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Evaluation of Early Results of Tibial Fractures Fixation in Pediatrics by Flexible Intramedullary Nailing

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ABSTRACT

Background: Tibial shaft fracture is an incapacitating pediatric injury. The treatment has traditionally been age-related, influenced by the type of injury, associated injuries and the location and type of the fracture. To a great extent, treatment options vary according to the surgeon's preference.

Objective: The aim of the present study was to evaluate the results of treatment of displaced diaphyseal fractures of the tibia in children aged between5 and 15 years by closed reduction and percutaneous flexible intramedullary nailing.

Patients and methods: A total of 18 patients were included in the study; they were admitted to the hospital suffering from tibial shaft fractures. On admission all patients were assessed by history taking, clinical examination and radiological evaluation. **Results:** The mean age was 10.22 (SD 1.99) years. Only 5 (27.8%) patients were girls, while 13 (72.2%) patients were boys. The mechanism of trauma in the patients was road traffic accidents in 15 (83.3%) patients and falling from height in 3 (16.7%) patients. Radiographic angulation occurred in 1 patient had varus malalignment (more than 5 and less than 10°). Limb- length inequality is less than 1 cm in all cases. The final results obtained were excellent in 15 (83.3%) patients and satisfactory in 3 (16.7%) patients. There was no statistically significant difference found between two reduction methods (opened and closed) regarding malalignment, complications and score flynn.

Conclusion: Flexible intramedullary nailing is a relatively simple and effective way to stabilize open and closed fractures of diaphyseal tibial fractures in the six to twelve years age group with few complications, allowing early mobilization and excellent functional outcome. The procedure has low morbidity and good results with short hospitalization.

Keywords: Tibial Fractures Fixation, Pediatrics, Flexible Intramedullary Nailing, Limb- length inequality.

INTRODUCTION

Tibial fractures in the skeletally immature patient are frequent and can usually be treated without surgery by closed reduction and casting during 6 or 8 weeks [(1)].

External fixation, although producing acceptable results, is fraught with many complications as is plate osteosynthesis and rigid intramedullary nailing which may also require a second major surgery for removal of implant [(2)].

Flexible intramedullary nailing is commonly used in femoral shaft fractures, but much less so for tibial fractures. This technique has many advantages. Namely, it does not require a postoperative cast; there is primary bone union with avoidance of growth plate injury, early weight bearing, and minimally invasive surgery with a short duration of hospitalization. The good results of flexible intramedullary nailing in femur and forearm fractures justify the use of this technique to treat tibial shaft fractures [(3)].

Multiple studies reported good results using flexible titanium nails in the treatment of unstable fractures of the tibia in children. They concluded that flexible intramedullary nailing is a relatively simple and effective way to stabilize open and closed fractures of the tibia in children with few complications, allowing early mobilization and an excellent functional outcome [(4,5)].

Reviewed the currently available evidence for the use of Elastic Stable Intramedullary Nails (ESIN) in the skeletally immature pediatric patient with an unstable fracture of the tibial diaphysis, it is concluded that the vast majority of pediatric tibial fractures can be successfully treated conservatively with immobilization in a cast. Unstable or open fractures, polytrauma and neurovascular compromise may each necessitate a surgical procedure. Elastic stable intramedullary nailing provides an acceptable option where surgery is unavoidable [(5)].

Griffet *et al.* assessed the use of flexible intramedullary nailing with flexible nails to treat displaced tibial fractures in children over 6 years old. They concluded that fixation of pediatric diaphyseal tibial fractures with flexible intramedullary nailing is a rapid, well-codified and effective method for treating long-bone closed fractures in children. Advantages over other fixation techniques include a lower infection rate, a lower refracture rate, ease of management, and an aesthetically pleasing scar[(6)].

The aim of this study was to evaluate the results of treatment of displaced diaphyseal fractures of the tibia in children aged between5 and 15 years by closed reduction and percutaneous flexible intramedullary nailing.

PATIENTS AND METHODS

The study included 18 patients presented at Zagazig University Hospital and Nasser Institute Hospital,

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suffering from displaced diaphyseal fractures of the tibia in children aged between 5 and 15 years. All patients were treated using Flexible Intramedullary Indications Nails.

Inclusion criteria: Children aged from 5 to 15 years, unstable fracture patterns (tibial spiral, oblique and comminuted shaft fractures are almost always very displaced and unstable), unaccepted closed reduction, and open fractures grades I.

