutes.

The theatre cost of these patients redistributed over the whole ST group (31 patients) and the average cost per patient was calculated as follows : (£ 389 × 35/60) × (13/31) = £ 95.

3) *Group C "STC"*

Five patients required the use of theatre to set the traction under anaesthesia.

The average time consumed was 37 minutes.

The theatre cost of these patients redistributed over the STC group (15 patients) and the average cost per patient was calculated as follows : (£ 389 × 37/60) × (5/15) = £ 80.

Radiology cost

1) Group A (*IMFN*)

Patients required three to six radiographs in addition to the use of fluoroscopy on insertion of the nails.

The average requirements were 4.06 radiographs per patient, the cost of femur radiographs was calculated as £ 103 for both antero-posterior and lateral views, and the fluoroscopy was calculated as £ 115.

The average cost per patient in this group was calculated as follows : 4.06 × £ 103 + £ 115 = £ 533.

2) *Group B* (*ST*)

Patients required four to nine radiographs with an average of 6.07.

Six patients in this group required fluoroscopy adding a cost of £ 22 per patient in this group.

The average cost was calculated as follows : 6.07 × £ 103 + £ 22 = £ 647.

3) *Group C* (*STC*)

Patients required three to seven radiographs with an average of 4.86.

One patient required fluoroscopy adding a cost of £ 7.6 per patient in this group.

The average cost was calculated as follows : 4.86 × £ 103 + £ 7.6 = £ 490.

Plaster cast cost

Applied only to the STC group, in which the traction was discontinued after initial callus formation and replaced by a 90/90 spica, the cost of the hip spica was calculated as £ 180. The social cost and the aftercare time and effort is considerable however difficult to estimate.

Physiotherapy cost

Group A (*IMFN*)

Patients required two to four sessions of physiotherapy with an average of 2.6 sessions per patient ; none of the patients in this group required the use of hydrotherapy.

The cost obtained from the hospital physiotherapy manager and calculated on the average salary of a physiotherapist per 15 minutes session, adding the average estimate cost of any physiotherapy equipments usage. The session estimate cost was calculated as £ 17 per session. Therefore the average physiotherapy needs per patient in this group was calculated as follows : 2.6 × £ 17 = £ 44.

Group B (*ST*)

Patients required three to nine sessions of physiotherapy with an average of 6.8 sessions per patient, costing £ 116 PP.

Seventeen patients required from one to four sessions of the usage of the hydrotherapy pool with a total of 39 sessions.

Hydrotherapy pool costs £ 45 for 30 minutes adding £ 34 for a supervising physiotherapist (as before) with a total of 39 × (£ 45 + £ 34) = £ 3081 to be divided over the whole 31 patients in this group, thus adding a cost of £ 99 to the physiotherapy cost calculated above, making an average of £ 215 per patient in this group.

Group C (*STC*)

Patients required 2-6 sessions of physiotherapy with an average of 3.4 sessions per patient, costing £ 57.8 per patient.

Two patients required the use of hydrotherapy with a total of 5 sessions adding a cost of £ 26 per patient in this group (£ 79 × 5/15), making an average physiotherapy cost of £ 84 per patient in this group.

Outpatient requirements

From our review there was no significant difference in the outpatients' visits in the three groups (IMFN average of 2.4 visits, ST average of 2.1 visits, and 3.2 visits for the STC group). The cost of running the outpatient clinic was difficult to obtain and to calculate in our study.

Complications

All patients had a satisfactory final outcome. Redness and minimal skin reaction was recorded in three patients in the STC group out of 15. Two patients from the ST group sustained hairline fractures after mobilisation and traction had to be reapplied. Nail backing out was recorded in three cases of the IMFN group out of 16 patients, which did interfere with full knee extension but with no residual problem after nail removal. One of the IMFN group had minor serous discharge from one of the

Fig. 3. — Antero-posterior and lateral radiographs of a femoral shaft fracture in a seven-year-old boy treated with skin traction. a : after four weeks, b : four months later, walking independently.

nail entry points with negative wound swab culture and spontaneous resolution.

