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Original Article

Results of the treatment of the open femoral shaft fractures in children

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ABSTRACT

Background: Intramedullary nailing has become the treatment of choice for closed femoral shaft fractures in children and adolescents. Immediate intramedullary nailing of open fractures of femur in children remains controversial, with most surgeons preferring to treat grade II or III open fractures either by debridement and traction or external fixation.
The aims: The aim of this study is to evaluate the results of intramedullary nailing of open femoral fractures in children.
Methods: 172 children were treated for femoral shaft fracture in our department. 19 fractures were opened in 18 patients.
Results: In children with polytrauma, multiple fractures, head injuries and other conditions which necessitate intensive nursing care, intramedullary nailing of opens femoral shaft fractures (type I, II, IIIA, IIIB) should be preferred.
Conclusion: Satisfactory results were obtained in all patients in terms of self evaluation of patients, radiological and clinical evaluation. The infection rate was much lower for patients who had been given a cephalosporin than for patient who had been given a penicillin or had been given no antibiotic.

1. Introduction

Intramedullary nailing has become the treatment of choice for closed femoral shaft fractures in children and adolescents.[1] Immediate intramedullary nailing of open fractures of femur in children remains controversial, with most surgeons preferring to treat grade II or III open fractures either by debridement and traction or external fixation.[2] Theoretical reason for the avoidance of reamed intramedullary nailing of open fractures of femur include an increased rate of infection and a decreased rate of union secondary to the disruption of the endosteal blood supply.[2] But recently the series of patients with open femoral fractures treated using intramedullary nailing were published.[1–3]

The aim of this study is to evaluate the results of intramedullary nailing of open femoral fractures in children.

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2. Materials and methods

From the 1st Jan 2001 to the 1 st Jan 2011, 172 children were treated for femoral shaft fracture in our department. 19 fractures were opened in 18 patients. The mean age of patients was 11,2 years.(5–14.5) Open physeal fractures have been excluded from this series .

Using the Gustilo-Anderson classification there were the type I in 12 patients, II in 3, IIIA-2, IIIB-1, IIIC-1. There were 5 transversal type fractures, 9 oblique, 5 comminuted fracture. 9 fractures were located in 1/3 proximal part of femur, 6 in middle shaft and 4 in the 1/3 distal part. No neuromuscular diseases or bone fragility were presented in our series.

The average Injury Severity Score for 19 patients was 30 (10 to 42). Most patients (20) had additional injuries, 6 head injury, abdominal in 5, other fractures in 5.

The treatment protocol that was used for open fractures of the femur has been described in our trauma department. All patients were immediately evaluated for the presence of associated injuries and debridement and intramedullary nailing of the fracture were done as soon as possible. Intravenous antibiotics were administrated preoperatively Cefazolin 100 mg/kg/day divided into doses given every 8 h. Time to start using antibiotics was 85 min after trauma (30–150). Antibiotics were used for 9 days (4–28). Mean time of surgery after trauma was 5.5 h (2–26). In 2 cases the first procedure was the neurosurgical hematoma evacuation. Operative debridement wasn't done for type I of fractures, only for type II and III. Debridement was performed in supine position. The wound was enlarged (1 patients) with resection of necrotic tissues, each patients had a lavage with using a pulsating system.

All nailing were performed with patient in the supine position using orthopedic table with traction. Longitudinal skin incisions (0.5–1 cm) at distal part of femur were used, the entry hole into bone is made using an awl and nails were placed in retrograde fashion through the distal part of femur. The nails were prebent sufficiently to leave a significant recoil force. For implant seizing, the narrowest diameter of the femoral diaphysis is measured and nails that are 40% of the narrowest diameter are used. The quality of reduction is controlled radiographically. The skin is closed and before waking patients the knee movement and internal and external rotation of the hip were done to prevent knee stiffness and femoral malrotation. The length of operated limb was the same to controlateral side, no shortening was done. No skin grafting was performed. All wounds were closed during the procedure. The mean duration of femoral procedure was 55 min (20–220). 4 patients needed the blood transfusion (250 ml-I, 250 ml-II, 750 ml-IIIA, 1000 ml-IIIC).

The child after surgery is nursed supine without splinting. The lower limb rested elevated on a pillow. Postoperative management with regard to weight bearing and range of motion of the extremity was individualized according to the fracture configuration and stability, the size of the implant and associated injures. Partial weight bearing was allowed around the 15th day post-op. for the transverse fractures. But for oblique and comminuted fractures patients were generally advised to restrict weight-bearing on the fractured femur until early callus was noted on follow-up XR. Union was defined as a no tender fracture site in a patient who was able to bear full weight and who was seen to have bridging callus on XR. Nails were removed 155 days after procedure (39–380).

