

Complication Rates and Results of Higher Weight for Age Patient in Pediatric Femoral Shaft Fractures Treated with Titanium Elastic Nailing

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Abstract

Objective: The incidence of femoral shaft fractures in pediatric population is approximately 20 in 100,000. The choice of treatment depends on age, weight, the mechanism of injury, type and location of fracture, socioeconomic status, and the cost effectiveness. In the literature, it has been shown that the relation between complications of titanium elastic nailing (TEN) of femoral shaft fractures. The objective of our study is to investigate the association between the weight and complication rates of pediatric femoral shaft fractures treated with TEN.

Methods: Between 2013 and 2016, a total of 50 patients aged between 6 and 13 years with femoral shaft fracture treated with TEN in our hospital were analyzed retrospectively. Complication rates were analyzed using the SPSS 22.0 program according to the fracture type, demographical features, and weight.

Results: The analysis showed that age, gender, the fracture site, and the localization of fracture did not have a statistically significant association in the group with complications and the other group ($p>0.05$). When comparing the fracture stability and complication rates, in the unstable femoral shaft fracture group, there were statistically significant high complication rates ($p<0.05$). The weight for age percentiles of the group with complications was statistically significantly higher than in the group without complications ($p<0.05$).

Conclusion: It was shown that there is association between the complication rates and weight for age percentiles. When choosing the patient or treatment modality, this factor should also be considered. We believe that the families should be informed about the increased risks in these overweight and obese patients.

Keywords: Femoral fractures, fracture fixation, intramedullary, trauma

INTRODUCTION

Femoral shaft fractures account for 2% of all pediatric fractures, and their incidence is approximately 20 in 100,000. These fractures show bimodal distribution in the early-childhood and middle-adolescence periods (1-6). They are usually caused by a high-energy trauma associated with falling or motor vehicle accidents. They are approximately 2.5 times more common in girls than in boys (7, 8).

Pediatric femoral shaft fractures are treated by various methods, such as the Pavlik bandage, immediate pelvipedal casting, pelvipedal casting after traction, open reduction-internal fixation, external fixation, and elastic or interlocking intramedullary (IM) nailing (9-12).

Treatment options vary depending on many factors, such as the child's age, weight, the injury mechanism, type and location of the fracture, accompanying injuries, familial social status, and treatment costs (12). In the literature, the most important factor affecting the treatment approach among these factors is the age of the child. Although there is little discussion on the immediate

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pelvipedal casting treatment or pelvipedal casting treatment after traction in the treatment of femoral shaft fractures in children under 5 years of age, the treatment of the pediatric population between the ages of 6 and 14 years is still controversial.

In recent years, surgical treatment has gained more importance in these fractures because it leads to minimal soft tissue injury, a shorter hospital stay, an early return to school or home, less psychosocial effects on the family and child, and economic effects (13-16). These surgical treatment options are associated with some complications, such as the occurrence of re-fracture and pin-tract infections after the external fixator treatment, the development of avascular necrosis of the femoral head following interlocking IM nailing (12) and coxa valga (17), and wide soft tissue dissection and infection after open reduction--internal fixation (12, 16).

Among these treatment options, elastic IM nailing is one of the conservative and surgical treatment modalities. It does not harm the physis or the femoral head with a small incision, it adapts to the osteocampsia, and it acts as a load sharing internal fixation tool until the callus tissue is formed without opening the fracture line (17). This technique has become even more popular, especially after reporting excellent results of elastic IM nailing in femoral midshaft fractures in the literature. At the same time, the application of elastic IM nailing is a method with a higher cosmetic acceptance compared to other surgical alternatives (18).

The ideal patient for elastic IM nailing is a child between the ages of 5 and 11 years, stable, below the weight of 50 kg, and has a fracture in the middle 80% of the femoral diaphysis (19). Complications are relatively low after this treatment. In a multicenter study on factors causing complications after the elastic IM nailing in pediatric femoral shaft fractures, poor outcomes have been reported in children with the weight of 50 kg and above at an up to 5 times higher rate and in children over 11 years of age at an up to 4 times higher rate (19). In the literature, while there are studies demonstrating a complication rate of 34% in children aged 10 years and above, the complications of elastic IM nailing were emphasized to be higher in older and bigger children in many studies (20).