Exclusion criteria: Heavy adolescents, complex fractures, open fractures grade IIIb and IIIc, and fractures with bone loss.

On admission patients were clinically assessed as follows:
Personal data: Name, age, sex, and address.
Complaints: Pain, swelling of the leg, inability to use the injured limb, and affection of other regions.
History of the present symptoms: Time of injury, mechanism of injury, and time lapse before surgery.

Clinical examination:
- *General examination included* pulse, blood pressure, level of consciousness, evaluation of the general condition of the patient, and systemic examination searching for associated injury.
- *Local examination included* side affected, swelling or deformity, palpation for tenderness, skin condition, examination of the whole body for other associated injuries, vascular and neurological examination of the affected limb. The ipsilateral hip, femur, knee and foot were examined for associated injuries.

Radiological assessment: Antero posterior- and lateral X-rays were done for the entire of the affected leg from the knee to the ankle, and antero posterior X-ray of the pelvis.

X-ray was examined for the following: (1) Level of the fracture: at the proximal, middle, or distal thirds. (2) Shape of the fracture: transverse, short oblique…. etc. (3) The presence of displacement (coronal or; sagittal), over riding and angulations. (4) Associated hip or knee fractures or dislocation. (5) X-ray for associated fractures elsewhere in the body guided by the clinical examination. (6) AO classification.
Laboratory investigations: (1) CBC. (2) RH and ABO incompatibility.

Ethical consent:
An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every guardian signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis:
Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric. The comparison between two groups with qualitative data were done by using Chi-square test and/or Fisher exact test was used instead of Chi-square test when the expected count in any cell was found less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done by using Independent t-test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$ = non-significant (NS). $P < 0.05$ = significant (S). $P < 0.001$ = highly significant (HS).

RESULTS
This study included 18 patients with diaphyseal fractures of the tibia in children. Table 1 summarizes demographic data of participants.

Table (1): Distribution of the studied cases according to Demographic Data

Variable		No.= 18
Age	Mean ± SD	10.22 ± 1.99
	Range	6 – 13
Sex	Female	5 (27.8%)
	Male	13 (72.2%)

Table 2 shows distribution of the studied cases according to limb-length inequality, malalignment, pain, complications and score flynn.

Table (2): Distribution of the studied cases according to Limb-length inequality, Malalignment, Pain, Complications and Score Flynn.

Variable		No.	%
Limb-length inequality	< 1.0 cm	18	100%
Malalignment	< 5 degrees	17	94.4%
	> 5 degrees	1	5.6%
Pain	None	18	100%
Complications:	None	16	88.9%
	Poor healing for waiting	1	5.6%
	Protrusion and removed	1	5.6%
Score Flynn	Excellent	15	83.3%
	Satiated	3	16.7%

Table 3 shows that there was no statistically significant difference found between the two the reduction methods, as regard age and sex.

Table (3): Comparison between Reduction method Closed (no. =15) and Reduction method Open (no. =3) regarding age and sex.

Variable		Reduction method		Test value	P-value	Sig.
		Closed	Open			
		No.= 15	No.= 3			
Age	Mean ± SD	10.07 ± 2.05	11.00 ± 1.73	-0.733•	0.474	NS
	Range	6 – 13	10 – 13			
Sex	Female	5 (33.3%)	0 (0.0%)	1.385*	0.239	NS
	Male	10 (66.7%)	3 (100.0%)			

P-value >0.05: Non-significant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS)
*: Chi-square test, •: Independent t-test

Table 4 shows that there was no statistically significant difference found between two groups regarding duration of operation (min) and number of image during operation, and there was highly statistically significant difference found between the two the reduction methods, regarding Blood loss during operation (CC).

Table (4): Comparison between reduction methods [closed (no. =15) and reduction method Open (no. =3)] regarding duration of operation (min), blood loss during operation (CC) and number of image during operation.

Variable		Reduction method		Test value	P-value	Sig.
		Closed	Open			
		No.= 15	No.= 3			
Duration of operation (min)	Mean ± SD	61 ± 14.28	76.67 ± 17.82	-1.816•	0.088	NS
	Range	45 – 90	60 – 100			
Blood loss during operation(CC)	Mean ± SD	45.67 ± 11.21	116.67 ± 15.28	-6.282•	0.000	HS
	Range	30 – 90	100 – 130			
Number of image during operation	Mean ± SD	42.47 ± 5.89	46.67 ± 11.28	-0.861•	0.402	NS
	Range	35 – 52	30 – 60			
Early result	No infection	15 (100%)	3 (100%)	NA	NA	NA

P-value >0.05: Non-significant (NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant (HS)
*: Chi-square test, •: Independent t-test

Table 5 shows that there was no statistically significant difference found between the two the reduction methods, regarding malalignment, complications and score flynn.

