

# Fractures of the femoral shaft in children treated with an AO-compression plate

## Report of 12 cases followed until adulthood

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Thirteen femoral shaft fractures in 12 children aged 0-15 years were each treated with an AO-compression plate. The mean age at operation was 11 (6-14) years, and all the patients were followed until closure of the growth plates. No deep infections occurred, and all the fractures healed without angulation or rotation. The mean overgrowth was 7 (-9-25)

mm. All the patients had unrestricted movement in the hip and knee, and had no complaints at the follow-up examinations. We conclude that plate osteosynthesis of femoral shaft fractures in children is a safe and reliable method for internal fixation when use of traction is not possible.

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The most common treatment for femoral shaft fractures in children is traction (Barfod and Christensen 1959, Aaronson et al. 1987) or traction followed by a hip spica (Sugi and Cole 1987) owing to the tendency towards overgrowth of the fractured limb after healing. Internal fixation is usually reserved for children with cerebral trauma, vascular trauma, multi-trauma, or severe fractures where the dislocation is unacceptable after application of traction (Viljanto et al. 1975, Fry et al. 1976, Ziv and Rang 1983).

We have chosen AO-compression plates for internal fixation of femoral shaft fractures in children in selected cases, and report here our experience using this method.

### Patients and methods

From 1976 to 1987, a total of 68 femoral shaft fractures in children aged 0-15 years were treated. Thirteen fractures in 12 patients (5 boys and 7 girls) with open epiphyseal plates were treated with a single AO-compression plate (Table 1). At the time of operation, their mean age was 11 (6-14) years, and 10 fractures were the result of a high-energy trauma. Femoral plates were used in all the patients except 3 (Cases 1, 6, and 12), where a tibial plate was used. Anatomic reduction was aimed at in all the fractures. There was a mean delay from trauma until surgery of 4 (0-10) days, and the mean hospital stay was 29 (8-60) days. Cases 6, 7, 11, and 12 also had other lesions that

prolonged hospitalization. The mean hospitalization of the remaining patients was 19 days. Three patients received prophylactic antibiotics.

All the patients were reviewed after closure of the epiphyseal plates, this being on an average 8 (4-15) years after the operation. Orthoroentgenography (Green et al. 1946) with the modifications made by Taillard (1956) was used for measuring leg length. Angular deformity was determined from the radiographs and rotation deformity (more than 10° of restricted rotation) from clinically examined hip rotation. Muscle atrophy was measured circumferentially 10 cm above the patella.

### Results

All the fractures healed without angulation or rotation deformity. The mean time until clinical healing (full weight bearing without pain) was 61 (31-90) days. There were no deep infections, although 1 patient developed a superficial wound infection that rapidly resolved after incision. The mean overgrowth was 7 (-9-25) mm. The plates were removed from 10 patients after a mean period of 11 (8-16) months. Two plates broke—both after fracture healing. One of these broken plates was not removed because the patient had Down's syndrome. Only 1 patient (Case 6) had more than 1 cm of femoral muscle atrophy at the review examination; this patient had sustained a severe injury

Table 1. Observations in 12 children with 13 femoral shaft fractures treated with plates

A	B	C	D	E	F	G	H	I	J
1	F	6	1	-	2	1	2	1	3
2	M	14	1	-	8	1	1	1	-9
3	F	14	1	+	0	2	1	2	3
4	M	12	1	-	7	1	1	2	25
5	F	12	1	-	2	1	1	2	5
6	M	6	2	-	0	1	1	3	10
7	F	10	3	-	4	1	1	2	5
8	M	12	1	+	3	1	1	2	12
9	F	14	1	-	8	1	1	3	3
10	M	13	1	-	3	1	1	2	16
11	F	13	4	-	5	1	1	2	
12	F	6	4	+	10	2	1	2	8

A Case  
 B Sex  
 C Age  
 D Indication  
 1 Poor reduction, angulation > 15°  
 2 Lower leg fracture and soft-tissue damage  
 3 Down's syndrome  
 4 Brain contusion  
 E Prophylactic antibiotics  
 F Delay of surgery from trauma (days)  
 G-I Fracture type  
 G 1 closed  
 2 open  
 H 1 middle  
 2 distal third  
 I 1 comminuted  
 2 transverse  
 3 oblique  
 J Overgrowth at review (mm)

to the ipsilateral lower leg, with an open fracture and dilaceration of the soft tissues. All the patients had unrestricted movement in the hip and knee joints, and no patients expressed any subjective complaints. Only 1 patient (Case 4) had to wear shoes with different sole heights.

## Discussion

Internal fixation of femoral shaft fractures in children is not a routine treatment in most clinics. However, it has been advocated for children with brain damage (Fry et al. 1976, Ziv and Rang 1983). Herndon et al. (1989) used intramedullary nailing in 21 adolescents (> 10 years of age) and did not observe any problems with differences in leg length or with trochanteric apophyseal arrest. The hospitalization was significantly shorter than in a similar group of conservatively treated patients. Further, Reeves et al. (1990) treated 52 fractures in adolescents with intramedullary nailing

or plate osteosynthesis without problems with trochanteric apophyseal arrest; and they also found that hospitalization was shorter than with conservative treatment. Similar good results after intramedullary nailing have been reported by other authors (Campen 1980, Kirby et al. 1981, Mann et al. 1986, Ligier et al. 1988). However, intramedullary nailing only offers equally secure fixation in rotation as plating if interlocking screws are used. The latter have not been used in these series, but rotation deformity has not been a major problem. If intramedullary nailing is used, the trochanteric apophysis is penetrated, which may lead to growth abnormalities in the trochanter and a change in the column angle (Herzog et al. 1976, Ziv et al. 1984, Kuur and Hougaard 1988). Plate osteosynthesis offers the possibility to effect anatomic reduction and rigid fixation without interfering with the trochanteric apophyses. In the present investigation, overgrowth has not been a problem except in a 12-year-old boy, who ended up with a severe overgrowth.

Breakage of the plates is far less important in children than in adults, because femoral shaft fractures heal so rapidly during childhood. For adults, Rüedi and Lüscher (1979) found that the plates broke after 14-20 weeks, breakage probably being caused by fatigue fractures due to bending stress resulting from an insufficient medial buttress in comminuted fractures. None of the fractures with broken plates in our material were comminuted. Bones in children are less rigid, and we believe that this creates increased bending stress leading to breakage of the plates.

No deep infections occurred in our series. Ziv and Rang (1983), however, reported that three out of five plate osteosynthesis were infected; they believed that the numerous tubes attached to the patients with cerebral damage were the cause of infection, and they recommended the use of prophylactic antibiotics. Only 2 out of 12 patients in our study had cerebral damage plus numerous tubes attached, and this may explain why we had no problems with infections.

The stay in hospital was longer in our study than in others where the patients were operated on without delay (Herndon et al. 1989, Reeves et al. 1990). This difference is due to our attempting conservative treatment in 10 patients before operation. If all the patients had been operated on without delay, the hospital stay would have been reduced to approximately 14 days.

In conclusion, we consider internal fixation of femoral shaft fractures with plate osteosynthesis to be a safe and reliable method for fixation in adolescents and smaller children when the customary conservative treatment is unsuitable. In addition, operative treatment is a good alternative to conservative treatment in the adolescent patient due to the shorter immobilization period and shorter hospitalization

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