In the literature, the relationship between the weight and the age of the child and elastic IM nailing treatment complications of femoral shaft fractures has been shown in many studies. The aim of this study was to determine the relationship between the complication rates of pediatric femur shaft fractures treated with elastic IM nailing and body weight percentiles of this pediatric population and to demonstrate the relationship with treatment outcomes.

METHODS

In this study, a total of 50 pediatric patients aged from 6 years to 13 years, whose mean age was 9.3 years, and who were operated with elastic IM nailing due to femoral shaft fracture in the Bağcılar Education and Research Hospital between 2013 and 2016, were analyzed retrospectively. Because of it was a retrospective study local ethics committee approval was not obtained but the study was planned in accordance with the Helsinki declaration and also written informed consents were obtained from the parents of the patients. The body weight of the patients ranged from 18 to 68 kg, with an average weight of 35.8 kg. Children with underlying metabolic/endocrine or neuromuscular diseases and pathological fractures, patients with ipsilateral or contralateral fractures, an accompanying vascular/nerve injury, and open fractures were not included in the study. The age and weight of the patients were recorded, and body weight percentiles were calculated.

The patients operated on a radiolucent operation table in supine position by four orthopedic surgeons who had the same surgical experience, and the fractures were reduced as closed with manipulative traction under fluoroscopy. Osteosynthesis was obtained using the retrograde titanium elastic nailing (TEN). Two nails were used in each patient. The diameter of the nail was chosen to be 40% of the narrowest part of the diaphysis. A mini incision that was 2-3 cm in length was applied to all patients.

After the operation, postoperative anteroposterior and lateral radiographies were taken, the operated lower extremities of the patients were elevated with a pillow, and the hip and knee mobilization was started on the postoperative day 1. The patients, especially those with unstable fractures, were not allowed to bear



Figure 1. a-f. Anterior-posterior and lateral direct radiographs of an 8-year-old male patient's right transverse midshaft femoral shaft fracture after a non-vehicle traffic accident (a, b). Postoperative anteroposterior and lateral radiographs of the patient who was operated with closed reduction by using two titanium elastic nails (c, d). Postoperative 6th month anterior-posterior and lateral direct radiographs of the patient (e, f)

weight on the operated extremities for 3-4 weeks. The patients were followed-up at regular intervals. When fracture healing was observed in at least three cortices in the anteroposterior and lateral radiographs, the occurrence of bone union was accepted, and the patient was allowed to bear weight completely. Both femoral elastic intramedullary titanium nails were removed in the postoperative 6th month in all patients (Figure 1a-f).

Patients' age, weight, weight percentiles, fracture localization and side, fracture stability, and complications were recorded. Leg length inequalities of more than 2 cm were noted.

Statistical Analysis

In the descriptive statistics of the data, the mean, standard deviation, median minimum-maximum, frequency, and ratio values were used. The distribution of the variables was measured by the Kolmogorov-Simonov test. The Mann-Whitney U Test was employed for the analysis of quantitative independent data. The chi-squared test was used for the analysis of qualitative independent data. The Statistical Package for Social Sciences, version 22.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for the data analyses.

RESULTS

In this study, a total of 50 pediatric patients who underwent surgery for closed femoral shaft fractures with the method of two elastic IM nails by applying the retrograde from the distal metaphysis between 2013 and 2016 were evaluated retrospectively. Of these patients, 42 (84%) were male, and 8 (16%) were female. The weight of the patients varied between 18 kg and 68 kg (median 35.8 kg), and their ages ranged from 6 years to 13 years. In terms of weight percentiles, 9 of the patients (18%) were below 25%, 10 (20%) were between 25% and 50%, 15 (30%) were between 50% and 75%, 4 (8%) were between 75% and 90%, and 12 (24%) were between 90% and 100% (Table 1). In terms of body weight, 14 of all patients (28%) were above 50 kg, and 36 (72%) were below 50 kg. Of these fractures, 25 (50%) were on the right side, and 25 (50%) were on the left side. Thirty-two (64%) of these fractures were stable, and 18 (36%) were unstable. With regard to the localizations of the fractures, 13 (26%) were proximal, 35 (70%) were middle, and 2 (4%) were distal femoral shaft fractures. The mean follow-up of patients was 22 months, and for at least 12 months (Table 1).

