



## Reconstruction plate fixation of subtrochanteric femoral fractures in children

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**Pediatric subtrochanteric femoral fractures are rare and have received limited attention in the literature. Treatment is controversial. Different treatment options are used : skin traction, 90/90 skeletal traction, spica casting, cast bracing, internal fixation and external fixation. The aim of this study is to present our results with internal fixation of subtrochanteric femoral fractures in children using a reconstruction plate. Between 2000 and 2004, eighteen patients with closed subtrochanteric femoral fractures were treated in the Mansoura Emergency Hospital. The average age at the time of injury was 8.2 years (range 5.3 years to 11.5 years). Pathological fractures and fractures associated with neuromuscular diseases were excluded from this study. Eight patients had head injuries and/or multiple injuries. In all cases a single 4.5 mm contoured reconstruction plate was used and a 6.5 mm cancellous screw was inserted through the plate into the femoral neck. Average follow-up was 38 months (range, 12 to 47 months). All fractures united with anatomical alignment within an average of 8 weeks (range 6 to 12 weeks). There were no deep infections and no significant limb length discrepancies. At the latest follow-up, no patient had any restriction of activities. Internal fixation with a reconstruction plate appears as a good treatment option for children with subtrochanteric femoral fractures.**

**Keywords :** subtrochanteric fracture ; children ; reconstruction plate.

### INTRODUCTION

Femoral shaft fractures, including subtrochanteric and supracondylar fractures, represent approxi-

mately 1.6% of all bony injuries in children (17). Paediatric subtrochanteric femoral fractures are rare and have received limited attention in the literature (7, 16). 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 (ilio-psoas), abduct (abductor group) and rotate externally (short external rotators) (26).

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

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and disadvantages of any operative procedure are also important factors (17).

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 (19, 20, 22, 28). Methods of internal fixation include ; intramedullary nails, compression plating and external fixator (10, 11, 19, 22).

The aim of the study is to evaluate the results of plate fixation of subtrochanteric femoral fractures in children.

### PATIENTS AND METHODS

Between 2000 and 2004, 18 children with closed subtrochanteric femoral fractures were treated in the Mansoura Emergency Hospital. The average age at the time of injury was 8.2 years (ranging from 5.3 years to 11.5 years). There were ten boys (55.6%) and eight girls (44.4%). The mechanism of injury included a fall from a height in twelve patients (66.7%) and a motor car accident in six (33.3%). The right femur was affected in eleven patients (61.1%) and the left in seven (38.9%). Eight patients (44.4 %) had head injuries and /or multiple injuries and ten patients (55.6%) had isolated sub-

trochanteric femoral fractures (table I). Pathological fractures, open fractures and fractures associated with neuromuscular diseases were excluded from this study.

Surgery was performed 3-7 days after injury. One unit of blood was available. Under general anaesthesia, a posterolateral muscle splitting approach was used. Minimal soft tissue dissection and periosteal elevation were done. Manual reduction and distraction was attempted for reduction, correction of angulation and restauration of length. In all cases, a single 4.5 mm contoured reconstruction plate was used and a 6.5 mm cancellous screw was inserted through the plate into the femoral neck. An intra-operative radiograph was taken to confirm that the proximal 6.5 mm cancellous screw was inserted into the femoral neck. No patient had bone grafting. No casts were used postoperatively.

Crutch-assisted walking with limited weight-bearing was allowed ten days postoperatively and full weight-bearing after six to twelve weeks. Hip range of motion and quadriceps exercises were started while the patient was in the hospital. Clinical and radiological assessment of the patients included duration of healing, alignment, presence or absence of postoperative infection, hip and knee motion, leg length discrepancy, and functional daily activities. A scanogram was made in all patients to detect any leg length discrepancy. Average follow-up was 38 months (range, 12 to 47 months).

Table I. — Data of children with subtrochanteric fractures

No.	Age (years)	Sex	Mechanism of injury	Associated injuries	Time elapsed before fixation (days)	Duration of healing (weeks)
1	5.3	M	Fall from a height	None	4	6
2	6.5	M	Motor car accident	Head injury	3	6
3	8.2	F	Fall from a height	None	4	8
4	11.5	F	Falling from a height	None	3	10
5	7.4	F	Motor car accident	Forearm fracture	5	7
6	8.5	F	Fall from a height	None	7	8
7	7.4	M	Fall from a height	None	3	9
8	6.6	F	Fall from a height	None	4	6
9	7.9	M	Motor car accident	Head injury	5	11
10	8.2	M	Fall from a height	Head injury	5	6
11	9.9	M	Fall from a height	Ipsilateral tibial fracture	6	8
12	9.0	F	Fall from a height	None	3	12
13	11.0	M	Fall from a height	None	3	10
14	8.0	M	Motor car accident	Head injury	7	8
15	7.8	M	Fall from a height	None	3	8
16	9.3	F	Motor car accident	Head injury	4	9
17	6.8	M	Fall from a height	None	4	8
18	7.4	F	Motor car accident	Retroperitoneal haematoma	3	7



**Fig. 1.** — Anteroposterior (A) and lateral (B) radiographs of a 6-year-old girl who sustained a subtrochanteric fracture. C, D. Anatomical reduction and internal fixation with a five-hole 4.5 mm reconstruction plate. E, F. Last follow-up with complete union.

