Outcome of Titanium Elastic Intramedullary Nail in the Treatment of Shaft of Femur Fracture in Children.

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ABSTRACT

Background

Femoral-shaft fractures are among the most common fractures of the lower extremity in children. There are several different options for treating femoral-shaft fractures in children. Elastic stable intramedullary nailing (ESIN) has become the standard treatment for fractures of shaft of femur in children for reasons including mini-invasive surgery, no need for casting, early mobilization and discharge as well as growing concerns toward cost-effectiveness.

Objective

To demonstrate the effectiveness of intramedullary fixation of fracture shaft of femur in skeletally immature children using the titanium elastic intramedullary nails.

Method

Forty children who underwent fixation with titanium intramedullary nails because of fracture of shaft of femur (Winquist and Hansen type 1 and 2) were reviewed. There were 60% male and 40% female patients and mean follow-up was six months. Time of union, deformity at fracture site, limb length discrepancy, knee range of motion and complications were assessed.

Result

Average age of the patients was 5.17 years (range 3 to 10). All patients achieved complete healing at a mean 12.8 weeks (range 10 to 20 weeks). Average limb length discrepancy was -0.16 cm (range -1.0 to 1.1 cm) average knee range of motion was 137.55 degrees (range 118 to 152 degrees). Complications were recorded in 13 (31.7%) patients and included: Five malunion which did not show any deformity or functional impairment and eight superficial wound infections which were healed after removal of nail. All patients were active as their pre injury levels at six months follow up.

Conclusion

Elastic stable intramedullary nailing is the method of choice for the simple pediatrics fracture shaft of femur, as it is minimally invasive and shows good functional and cosmetic results. It allows short hospital stay and quick recovery from pain and is cast-free.

KEY WORDS

Children, fracture shaft of femur, titanium elastic nail (TEN).

INTRODUCTION

Femoral-shaft fractures are among the most common fractures of the lower extremity in children, with an annual incidence of up to 1 per 5,000.[1,2] There are several different options for treating femoral-shaft fractures in children, including early or immediate application of a hip spica cast, skeletal or skin traction followed by spica cast, closed reduction and minimally invasive plate osteosynthesis, close reduction and, elastic intramedullary nailing, external fixation, plate fixation, and internal fixation with the insertion of intramedullary nails.[3,4] Selecting the management strategy is dependent on factors such as the presence of other associated injuries or multiple trauma, fracture properties, age, and socioeconomic factors. Although initial traction followed by spica casting is traditionally used for femoral-shaft fractures in children, recent studies have shown its possible effects on social, economic, educational, and emotional costs. In contrast, elastic intramedullary nailing of femoral-shaft fractures has gained extensive popularity because of its better clinical and psycho-socioeconomic outcomes with lower risk of complications.[5,6]

Elastic stable intramedullary nailing (ESIN) has become the standard treatment for fractures of shaft of femur in children for reasons including mini-invasive surgery, no need for casting, early mobilization and discharge as well as growing concerns toward cost-effectiveness. The use of nails in children was pioneered in forearm fractures by Perez et al. 1977 and Firica et al. 1981.[7,8] But, the concept of two elastic intramedullary pins facing each other in a secant arc was developed and applied first to femur shaft fractures by the members of surgical staff from Nancy, France.[9] Under their impulsion, ESIN was promoted worldwide. We aimed to report our early experience of ESIN in fracture shaft of femur in children with short term follow up focusing on complications, and treatment results.

METHODS

This prospective observational study was conducted from July 2011 to December 2012 in the Department of orthopedic and trauma Surgery of Universal Medical College Teaching Hospital, Bhairhawa, Nepal. Children 3–10 years of age or maximum weight up to 40 Kg with simple femoral-shaft fractures (Winquist and Hansen Type I and II) participated in the study consecutively. Exclusion criteria were segmental, Winquist types III and IV comminuted fractures, previously diagnosed neuromuscular disease (e.g., cerebral palsy), metabolic bone disorders (e.g., osteomalacia), or pathological fractures, history of previous fracture or deformity in either limbs. Parents of all children gave informed consent prior to the study, which was authorized by the local scientific ethical committee. Surgery was performed with general anesthesia under the C-arm image intensifier. After a linear incision of about 2 cm, opening the fascia, and splitting the muscle fibers, a hole was opened in the distal femoral metaphysis about 2 cm proximal to distal femoral physis plate with a curved owl and enlarged. Then, each prebent titanium elastic nail was placed in retrograde through the distal part of the femur. Each nail was about 40% of the canal diameter at the narrowest site of the femoral shaft. Those cases where close reduction could not be achieved, open reduction were done through 2.5 cm anterolateral incision at the level of fracture. Nail was cut short to bury under the soft tissue. Wound was closed with sutures. Compression dressing was applied. All patients received second-generation cephalosporin prophylaxis, which was initiated just before the operation and continued 72 hours postoperatively. Knee bending exercises was started postoperatively as pain tolerated.