Complications such as pin-tract irritation, superficial and deep infection, shortness, a reduced joint range of motion, re-fracture, non-union, mal-union, delayed union, varus-valgus and procurvatum-recurvatum angulation disorder, compartment syndrome, neurovascular injury, or the need for another surgical procedure were considered. With regard to the rates of these complications, 20 (40%) of the patients developed complications, and 30 (60%) had no complication during follow-up and treatment periods. None of the patients had more than one complication. Of the patients developing complications, 12 (60%) had pain due to pin-tract irritation, 6 (30%) had superficial wound site infection, and 2 (10%) had shortness less than 2 cm.

In 9 of the patients who developed pain due to pin-tract irritation and knee-joint movement limitation, a prominent nail tip was palpated under the skin upon the examination. The patients with superficial wound site infection were treated with oral antibiotics without any re-operation requirements and without any

Table 1. Demographic characteristics and percentile percentages of the patients

	Min-Max	Median	Mean±SD	
Age	6-13	9	9.3±23	
Gender	Male		42	84.0%
	Female		8	16.0%
Weight	18-68	34	35.8±12.4	
	≤25%		9	18.0%
	26-50%		10	20.0%
Percentile	50-75%		15	30.0%
	75-90%		4	8.0%
	90-100%		12	24.0%

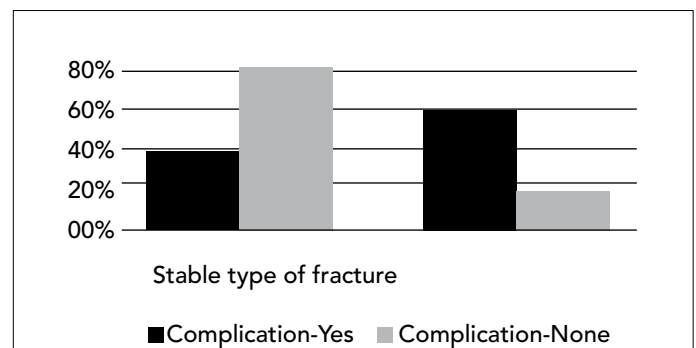


Figure 2. Comparison of the fracture stability and complication rates

problems. There were shortenings of 1.5 cm and 1.7 cm in 2 patients with shortness. In the clinical follow-up, none of them had any functional problems.

In none of the patients, possible complications such as a decrease in the joint range of motion, re-fracture, non-union, mal-union, delayed union, varus-valgus and procurvatum-recurvatum angulation disorder, deep infection, compartment syndrome, neurovascular injury, or the need for another surgical procedure were observed at the completion of the clinical follow-up. When the clinical follow-up was terminated in the patients who developed complications, no problems were encountered from radiographic and functional aspects. When the stability and complication rates of the fractures were compared, the complication rates were found to be significantly higher in the group with the unstable femoral shaft fracture ($p < 0.05$) (Figure 2).

When the body weight percentiles and complication rates of the patients were compared, while no complication was observed in patients with the body weight percentile up to 50%, complications developed in 4 patients (20%) with the body weight percentile between 50% and 75%, in 4 patients (20%) with the body weight percentile between 75% and 90%, and in 12 patients (60%) with the body weight percentile between 90% and 100% (Figure 3). Of these patients developing complications, 14 (70%) were over 50 kg, and 6 (30%) were below 50 kg.