3. Results

The mean follow up was 56 month (24–144). No compartment syndrome was noticed. XR was done in all patients according to our hospital protocol, 1and 3 month after the procedure. In 17 patients bone consolidation was obtained 3 month post-–op. 1 patients with deep infection presented bone consolidation 4.5 month post-op.

In 1 patients, 14 years old with comminuted femoral fracture after surgery, leg discrepancy was 1.5 cm due to incorrect stabilization. Patient need the second procedure 14 days after the first, and external fixation was used without ablation of nails.

Knee joint stiffness was present in 2 patients because irritation of the nail at the entry site with mobility of knee joint 10–90° and 15–75°. After ablation of nails joint stiffness disappeared after 3 and 3.5 weeks. Angular deformity of rotation more than 10° was not noticed. Refracture did not occur in any of patients. Patient 10,5 years with open femoral fracture type II according to Gustillo classification and multiple trauma; head and thorax injury, treated on Intensive Care Ward, presented infection with Staphylococcus aureus 19 days after procedure. Antibiotherapy with Vancomycin was done. Debridement had to be performed within four weeks and conversion from intramedullary to external fixation was used. Infection was stopped 6 weeks after trauma.

2 patients (type II, IIIA) needed second procedure for resection of necrotic tissue. No skin grafting was used.

4. Discussion

Femoral fractures represent about 2% of all fractures in childhood[1] and about 7% of all open fractures.[3] Infection rates in children with open fractures have been reported to be lower than those in adults with such fractures.[1–3] A small child can sustain a fracture by a simple fall on level ground while playing, but for older child a stronger force is required[4] and it can be result from motor–vehicle accident.[5]

In children who are five years of age or younger, early closed reduction and application of a spica cast is an ideal treatment for most diaphyseal femoral fractures. In skeletally mature adolescents, use of an antegrade solid intramedullary nail has become the standard of treatment. The treatment for children between six and sixteen years of age is an elastic intramedullary nailing.[5,6] Nowadays rigid trochanteric entry nailing, submuscular plating and flexible IM nailing are options in patients aged ≥11 years; however, no studies have directly compared all three methods.[1–4] Because the ideal device for the treatment of most femoral fractures in children would be a simple, load-sharing internal splint that allows mobilization and maintenance of alignment and extremity length until bridging callus forms. The device would exploit a

child's dense metaphyseal bone, rapid healing and ability to remodel without risking damage to the physes or the blood supply to the capital femoral epiphysis.[5] In patients with multiple trauma, immediate stabilization of the femur is ideal. When a patient presents with an isolated open fracture of the femur, it is also best to irrigate, debride, and fix the fracture as soon as possible, as irrigation and debridement followed by skeletal traction for several days increase the risk of infection and can result in respiratory complications and difficulties with respect to nursing care.[6]

Early stabilization of femoral fractures has been shown to decrease morbidity and mortality. However, a severely injured patient who remains physiologically unstable may be able to tolerate only the shortest surgical procedure for fixation of a fracture of the femur. Option for surgical stabilization of fractures of the shaft of the femur include plate fixation, intramedullary nailing and external fixation.[7]

Although the specific techniques may vary, it is currently accepted that open fractures should be managed by early debridement of the wound and stabilization by internal or external fixation.[5,7] External fixation is an expedient and minimally invasive method of long bone fracture stabilization, but there have been reports of high rates of complications when fractures of femur have been treated with this method until union.[7,8] Treatment with external fixation for femoral shaft fractures could provide to refracture, pin infection, knee stiffness and nonunion .[5,7] The skeletal traction is a poor method of femoral fracture stabilization. There are many benefits of early fracture stabilization in multiply injured patients; the procedure facilitates patient mobility, improves pulmonary toilet,decreases inflammatory mediator response and decreases thromboembolic phenomena.[7,8] It nous seems that nailing the femoral fractures in children before age 6 years old is a good indication in polytrauma and depends of clinical conditions.

