

Results of Flexible Nails for Fixation of Tibial Diaphysis Fractures in Children

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Abstract

Background: Fracture tibia is one of the most common fractures in the pediatric age group. It accounts about 15% of cases. In majority of cases, close reduction and plaster application is the mainstay of treatment. **Objectives:** The objective was to assess the outcome of flexible nails in the treatment of tibial diaphysis fractures in children and to evaluate the results regarding the union rate and complications including limb length discrepancy, angular deformities, and pain. **Materials and Methods:** This prospective descriptive case-control study which included 30 children with 30 unilateral tibial diaphysis fractures in which the physis were open, all were closed, and open (type 1 and type 2) fractures, and with displaced transverse, short oblique, and spiral fractures, in which the trial of close reduction was failed. All patients are admitted and operated at West Erbil Emergency Hospital. Alignment of fractures, any infection, delayed union, nonunion, limb length discrepancy, motion of knee joint, time of complete union, and skin irritation were assessed with minimum follow-up period of 6 months. **Results:** In the current study, the complete union was achieved in 9–11 weeks in 20 (66.7%) patients, while in 6 (20%) patients, achieved in 12 weeks, and in 4 (13.3) patients, achieved in 13–16 weeks that were regarded as a delayed union. In 6 (20%) patients, there were nail protrusion and skin irritation, no shortening more than 0.5 cm was recorded, shortening <0.5 cm recorded in 12 (40%) patients, and no lengthening was recorded. In 3 (10%) patients, the angulations in coronal and sagittal views were 5°–10°. There was no case of nonunion. **Conclusion:** Elastic nails are an effective way for the treatment of the pediatric tibial diaphysis fractures. It is a simple and easy method but with radiation risk, although elastic nails have complications, all are avoidable and minor that will be managed with minimal intervention.

Keywords: Children, flexible nails, tibial diaphysis fracture, treatment

INTRODUCTION

Fracture tibia is one of the most common fractures in the pediatric age group. It accounts about 15% of cases. The prevalence of tibia fractures in both boys and girls has increased since 1950. The average age of occurrence is 8 years, and the frequency of occurrence does not change significantly with age. Seventy percent of pediatric tibial fractures are isolated injuries; ipsilateral fibular fractures occur with 30% of tibial fractures. Fifty percent to 70% of tibial fractures occur in the distal third and 19%–39% in the middle third. The least commonly affected is the proximal third. Thirty-five percent of pediatric tibial fractures are oblique, 32% comminuted, 20% transverse, and 13% spiral.^[1]

Rotational forces produce an oblique or a spiral fracture and are responsible for approximately 81% of all tibial fractures. Most tibial fractures in children are the result of traffic accidents.

The tibia is the second most commonly fractured long bone in abused children.^[1]

In majority of cases, close reduction and plaster application is the mainstay of treatment. Surgical treatment is indicated in case of failed close reduction, open fracture, fracture with neurovascular injuries, and polytrauma patients.^[2]

In large series of tibial shaft fractures treated with above-knee casts, the initial shortening of 10 mm was compensated wholly or partially by growth acceleration, mild varus deformities corrected spontaneously, valgus deformities, and posterior

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angulation persist to some degree and rotational deformities persisted, especially internal rotation. Spontaneous correction of angular deformity after tibial fractures has been reported to occur in boys up to age 10 years and in girls up to 8 years, however other reports indicate that little spontaneous correction occurs regardless of the age of the child.^[3]

Treatment of pediatric fractures dramatically changed in 1982, when Metaizeau *et al.* from Nancy, France, developed the technique of flexible stable intramedullary pinning using titanium pins. In the last two decades, there was increased interest in the operative treatment of pediatric fractures, although debate persisted over its indication.^[4]

Flexible intramedullary nailing in long bone fractures in pediatric age groups has become popular because of its effectiveness and less complications. Flexible intramedullary nails achieved biomechanical stability from its C configuration, which produce three points of fixation and acts as internal splint.^[4]

The aim of this study was to assess the outcome of flexible nails in the treatment of tibial diaphysis fractures in children and to evaluate the results regarding the union rate.

MATERIALS AND METHODS

This is a prospective descriptive case-control study which included 30 children with 30 unilateral tibial diaphysis fractures collected over the period between June 1, 2016 and June 1, 2017 with a minimum follow-up period of 6 months. All patients were admitted and underwent closed elastic nailing at West Erbil Emergency Teaching Hospital. A written consent was obtained from the parents of patients who were enrolled in this study. All patients had sustained trauma either due to road traffic accidents (RTAs) or fall from height (FFH).

