Original Article

A comparative study of surgical management of subtrochanteric fractures in children.

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Abstract:

Introduction: Subtrochateric femoral fracture is a major cause of morbidity and mortality in patients with lower extremity injuries. There have been no studies that have specifically looked at the management of subtrochanteric femoral fractures in skeletally immature adolescents. It was the purpose of this study to investigate the treatment of this injury in this unique patient population. ***Methods:*** This study was conducted in the Department of Orthopaedic surgery in M. M. Medical College from July 2006 to November 2008. Thirty-four patients were recruited from Emergency and out patient department having closed subtrochanteric femoral fracture. All patients were operated under general or spinal anesthesia. All patients were followed for twelve months. ***Results:*** All children achieved union in a mean time of 10 weeks (range from 6 - 16 weeks) depending on the type of long bone. Full weight bearing was possible in a mean time of 8.8 weeks. Mean duration of hospital stay was 9.8 days. The mean follow-up period was 28 months (17-48 months). Complications were recorded in 4 (11.77%) patients and included: two entry site skin irritations, one protrusion of the wires through the skin and one delayed union. The results were excellent in 97.06% and good in 2.97% patients. Conclusions: We conclude that Rigid and close interlocking nailing between the age of 9-16 years offered excellent fracture stability allowing early mobilization (early weight bearing) and joint motion in comparisons to the other groups and between the age of 6-8 years titanium elastic nail and bridging plate offered excellent result.

Key wards: Subtrochanter, Fracture, Pediatric, Intramedullary.

Introduction:

Femoral shaft fractures, including subtochanteric and supracondylar fractures, represent approximately 1.6% of all bony injuries in children [1]. Paediatric subtrochanteric femoral fractures are rare and have received limited attention in the literature [2, 3]. The subtrochanteric femoral fracture in children is a special type which occurs 1 to 2 cm below the lesser trochanter. The proximal fragment tends to flex (iliopsoas), abduct (abductor group) and rotate externally (short external rotators) [4]. The treatment of subtrochanteric femoral fractures in children is controversial. Different treatment options have been used: skin traction, 90/90 skeletal traction, immediate spica casting, cast bracing, internal fixation and external fixation. Treatment choices are influenced by the child's age and size and whether the femoral fracture is an isolated injury or part of a polytrauma. Economic concerns, the family's ability to care for a child with a spica cast or external fixator, and the advantages and disadvantages of any operative procedure are also important factors[1]. Indications for operative treatment include multiple trauma, head injury, open fracture, floating knee, vascular or neurological injuries, failure of conservative treatment, older child or adolescent and social indications[5, 6, 7, 8]. Methods of internal fixation include; intramedullary nails, compression plating and external fixator[5, 7, 9, 10].

Methods:

This prospective study was carried out at Orthopaedics department of M.M. Medical college from July 2006 to November 2008. It was approved by institutional medical ethics committee. A total of 34 patients with subtrochanteric femur fracture admitted to our institute were included in present study. A written informed consent was obtained from all the patients; they were explained about treatment plan, cost of operation, and hospital stay after sur-

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gery, and complications of anaesthesia. They were followed up after surgery, were clinically and radiologically assessed for fracture healing, joint movements and implant failure. According to the criteria the results are graded as excellent when the fractures unites within 16 weeks without any complication, good when union occur within 24 weeks with treatable complications like superfi cial infection and knee stiffness and poor when union occur before or after 24 weeks with one or more permanent complications like infection (osteomyelitis), implant failure, non-union, limb shortening and permanent knee stiffness. Delayed union was recorded when the fracture united between three to six months while nonunion was noted when union had not occurred after eight months of treatment Follow-up was done. Patients with closed subtrochanteric femoral fracture with age between 6-16 years and presented within a week of the injury and did not have any previous surgical treatment for the fracture was included in the study. Malnourished patients and those with open fractures, pathological fractures and fracture nonunion were excluded from the study. Examination of patients was done thoroughly at the time of admission to exclude other injuries. Patients were included when part of the fracture was within the inferior aspect of the lesser trochanter and 5 cm below it, Patients underwent skin traction till their operation. Anteroposterior and lateral radiographs were obtained from the hip to the knee. Fractures were classified according to Seinsheimer classification (In type I there were 6 patients, in type II a-10 patients, in type II b- 8 patients, in type II c- 4 patients, in type III a-3 patients, in type III b-2 patients, in type IV-1 patient and in type V- 0 patient) (Table II). In all the patients surgical management of subtrochater of the femur was performed on seventh to fourteenth day after the injury. In patients who were not fit for surgery due to associated injuries to vital organs, were haemodynamically unstable or due to active infection at injury site, or were pyrexial delayed surgical management was performed when their over-all condition improved. All patients were operated under general or spinal anesthesia. First generation cephalosporin was administered at the time of induction of anesthesia as prophylaxis. Patients were laid supine on the fracture table with traction pin in condyles of fractured femur. The fracture was reduced by traction and manipulation under image intensifi cation. After preparing the femur in standard manner, internal fixation with implants were done. Rehabilitation such as touch down weight bearing was started on 2nd post-operative day and sutures were removed on 14th post-operative day. These patients were assessed clinically and radio logically for union timing at nine months following surgery. Patients were assessed for delayed union (more than 4-6 weeks postoperative) and non union (nine months following surgery). Stastical analysis was limited to calculation of percentage of patients who had unions, malunions, delayed unions, or non unions and Excellent, Good, and poor outcomes (Table IV).