Patients were discharged after 3rd post operative day with non weight bearing crutch walking and followed up in outpatient department. Follow-up visits were made at two weeks when sutures were removed, six weeks when wound infection and progress of union was observed in x ray. At the same time patient was allowed to bear weight as tolerated. Then patient was followed up every fortnight to see progress of union. Nails were removed when union was achieved radiologically as well as clinically. Radiographs were reviewed for evidence of healing, defined as bridged femoral cortices (three or four of four cortices) on anteroposterior and lateral radiographs.[10] Clinical union was considered when patient can walk comfortably without support. Limb alignment and limb length discrepancy were assessed immediate post operatively and at the final follow up when nails were removed. Measurements of angulations in the sagittal and coronal planes were done on anteroposterior and lateral radiographs that were made at the first post operative day and at the time of removal of the nail. Limb length discrepancy was also measured in comparison to normal limb. Range of knee motion, incision and skin infections were also assessed at each visit. After six months post operatively all parents were contacted by phone to find out any possible complications. The complications were classified as major or minor. Major complications were defined as conditions leading to unscheduled nail removal or operative treatment, including deep infection, implant irritation, or pain and nail breakage and mlunion and nonunion.[11] Nonunion was defined as the absence of osseous union more than six months after the injury.[12] Malunion was defined as an angulations of >10 degree in the coronal plane or >15 degree in the sagittal plane. Minor complications were defined as nail irritation or infection that was treated non operatively.[11]

Data were analyzed using SPSS software (windows version 16.0).

Table 1. **Master chart of 40 cases with their particulars and follow up findings**

Case	Age	Sex	Wt. in Kg	Angulation on Postoperative Radiograph (degree)		Angulation on Final Radiograph (degree)		Knee ROM (degree)	Union (weeks)	Limb length discrepancy (mm)
				Anteroposterior	Lateral	Anteroposterior	Lateral			
1	4	M	22	Varus 1	Ant 3	Varus 3	Ant 10	142	16	16
2	3	M	20	Varus 2	Ant 6	Varus 5	Ant 8	138	10	10
3	7	F	27	Valgus 5	Ant 7	Varus 4	Ant 2	146	18	18
4	5	M	28	Varus 4	Ant 2	Varus 6	Ant 7	128	14	14
5	7	F	30	Varus 6	Post 8	Varus 9	Post 18	122	18	18
6	9	M	31	Varus 5	Ant 9	Varus 10	Ant 15	134	18	18
7	5	M	29	Varus 4	Ant 2	Varus 4	Ant 11	140	16	16
8	7	M	33	Varus 6	Post 7	Varus 7	Post 10	138	18	18
9	7	F	30	Varus 7	Ant 4	Varus 10	Ant 14	130	14	14
10	10	F	34	Valgus 4	Ant 10	Valgus 6	Ant 16	128	16	16
11	4	M	21	Varus 1	Ant 0	Varus 4	Ant 1	150	10	10
12	7	F	28	Varus 3	Ant 2	Varus 5	Ant 5	144	14	14
13	8	F	28	Varus 2	Ant 1	Varus 6	Ant 6	136	16	16
14	9	M	33	Varus 5	Ant 7	Varus 7	Ant 11	132	16	16
15	7	M	26	Varus 5	Post 6	Varus 8	Post 9	148	18	18
16	3	M	18	Valgus 2	Ant 3	Valgus 5	Ant 7	152	12	12
17	6	F	26	Varus 3	Ant 1	Varus 7	Ant 5	134	14	14
18	6	M	24	Varus 2	Post 5	Varus 6	Post 7	140	12	12
19	8	M	32	Varus 4	Ant 5	Varus 7	Ant 9	128	18	18
20	3	F	20	Varus 4	Ant 7	Varus 3	Ant 8	144	10	10
21	6	M	28	Varus 2	Ant 2	Varus 7	Ant 7	136	14	14
22	8	F	29	Valgus 4	Ant 6	Valgus 9	Ant 12	140	18	18
23	4	M	18	Varus 1	Post 4	Varus 3	Post 4	148	12	12
24	6	M	26	Varus 2	Ant 4	Varus 5	Ant 3	128	16	16
25	3	M	20	Varus 2	Post 1	Varus 7	Post 0	142	12	12
26	10	F	36	Varus 7	Ant 12	Varus 16	Ant 19	134	20	20
27	5	M	25	Varus 5	Ant 4	Varus 3	Ant 8	140	16	16
28	7	M	28	Valgus 5	Ant 9	Valgus 6	Ant 11	130	18	18
29	5	F	24	Varus 4	Ant 3	Varus 9	Ant 10	142	12	12
30	6	F	30	Varus 7	Ant 7	Varus 14	Ant 16	122	16	16
31	7	F	33	Varus 9	Post 11	Varus 10	Post 18	136	18	18
32	3	M	19	Varus 1	Ant 2	Varus 3	Ant 2	150	10	10
33	8	M	36	Valgus 4	Ant 10	Valgus 16	Ant 10	134	18	18
34	4	M	26	Varus 2	Ant 0	Varus 9	Ant 7	146	14	14
35	6	F	28	Varus 6	Ant 11	Varus 8	Ant 10	144	16	16
36	3	F	20	Varus 2	Post 1	Varus 4	Post 8	138	14	14
37	6	M	24	Varus 5	Ant 7	Varus 9	Ant 7	140	16	16
38	8	M	32	Varus 5	Ant 3	Varus 7	Ant 14	134	14	14
39	10	M	36	Varus 8	Ant 10	Varus 15	Ant 11	118	20	20
40	7	F	33	Valgus 8	Post 13	Valgus 18	Post 10	146	16	16