Inclusion criteria

1. Children and adolescent patients with tibial diaphysis fractures in which the physis were open
2. All closed and open (type 1 and type 2) fractures
3. Patients with displaced transverse, short oblique, and spiral fractures, in which the trial of close reduction was failed
4. Patients with multiple injuries.

Exclusion criteria

1. Obese child more than 40 kg.
2. Vascular injuries which include segmental fractures, fractures near the knee or ankle joint, and patients with compartment syndrome of the leg.

All data were analyzed in a prospective manner from the preoperative period, intraoperative till the postoperative period including the outcome of the surgery regarding the union rate and complications.

Preoperative evaluation

After admission, all patients were assessed clinically and associated injuries were identified and treated accordingly; a brief history was taken from the patients and they receive

adequate analgesia, IV fluid, and adequate temporary splintage. AP and lateral radiograph of the leg including knee and ankle joint were taken and all were operated within 1 day after doing all necessary preoperative investigations including CBC and viral screen and blood group.

Ethical consideration

The study was conducted in accordance with the ethical principles that have their origin. It was carried out with patients' verbal approval before the sample was taken. The ethical approval of the present study was taken from the ethical clearance by the Ethical and Research Committee of the Iraq Board of medical specialties.

RESULTS

All 30 patients that sustained tibial diaphysis fractures were identified. Demographic data of the patients, fracture pattern, level of fracture, type of fracture, and associated injuries are mentioned in Table 1. All patients were skeletally immature; the average age was 7.6 years.

The gender incidences were 20 (66.7%) males and 10 (33.3%) females. The fractures were on the right side in 20 (66.7%) patients and 10 (33.3%) patients were on the left side.

The most common mechanism of the injury was RTAs in 22 (73.3%) patients and FFH in 8 (26.7%) patients.

In 20 (66.7) patients, the fractures were short oblique, in 6 (20%) were transverse, and in 4 (13.3%) patients were spiral. The fractures were closed in 24 (80%) patients, in 5 (16.7%) patients were type 1 open fracture, and in 1 (3.3%) patient was type 2 open fracture. In the current study, the associated injuries include (two patients with head injuries, one patient

Table 1: Demographic data of patients with tibial diaphysis fractures

Variables	Categories	n (%)
Gender	Male	20 (66.7)
	Female	10 (33.3)
Side of fracture	Right	20 (66.7)
	Left	10 (33.3)
Mechanism of injury	RTA	22 (73.3)
	FFH	8 (26.7)
Site of fracture	Upper	2 (6.6)
	Middle	20 (66.7)
	Lower	8 (26.7)
Pattern of fracture	Short oblique	20 (66.7)
	Spiral	4 (13.3)
	Transverse	6 (20.0)
Type of fracture	Open Type I Gustilo	5 (16.7)
	Open Type II Gustilo	1 (3.3)
	Closed	24 (80.0)
Associated injuries	Yes	5 (16.7)
	No	25 (83.3)
Total		30 (100)

RTA: Road traffic accident, FFH: Fall from height

with fracture clavicle, one patient with fracture 1st metatarsal bone, and another one patient with fracture distal radius) were present in 5 (16.7%) patients.

All patients that undergo operation, the operation time were taken to account, in which four (13.3%) patients with duration of operation were between 20 and 29 min, and in 26 (86.7%) patients, the duration of operation were 30–60 min, and average was 38.53 min as shown in Table 2. All fractures reduced closely.

In the current study, all patients were immobilized with back slab postoperatively, in which 14 (46.7%) patients were immobilized for 2–3 weeks, and 9 (30%) patients were immobilized for 4 weeks and 7 (23.3%) patients were immobilized for 5–6 weeks as shown in Table 3.

Regarding the complications that occur in our study, all were minor and treated accordingly; in 6 (20%) patients, there were nail protrusion and skin irritation that were treated in two of them by cutting the tip of nails because of severe pain and irritation as shown in Table 4.