Table IV: Out come of results of subtrochanteric fractures (n=34)

Out comes	No	Percentage
Excellent	33	97.06%
Good	1	2.97%
Poor	0	0%

Ethical and legal procedure

The protocol was approved by an ethics committee and thus meets the standards of the Declaration of Helsinki in its revised version of 1975 and amendments made to it in 1983, 1989 and 1996 (JAMA 1997; 277:925-6).

Table I. Age and sex variations in study group (n=34)

Age (years)	Male	R	L	Female	R	L	Total
6-8	4	3	1	2	1	1	6
9-12	6	3	3	4	2	2	10
13-16	12	7	5	6	4	2	18
Total	22	13	9	12	7	5	34

Results:

There were 22 (64.70%) male and 12 (35.29%) female patients (Table I). The mechanism of injury was road traffic accident in 80% of patients, fall from height 10% and industrial accident was 10%. Injury to left lower limb was seen in 41.18% and right lower limb in 58.82% of patients. The average hospital stay was 18 days. In group A, patients were having fracture according to seinsheimer classification, type I (6 fractures), type II A (10 fractures), type IIB (8 fractures), type IIC (4 fractures), type

IIIA (3 fractures), type IIIB (2 fractures), type IV (1 fracture) and type V (0 fracture). These patients were divided into seven groups. Patients in A group were fixed with Elastic stable intramedullary nailing, group B with proximal femoral nailing, group C with interlocking nailing, group D with Enders nailing, group E with dynamic hip screws, group F with dynamic condylar screws and group G with low-contact dynamic compression plates (Table III) (Figure1-IV). In group A, complication of titaneum elastic nails was skin irritation at the nail entry site and in group D there was protrusions of the wires through the skin and malunion. In group B,C, E,F and G found no significant complication. Flexible nails are not suitable for proximal fractures and can withstand only 40% of the body weight and recommend starting of weight bearing to be delayed until the appearance of early callus formation at three to four weeks time following the fixation. In group B and C, between the age of 9-16 years, Rigid and close interlocking nailing on the other hand offered excellent fracture stability even in heavier adolescents especially those with a comminuted fracture pattern allowing early mobilization and joint motion in comparisons to the other groups. We placed the nails through the lateral aspect of the trochanter between the apophysis and the tip of the trochanter and avoid the piriformis fossa and the tip of the trochanter. No patient developed any significant complications such as alterations in the proximal femoral anatomy or a vascular necrosis. Physical therapy was started immediately if it was possible because of related injuries. Post-operatively, mean follow-up was 28 months (17 -48 months). No major complications were observed in relation to surgery. Complications as a result of the procedure were recorded in 4(11.77%) patients and included one patient (2.97%) were labeled as delayed union because of obvious gap at the fracture site in subsequent radiographs (Table V).

This was due to over distraction of fracture during operation, and was treated by bone graft, two entry site skin irritations; one protrusion of the wires through the skin although they had been buried during the procedure. This nail required removal 2-3 weeks prior to the planned date of removal. There was no instance of loss of reduction, or nail migration during the post-operative period. No clinically significant deformities were ob-served. There were no cases of nonunion or mal-union. All patients achieved complete radiographic healing at a mean of 10 weeks (range from 6 -16 weeks).In a subjective measure of outcome at follow-up, 33(97.06%) of the patients were excellent and 1 (2.97%) good; no patients or parents reported their out-come as not satisfied (Table IV). At follow-up all patients went on to osseous union and regained a full range of movement after rehabilitation.