## RESULTS

Radiographic evaluation revealed that the most common fracture pattern was a transverse fracture (in seven patients, 39.9%). Five patients (27.8%) had a short oblique fracture, four (22.2%) had a spiral fracture and two (11.1%) had a fracture with a butterfly fragment. Using the Winquist and Hausen classification (30), all patients had grades 0, 1 or 2 comminution only.

All fractures united with anatomical alignment (fig 1-3) within an average of eight weeks (range, 6 to 12 weeks). There were no deep infections but two patients (11.1%) presented a superficial wound infection that responded well to antibiotic and careful wound care. Patients with head trauma and /or multiple injuries were hospitalized for a longer period than those with isolated subtrochanteric femoral fractures (average 9.5 versus 3.5 days). In this study, only three children (16.7%) needed blood transfusion because of the associated injuries.

Clinical evaluation revealed a full range of motion at both the hip and knee joints in all patients. Patients participated fully in sports activities and none had restriction of activities.

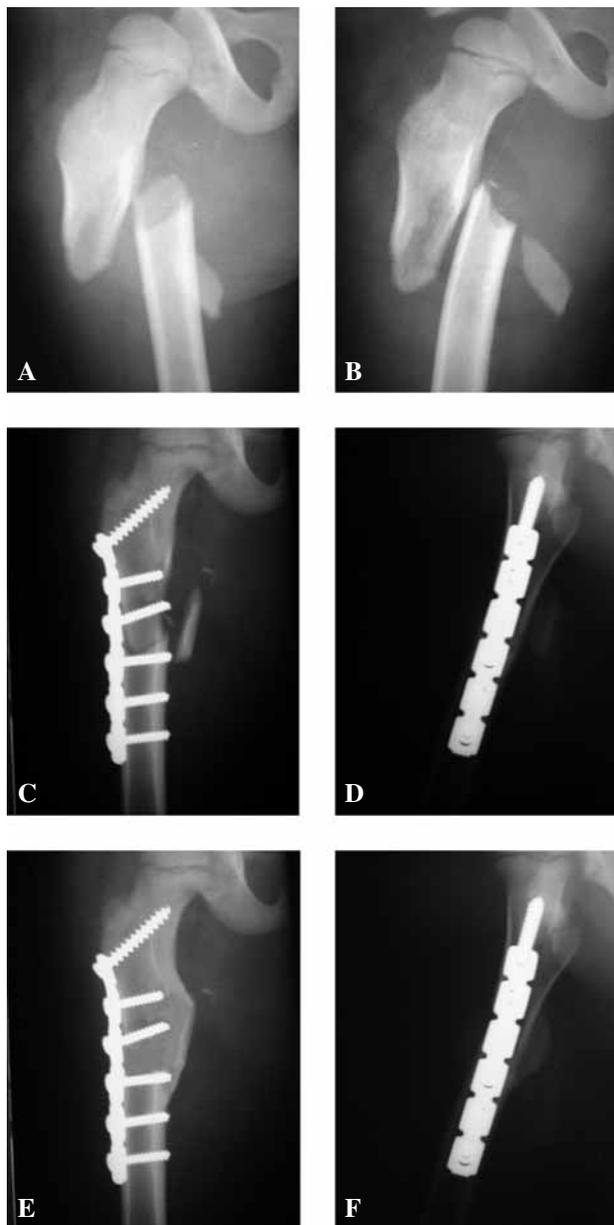
Scanograms revealed overgrowth of the injured femur with an average of 0.9 cm (range, 0.5 to 1.2 cm) in twelve patients (72.2%). Only one patient (Case 11) noticed the leg length inequality. No patient needed a shoe-lift.

At the latest follow-up, there were no patients with implant failure, refracture, heterotopic bone formation or avascular necrosis of the femoral head.