Table 2: Duration of operation

Duration of operation (min)	Frequency (%)	Average
20-30	4 (13.3)	38.53
31-60	26 (86.7)	
Total	30 (100.0)	

Table 3: Postoperative immobilization

Postoperative immobilization (weeks)	Frequency (%)
2-3	14 (46.7)
4	9 (30)
5-6	7 (23.3)
Total	30 (100)

Table 4: Complications at 6 months

Variables	Categories	n (%)
Shortening	No	18 (60)
	<0.5 (cm)	12 (40)
Lengthening	Yes	0
	No	30 (100)
Angulation in AP view (°)	<5	27 (90)
	5-10	3 (10)
Rotation (°)	<5	30 (100)
Angulation in lateral view (°)	<5	27 (90)
	5-10	3 (10)
Pain at fracture site	Yes	0
	No	30 (100)
Nail protrusion and skin irritation	Yes	6 (20)
	No	24 (80)
Limitation of knee movement	Yes	3 (10)
	No	27 (90)
Total		30 (100)

AP: Anteroposterior

In 9 (30%) patients, the results were satisfactory due to skin irritation (in 6 of them) or malalignment (in 3 of them), and in 21 (70%) patients, the results were excellent and there were no poor results.

DISCUSSION

Tibial diaphysis fractures are common among the pediatric age groups, and still, it can be managed by cast immobilization as the first line of treatment, however sometimes, there are certain indications for surgical stabilization such as multiple injuries, unstable fractures, head injuries, open fractures, and failure of conservative treatment.^[5]

In the past, most of them even unstable fractures were treated by manipulation and cast immobilization had certain complications including malunion, limb length discrepancy, or they use traditional fixations like external fixations which sometimes lead to pin tract infection. But with the development of elastic nails, most of these complications have been minimized as these nails provide a load-sharing biocompatible internal splint, allow early mobilization, and avoid any growth disturbance by preventing damage to the epiphyseal plate and with minimal risk of infection and soft tissue damage.^[6]

In the current study, the right side was more common than the left side, 66.7% were right and 33.3% were left, regarding the mechanism of injury in the current study. RTA was more common than FFH in which 73.3% were due to RTA, while in 26.7% were due to FFH. These results are compatible to study was conducted by Dr. Rshid Anjum showed that the right side was more common than the left, 60% were right and 40% were left, also the RTA was the most common one, 80% were due to RTA and 20% due to FFH.^[7]

The current study showed that the fractures were more common in the middle third about 20 (66.7%) patients, while 8 (26.7%) patients occurred in the lower third and 2 (6.6%) patients with upper third fractures, although the most common one is the distal one,^[1] the current study showed that the middle was the most common which might be due to excluding fractures near the joints in the current study; these results are compatible to study done by Sankar and Kristofer which included 19 patients, in 15 of them occurred in the middle third, in two of them occurred on upper third, and in the other two patients occurred in the lower third which was due to the same reason.^[8]

In the current study, the average of time of complete union was 11.33 weeks which is compatible to study done by O'Brien; it showed that the time of complete union was 9 weeks,^[9] in other study done by Zarad, the average time of complete union was 10 weeks which is compatible to the current study.^[10] In a study done by Mark G. Swindells, the average of time of complete union was 10 weeks^[11] and in a study done by Atul Bhaskar, the average of time of complete union was 11 weeks^[12] which are all compatible.

In the current study, there was no any case of nonunion as they were all reduced closely which is compatible to the study

done by Basil Kamran which also did not have any case of nonunion.^[13] In the current study, there were four cases of the delayed union in which complete healing took more than 12 weeks which was due to type of fracture which was open, this is compatible to study done by Kapil Mani in which there were four cases of the delayed union from a total of 45 cases and no cases of nonunion.^[5]

Regarding the complications that occurred in the current study, most were minor, including nail protrusion that happened in six patients which was due to improper cutting of the nails and angulation 5°–10° in three patients which was due to inadequate reduction. This is compatible to a study done by Elseyd Ahmed in which there were three patients of a total of 20 patients with nail protrusion and skin irritation, and only two patients with angulation 5°–10°.^[14]

Regarding limb length discrepancy, in the current study, not more than 5 mm discrepancy was recorded and this little discrepancy might be due to overlapping, especially in spiral fractures, compatible results were recorded by a study done by Jeong Heo, in 16 patients with tibial diaphysis fracture no more than 10 mm discrepancy was recorded.^[15]

CONCLUSION

Elastic nails are an effective way for the treatment of pediatric tibial diaphysis fractures; they control the length, angulations, and rotation as they provide stability through three points of fixations for each nail. It is a simple and easy method but with radiation risk. Although elastic nails had complications, all are avoidable and minor that managed with minimal intervention.

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Conflicts of interest

There are no conflicts of interest.

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