Table V: Complications (n=34)

Complications	No
1 entry site skin irritations	2
2 protrusions of the wires through the skin	1
3 delayed union	1

Table II: No. of fracture cases according to Seinsheimer classification (n=34)

Age (years)	Classification							
	I	IIA	IIB	IIC	IIIA	IIIB	IV	V
6-8	1	1	2	1	1	0	0	0
9-12	2	3	2	1	1	1	0	0
13-16	3	6	4	2	1	1	1	0
Total	6	10	8	4	3	2	1	0

Discussion

Paediatric subtrochanteric femoral fractures present a special unstable type which receives no special attention in the literature[2, 3]. Patient's age may be the most important single variable regarding pediatric femoral fracture treatment. The treatment for children between the ages 6-12 years is the most controversial. Treatment options include traction followed by hip spica cast, immediate spica casting, cast bracing, internal fixation and external fixation[11]. Traction followed by hip spica cast is the method preferred by many surgeons for the treatment of children aged 6-10 years [8]. Aronson et al [12] studied 54 children who had been treated in distal femoral 90/90 traction for an average of 24 days before being placed in a 1 1/2 hip spica cast. At an average follow-up of 4.3 years, all children were functionally normal and showed a symmetric range of motion of hip and knee. However, this method requires a relatively long hospitalization and accurate control of fracture alignment with frequent radiographs and adjustment in traction as needed. 90/90 skeletal traction with post traction spica is not suitable in children weighing more than 45 kg or in children older than 10 years of age as it will be associated with an unacceptable

Table III: Implant used in subtrochanteric fractures (n=34), Elastic Stable Intra- medullary Nailing (ESIN),Proximal femoral nail (PFN), Interlocking nail (ILN), Dynamic hip screw (DHS), Dinamic condylar screw (DCS),Low contact dynamic compression screw (LCDCP).

Age (years)	Implant						
	Group A	Group B	Group C	Group D	Group E	Group F	Group G
	ESIN	PFN	ILN	ENDERS	DHS	DCS	LCDCP
6-8	1	0	0	1	1	1	1
9-12	2	2	2	2	2	1	2
13-16	2	3	3	2	3	3	3
Total	5	5	5	4	5	5	5

high incidence of femoral shortening and malrotation[13, 14]. Immediate spica casting, popularized by Staheli and Sheridan[15] is indicated for isolated femoral shaft fractures in children under 6 years of age. Infante et al[16] expanded the indications for spica casts to children up to age 10 and up to 50 kg. Its primary advantages are simplicity, low cost, and generally good results. Ferguson and Nicol [17] conducted a prospective study of early spica casting in children less than 10 years of age. They found
that age greater than 7 years was a variable predictive of a higher risk of failure of this technique to achieve satisfactory alignment. Martinez et al[18] reported excessive shortening and angular deformity in 26 of 51 patients after immediate spica casting. Several studies have documented superior results with internal fixation compared to non operative treatment[19, 20, 21]. According to Kregor et al [5] the indications for operative fixation of paediatric femoral fractures were presence of associated closed head injury and/or multiple injuries, open fractures and failure of conservative treatment. We applied the indications to include isolated paediatric subtrochanteric femoral fractures as we believe that it is difficult to maintain such fractures in an accepted position by non operative means. Methods of internal fixation of paediatric subtrochanteric fractures include intramedullary nails, compression plating and external fixators[5, 7, 9, 10]. Awareness of the advantages and disadvantages of intramedullary nails, compression plates and external fixator and the skill to apply each method safely are requisites to the ideal management of such fractures [4]. Good results were reported with external fixators, but the rates of pin tract infection, refracture and loss of reduction are high [7, 11, 22, and 23]. We preferred not to use the external fixator in the treatment of paediatric subtrochanteric femoral fractures as there is no sufficient room for application of the pins into the proximal femoral fragment. Flexible intramedullary nailing is nowadays the treatment of choice in paediatric femoral fractures. Patients are able to partially weight bear early because a rod is a load-sharing device, there is rapid fracture healing and a low incidence of malunion and non union [6, 9, 19, 20, 24]. Disadvantages of intramedullary nailing are lack of rotational control, exposure to irradiation and backing out of implants [5]. Fixation of subtrochanteric fractures in children using intramedullary nails need special experience and may be difficult to achieve. Plate fixation, despite the negative report of Ziv and Rang [25], has been shown to work well in the paediatric age group [5, 10, 14, 26, 27]. The disadvantage of plating are the need for plate removal, poor cosmetic appearance of the scar, blood loss associated with exposure and reduction of the fracture and reported higher degree of overgrowth induced by the plates compared with intramedullary fixation [25] AND28. On the other hand, patients treated with a plate require less assistance, can walk with crutches within ten days postoperatively and return to school sooner than children treated in 90/90 skeletal traction [21]. Ward et al [27] reported the use of a [4.5] mm AO dynamic compression plate for the treatment of femoral shaft fractures in [25] children, 6 to 16 years of age,[22] of whom had associated fractures or multisystem injury. The primary indication for this technique was simplification of nursing care and rehabilitation of children with an associated head injury or polytrauma. The average time to fracture union was [11] weeks. There were no infections and no angular deformities. Kregor et al [5] reported on [12] patients who had [15] femoral fractures treated with compression plating. All fractures healed at an average of [8] weeks.