OVERALL COST

In our study there was a significant variation in the hospital stay cost between the IMFN group and both ST/STC groups. Patients treated with traction stayed almost four times longer than patients treated with IMFN, which was the main reason for the large difference in the total cost almost tripling the ST cost comparing to the IMFN (table I). Applying a cast did not reduce the hospital stay significantly as referred to by Hinton *et al* (*8*). Significant variation was also found in the physiotherapy needs between the IMFN group and the ST group : the cost was higher in the latter group due to the need for hydrotherapy, patients in both the ST and STC groups needed more effort to regain their confidence and restore their independency. No significant difference in the radiology cost between the three groups was observed (table I).

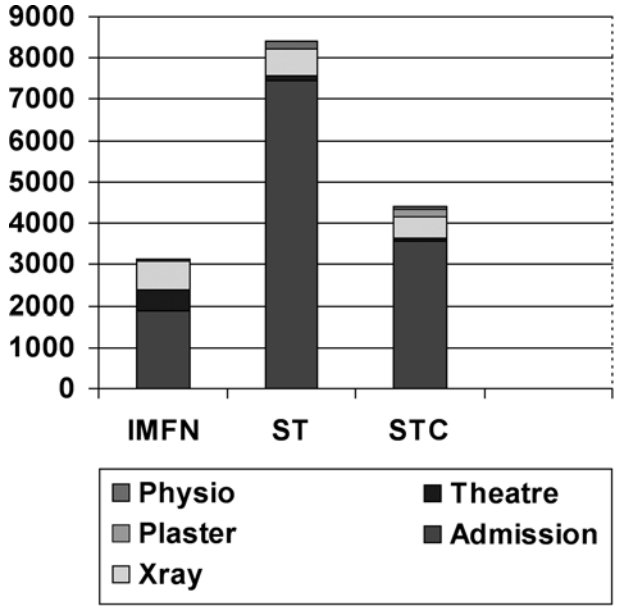

Fig. 4. — Breakdown of the cost per patient with regards to treatment and diagnostic needs (in GB £).

Table I. — Summary of the average costs per patient

	IMFN	ST	STC
Hospital Stay	£ 1864	£ 7471	£ 3572
Theatre	£ 684	£ 95	£ 80
Radiology	£ 533	£ 647	£ 490
Physiotherapy	£ 44	£ 215	£ 84
Cast	NA	NA	£ 180
Total	£ 3126 (5080 €)	£ 8643 (14044 €)	£ 4425 (7190 €)

DISCUSSION

Treatment of femoral shaft fractures in children depends mainly on the skeletal maturity of the patient and the surgeon's preference. An acceptable final outcome was observed with either conservative or operative methods with no significant difference in the literature to recommend one over the other (*3, 4, 11, 13, 14*). In our study we tried to highlight the cost differences in various treatment modalities. We do not think that the cost should be the only factor in deciding the management option, but with the equality in the outcome, the treatment cost should be considered if both options were justified (*6, 12*).

One important factor that was not included in our study with regards to the cost is the social cost on the family of the children with such injuries. It is important to consider parental time off work. Another limitation encountered in our study was the difficulty to include the care needed for a child in a spica cast or recently discharged from long hospital admission after traction, such costs are highly variable and difficult to obtain. Several studies have indicated that flexible nailing of these fractures would allow rapid return to school and faster adaptation to their social surroundings in comparison with non-operative methods (*2, 5, 9*).

CONCLUSION

Intramedullary flexible femoral nailing as a recognised way of treating femoral shaft fractures in paediatric patients has reduced the hospital stay by 75% in comparison to the conservative method of traction. This resulted in cutting the overall cost of the treatment by approximately one third in comparison to the treatment using traction. IMFN was also associated with a significant reduction in physiotherapy needs, as children treated with nailing regain confidence and dependency much faster than their counterparts treated with traction or casting.

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