For type - I, II and IIIA B open fractures, the choice of fixation technique is not affected by the characteristics of the wound. Shaft femoral fractures should be fixed with intramedullary nailing, with the use of intramedullary reaming of bone for insertion of the nails, as several authors have shown that this techniques doesn't increase the risk of infection (200). Some authors propose using immediate external fixation for open fractures type IIIA, IIIB, IIIC, and followed by early closed intramedullary nailing. Type IIIC fractures should be treated temporarily with external fixation, as this requires less operative time and results in less soft tissue destruction however, a plate can be applied if the surgeon is comfortable with this technique. Definitive stabilization is performed when the condition of the wound and the patient permits.[2] In our department we use external fixation for type IIIC fractures, and after vascular repair we didn't converse external to internal fixation (Table 1).

Young children have a greater potential for periosteal bone formation. Healing is usually faster and more reliable in children that it is in adults with similar injures, and children can even have reconstitution of bone in face of bone loss.[1,2]

Fortunately, regardless of the treatment method, the vast majority of children with a diaphyseal femoral fracture have an excellent long-term results[5] and nonunion and major complications are not very common in pediatric fractures.[1,3]

Debate continues on the timing of closure in open fractures particularly on the role of immediate closure in type III injures. But with the availability of potent antibiotics and refinement in the techniques of surgical debridement, surgeons have advanced towards early and immediate closure of the wound. However, there is ample evidence that infection is generally the result of hospital acquired colonization rather than primary contamination. It has been shown that there is no correlation between contaminating organisms and those isolated in subsequent infection. Pre-operative cultures rarely grow drug-resistant organisms which are often found in infected open

Table 1 – Patients age, fracture type, trauma associated, ICU stay.

Number	Age	Trauma associated	Fracture type	Gustillo-Anderson	Intensive care unit stay	ISS scores
1	5		Transversal	I		9
2	7.5		Oblique	II		16
3	8	Head trauma- cerebral concusion	Oblique	II	+	32
4	9		Oblique	I		9
5	9.2	Humeral fracture	Oblique	I		13
6	9.5	Abdominal injury	Oblique	I	+	25
7	10.5	Head trauma- epidural hematoma, thorax injury	Transversal	II		41
8	10.8	Abdominal injury; Radial fracture	Transversal	I		20
9	11.2	Head trauma- cerebral concusion	Oblique	I		18
10	11.5	Head trauma- cerebral concusion	Comminuted	IIIA		25
11	12.8	Abdominal injury	Comminuted	I		13
12	13		Transversal	I		9
13	13.3	Head trauma- cerebral concusion; Pelvic fracture	Comminuted	IIIA	+	45
14	13.5	Abdominal injury	Comminuted	IIIB		25
15	14	Head trauma- cerebral concusion Bilateral femoral fractures	Oblique Transversal	I I		17
16	14.2	Radial fracture	Oblique	I		13
17	14.4	Abdominal injury, Monteggia fracture	Comminuted	IIIC	+	38
18	14.5	Head-cerebral concusion, thorax injury	Oblique	I		22

injures. Patzakis found that only 18% of infections were caused by the organism which was initially isolated in peri-operative period.[1,8] The rate of infection may in fact be greater in wounds which are left open in the hospital environment for closure at a later date. Leaving wounds open may also lead to avoidable desiccation of the tissues resulting in increased secondary loss of tissue, an increase in the number of surgical procedures required, a lengthened in patient stay and extra cost.[1,2]

The rates of infection after open femoral fractures in children was reported a 3% overall infection rate, with rates of 2% for type I fractures, 2% for type II fractures and 8% for III fractures.[1,2,4,5] The factors that influenced the infection rate included a failure to administer antibiotics, increased time from the injury to the administration of antibiotics, extended soft tissue damage. The infection rate was 2% for patients who had been given a cephalosporin, 10% for those who had been given penicillin and 14% for those who had not been given antibiotics. For first line prophylaxis is recommended the cephalosporin and eventually in type II and III gentamicin. There is no studies demonstrating a benefit to use of vancomycin or other agents instead of cephazolin.[1,2]

5. Conclusion

1. Treatment of open femoral fractures is a challenging problem
2. In children with polytrauma, multiple fractures, head injuries and other conditions which necessitate intensive nursing care, intramedullary nailing of opens femoral shaft fractures (type I, II, IIIA, IIIB) should be preferred.
3. Satisfactory results were obtained in all patients in terms of self evaluation of patients, radiological and clinical evaluation.
4. The infection rate was much lower for patients who had been given a cephalosporin than for patient who had been given a penicillin or had been given no antibiotic.

Conflicts of interest

All authors have none to declare.

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