The mean healing time in our study was the same as that reported by Kregor et al[5]. Ziv and Rang [25] reported three deep infections among five children with head injuries and with femoral shaft fractures. They believed that infec-tions were related to the large number of tubes attached to these patients and their decreased resistance. Eren et al [26] reported one case of osteo- myelitis (2.1%) which occurred in a child with polytrauma. In our study, we encountered no deep infections. Many other reports documented no deep infection with plate fixation [5, 10, and 27]. Flynn et al reported two deep infections (3%) with titanium elastic nails [9]. Extensive dissection and periosteal stripping during plate application may lead to overgrowth. Overgrowth was not a significant problem in the series of Kregor et al[5], with an average increase in length of 0.9 cm (ranging between 0.3 and 1.4 cm), but Ward et al[27] reported several patients with considerable overgrowth (approximately 2.5 cm), and Hansen [29] reported overgrowth of 2.5 cm in a 12-year-old boy, suggesting that overgrowth is possible in children over 10 years of age. Eren et al [26] reported a series of 40 children aged 4 to 10 years with significant lengthening on the operated side in 40% of patients, averaging 1.2 cm (range, 0.4-1.8 cm). In agreement with Kregor et al[5], overgrowth was not a significant problem in our study. Scanograms revealed overgrowth of the injured femur with an average of 0.9 cm (range, 0.5 to 1.2 cm) in twelve patients (72.2%). Hardware failure is a possible complication with any implant. In the series of Ward et al[27], there was one broken plate postoperatively in a boy who began full weight bearing a few days postoperatively. Fyodorov et al [10] reported hardware failure in 2 of 23 femoral fractures treated with dynamic compression plating. Hardware failure occurred at 6 weeks. One was treated with revision plating and the other with spica casting; both fractures healed uneventfully. No other complications were noted in their patients. In this study, implant failure did not occur in any patient. The need for hardware removal is controversial [26, 27 and 30]. Refracture is rare distal to the plate or through screw holes and whether bone atrophy under the plate is caused by stress shielding or by avascularity of the cortex is unknown [1 and 31]. In the series of Ward et al [27], there was a refracture through a screw hole in one of [15] patients who had the plate removed. They do not recommend plate removal in asymptomatic children. Eren et al[26] also reported one patient (out of 40 patients) who sustained a refracture 9 years after plate removal. This occurred with a minor trauma while he was playing basketball. On the other hand, Bransby- Zachary[30] recommended plate removal because they had five late fractures 20 to 60 months after internal fixation. In this study, we encountered no refracture or problems leaving the implants in place during the follow-up period.

Conclusion

Subtrochanteric femoral fractures in children can be managed successfully in a variety of ways. Ultimately, many factors play a role in the choice of management, including the age and size of the child, fracture pattern, associated injuries and surgeon and family preferences. Operative management whether intramedullary or extramedullary devices both give better results because when operative treatment is undertaken, it should be by experienced surgeons using the technique with which they are most familiar. Children between the ages of 6 and 8 years are typically managed with TENs, but submuscular bridge plating is also an option, particularly for comminuted fractures. For children older than 8 years, rigid antegrade nails using a lateral trochanteric entry site have been successful and without reported major complications, although more studies are needed. In length-unstable fractures and in older, heavier patients, trochanteric entry nailing or plating is recommended. Traditional plating has excellent results reported in the literature, but involves a larger surgical approach and scar.

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