RESULTS

There were total 40 patients. Male patients were 60% and female were 40%. Average age was 5.17 years ranging from 3 to 10 years. All fracture united with average time of 12.8 weeks ranging from 10 to 20 weeks. Average limb length discrepancy was -0.16 centimeter ranging from -1.0 centimeter to 1.1 centimeter. Mean knee range of motion was 137.55 degrees ranging from 118 to 152 degrees. There were no major complications. Five cases had to open to achieve reduction. There were 5 cases of malunion and 8 cases of superficial infections. Detail is elaborated in the table 1 and complications are in table 2.

Table 2. Complications.

Complication	No of cases (n=40)
malunion	5
Nonunion	0
Deep infection	0
Superficial infection	8
Nail breakage	0
Implant revision	0

DISCUSSION

Pediatric femoral shaft fractures are conventionally treated by either primary hip spica or skin traction followed by hip spica. Fractures readily unite with some amount of overlapping and angulations which is believed to get corrected by remodeling potentiality in children.[13-15] This treatment requires prolonged hospitalization or immobility which has raised awareness of the possible social, economic, educational, and emotional burden of prolonged immobilization.[5,6,16] After publication of good outcomes by the Nancy group in the early 1980s, Elastic Stable Intramedullary Nailing (ESIN) has become a well-accepted method of surgical treatment of long bone fractures in children and adolescents.[9,17] Compared to plating, flexible intramedullary nailing of the femoral shaft fractures in patients provides better results.[18] There are many reasons for this acceptance including absence of postoperative casting in most cases, primary bone union without growth plate injury, rapid recovery of joint motion and return to physical activities, minimally invasive surgery allowing small and aesthetic scars, low infection rate, and shortened hospital stays.[19] In our series, there was more male as compared to female child which can be explained by the fact that male children are physically more active so get more injuries. Average union time was 12.8 week which is in comparison with the other series.[20,21] In our series we have found that there was average shortening of 0.16 cm which is very minimal in other series. This study reveals that there is some amount of shortening in the beginning but later there will be overgrowth. In our series knee range of motion was good in almost all cases except in those cases where there was superficial infection. These superficial infections caused pain and inflammation around knee which may cause reduction in the range of motion. This was recovered after control of infection after removal of nail. We encountered 5 (12.5%) cases of malunion but this malunion did not present any clinical and functional disability. Our rate of malunion is less that other series.[22]

Li et al. provided biomechanical evidence that patients weighing more than 40 to 45 kg who undergo stabilization of a transverse midshaft femur fracture with ESIN are at risk for loss of reduction in the sagittal and coronal planes.[23] We believe that remodeling potentiality in children will rectify angulation over period of time as shown in series of Flyn et al. where 20 degree angulation was remodeled to 7 degrees over a period of one year.[14] In our series we encountered 8 cases of superficial infection which resolves after removal of nail. This problem occurred in our initial cases where the nail was left long. This was protruding under the skin and cause infection. In later cases we used to cut the nail only one centimeter out of bone. Although in literature many complications including osteomyelitis, refracture, asymptomatic proximal nail migration, delayed healing or nonunion were described, in our series we did not encounter such complications.[5,24-27]

Our study has shortcomings such as the limited number of patients, short follow up duration and the lack of a control group. Therefore, further studies are needed involving large number of cases to draw definitive conclusion.

CONCLUSION

Elastic stable intramedullary nailing is the method of choice for the simple pediatrics fracture shaft of femur, as it is minimally invasive and shows good functional and cosmetic results. Surgical technique is simple and reproducible. It allows short hospital stay and quick recovery from pain and is cast-free.

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