Table (5): Comparison between reduction methods [Closed (no. =15) and reduction method Open (no. =3)] regarding malalignment, complications and score Flynn.

Variable		Reduction method				Test value*	P-value	Sig.
		Closed		Open				
		No.	%	No.	%			
Malalignment	< 5 degrees	14	93.3%	3	100%	0.212	0.645	NS
	> 5 degrees	1	6.7%	0	0%			
Complications	None	14	93.3%	2	66.7%	5.400	0.067	NS
	Poor healing for waiting	1	6.7%	0	0%			
	Protrousion and removed	0	0%	1	33.3%			
Score flynn	Excellent	13	86.7%	2	66.7%	0.720	0.396	NS
	Satiated	2	13.3%	1	33.3%			

P-value >0.05: Non-significant (NS); P-value <0.05: Significant(S); P-value <0.01: highly significant (HS), *: Chi-square test, •: Independent t-test.

DISCUSSION

In the present study and according to the used criteria for evaluation [7, 8], the results obtained in the 18 patients were excellent in 15 (83.3%) patients, and satisfactory in 3 (16.7%) patients. One of these satisfactory cases had pain at nail insertion which resolved after nail removal after about 3 months. Another one of the satisfactory cases had about 10 degrees angulation, and the last case of the 3 satisfactory patients had poor healing. Our results obtained were found comparable to the results of other studies that used the same method of treatment [9,10].

O'Brien *et al.* [9] reported 16 fractures of the tibia, fixed internally with flexible titanium nails, which achieved a very good functional outcome with no significant angulation or leg length discrepancy and no infections [9]. **EL-Adl *et al.*** [11] treated 25 tibial fractures by ESIN. Based on **Flynn *et al.*** [8] outcome rating system, 75.8% of the results were excellent, 24.2% were satisfactory and there were no poor results.

Vallamshetla *et al.* [12] reported on 56 fractures of the tibia, fixed internally with intramedullary elastic nails with excellent outcome in 84% of cases (two residual angulations of the tibia, two leg-length discrepancy, two deep infections, one delayed union and two failures of fixation).

In this study, all children had open tibial growth plates at the time of fixation. The mean age of closed method was 10.07 years, whereas the mean age of open method was 11 years. In the closed method, there were 5 females and 10 males. While in open method, there were 3 males and no male. The difference was statistically insignificant. This indicates that age and sex were not an influencing factor on the reduction method.

Rotational malalignment was not noted in **EL-Adl *et al.*** [11] study due to utmost care being taken during intraoperative limb positioning. **Ligier *et al.*** [13] and **Flynn *et al.*** [8] have reported a similar finding, supporting the concept that TENs can give rotational stability if good care is taken intra-operatively during nail insertion and postoperatively, especially for comminuted, spiral, and long oblique fractures.

In this series, one patient had varus malalignment (more 5 and less than 10°). Analysis of this fracture showed improper contouring of the nails; the apex of curvature was distal to the fracture site. Analysis of this fracture revealed that one of the nails was improperly contoured.

Goodwin *et al.* [10] reported two cases of angulation (more than 10°). **Sankar *et al.*** [14] reported four patients had a malunion with malalignment greater than 5°, one in the sagittal plane and three in the coronal plane.

In this study, all patients had their nails removed as a day case procedure under general anaesthesia after an average period of twenty weeks (range from twelve to twenty-eight weeks postoperatively), without any complication during or after the procedure.

In **Kubiak *et al.*** [15] work nails were removed after an average period of thirty-six weeks (range, 16 to 78 weeks). In **El-Adl *et al.*** [11] study the TENs were removed in 87.8% of patients, on average 5.9 months after operation (range, 3 to 9 months).

In conclusion, flexible intramedullary nailing is a relatively simple and effective way to stabilize open and closed fractures of diaphyseal tibial fractures in the six to twelve years age group with few complications, allowing early mobilization and excellent functional outcome. The procedure has low morbidity and good results with short hospitalization.

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