## DISCUSSION

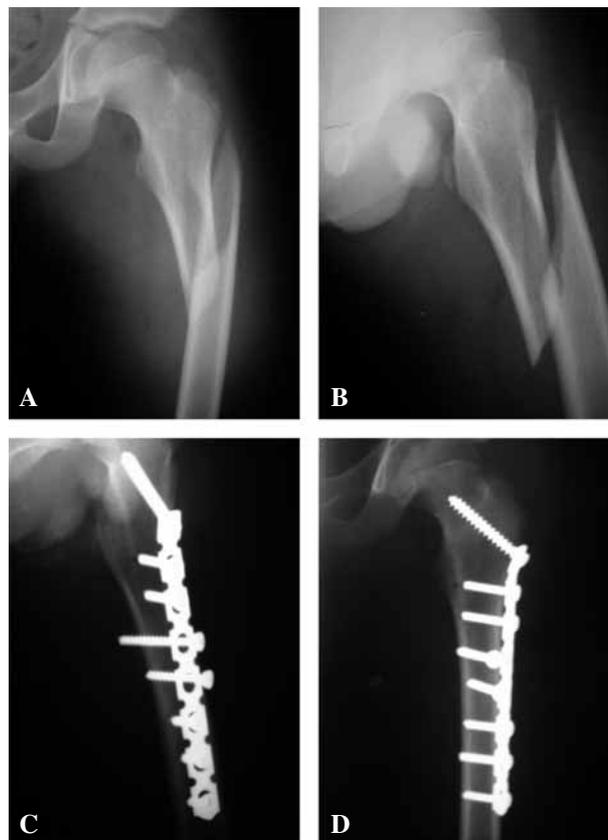
Paediatric subtrochanteric femoral fractures present a special unstable type which receives no special attention in the literature (7, 16). Patient's age may be the most important single variable regarding paediatric femoral fracture treatment. The treatment for children between the ages 6-12 years is the most controversial. Treatment options include traction followed by hip spica cast, immediate spica casting, cast bracing, internal fixation and external fixation (12).

Traction followed by hip spica cast is the method preferred by many surgeons for the treatment of children aged 6-10 years (28). Aronson *et al* (1) studied 54 children who had been treated in distal



**Fig. 2.** — Anteroposterior (A) and lateral (B) radiographs of an 8-year-old boy who sustained a subtrochanteric fracture with a butterfly fragment. C, D. Postoperative radiograph after anatomical reduction and fixation with a six-hole 4.5 mm reconstruction plate. E, F. Last follow-up with complete healing.

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



**Fig. 3.** — Anteroposterior (A) and lateral (B) radiographs of a 11-year-old boy who had a subtrochanteric fracture. C, D. Last follow-up with complete union after anatomical reduction and fixation with an eight-hole 4.5 mm reconstruction plate. Two interfragmentary screws outside the plate were used.

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 high incidence of femoral shortening and malrotation (14, 24).

Immediate spica casting, popularized by Staheli and Sheridan (27) is indicated for isolated femoral shaft fractures in children under 6 years of age. Infante *et al* (15) 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 (9) 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* (21) 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 (4, 18, 24). According to Kregor *et al* (19), 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 same indications in this study but we extended 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 (10, 11, 19, 22). 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 (26).

Good results were reported with external fixators, but the rates of pin tract infection, refracture and loss of reduction are high (2, 12, 22, 25). 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 (4, 10, 18, 20, 23). Disadvantages of intramedullary nailing are lack of rotational control, exposure to irradiation and backing out of implants (19). 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 (32), has been shown to work well in the paediatric age group (8, 11, 13, 19, 24, 29). The disad-

vantage 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 (31, 32). 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 (24).

Ward *et al* (29) 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* (19) 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* (19).

Ziv and Rang (32) reported three deep infections among five children with head injuries and with femoral shaft fractures. They believed that infections were related to the large number of tubes attached to these patients and their decreased resistance. Eren *et al* (8) reported one case of osteomyelitis (2.1%) which occurred in a child with polytrauma. In our study, we encountered no deep infections but two patients (11.1%) had superficial wound infection that responded well to antibiotic and careful wound care. Many other reports documented no deep infection with plate fixation (11, 19, 29). Flynn *et al* reported two deep infections (3%) with titanium elastic nails (10).

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* (19), with an average increase in length of 0.9 cm (ranging between 0.3 and 1.4 cm), but Ward *et al* (29) reported several patients with considerable overgrowth (approximately 2.5 cm), and Hansen (13) 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* (8) 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* (19), 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* (29), there was one broken plate postoperatively in a boy who began full weight bearing a few days postoperatively. Fyodorov *et al* (11) 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 (5, 8, 29). 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 (3, 17). In the series of Ward *et al* (29), 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* (8) 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 (5) 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

Internal fixation with a reconstruction plate appears as a good treatment option for subtrochanteric femoral fractures in children.

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