While the mean body weight of the patients who developed complications was 38.5 kg, it was detected to be 30 kg in the group

without complications. In terms of the complication rates in patients with the body weight above 50 kg and body weight percentiles between 90% and 100%, the results were found to be similar (Figure 3). Of 8 patients with the body weight percentile below 90%, 6 had pain associated with pin-tract irritation and movement limitation, and 2 had a superficial wound site infection. In the patient group with a weight percentile between 90% and 100%, pin-tract irritation was detected in 6 patients, a superficial wound site infection in 4 patients, and shortness in 2 patients.

The age, sex distribution, side distribution, and fracture localization of patients with and without complications did not differ significantly ($p>0.05$). The weight percentile values were significantly higher in the group with complications than in the group without complications ($p<0.05$) (Table 2).

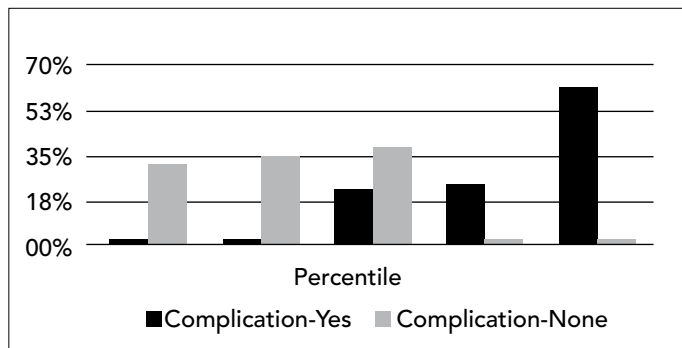


Figure 3. Comparison of weight percentile percentages and complication rates of the patients

DISCUSSION

In the treatment of pediatric femoral shaft fractures, TEN has been frequently used in recent years as a biological and minimally invasive treatment method for the reduction and stabilization of these fractures, with minimal complications and easy treatment (21). Treatment options vary depending on many factors, such as age, weight, the injury mechanism, fracture type and location, accompanying injuries of the child, familial social status, and treatment costs. All these factors lead to difficulties in the treatment of pediatric patients and in the management of complications.

Overweight and obese patients are especially more prone to the development of complications and medical problems in orthopedic surgery (22). In the previously conducted studies, the effects of being overweight or obese on the fracture union were investigated, and the high complication rates in these groups were thought to be due to the negative effects of endocrine effects of fat tissue on the bone tissue (23). It has also been shown that vitamin D levels are lower in obese patients and that this affects the bone health negatively (24). Obese patients are also in the high-risk group for the occurrence of fractures due to a lower bone mineral density (25).

Obesity is also one of the factors affecting the choice of surgeon in terms of treatment options in the fracture treatment. Particularly in some studies on pediatric femoral shaft fractures, obese patients treated with surgical and conservative approaches were compared, and the difficulty of pelvipedal casting and the com-

Table 2. Comparison of the demographic characteristics, fracture type and weight percentile percentages of the patients with complication rates

		Complication-Yes		Complication-none		p
		Mean±SD	Median	Mean±SD	Median	
Age		9.4±2.3	9	9.2±2.3	9	0.749
Gender	Male	18		24		0.345
	Female	2		6		
Weight		42.5±13.1	38.5	31.4±9.9	30	0.004
Percentile	<25%	0	9			0.000
	26-50%	0	10			
	50-75%	4	11			
	75-90%	4	0			
	90-100%	12		0		
Side	Right	13		12		0.083
	Left	7		18		
Fracture localization	Proximal	4		9		0.645
	Middle	16		19		
	Distal	0		2		
Type of fracture	Stable	8		24		0.004
	Unstable	12		6		

Mann-Whitney U Test/Chi-Square Test

plications of surgical treatment were discussed for these patients (26). For these reasons, the choice of treatment for these patients creates difficulties for orthopedic surgeons. In the literature, there are also studies showing that obesity increases the risk of non-union in the upper and lower extremity fractures (27). In our study, when all groups were evaluated, non-union was not observed.

Surgical treatment is primarily considered particularly in patients with accompanying head trauma, multitrauma, open fractures, and pathological fractures and in cases with an obstacle for casting (10). In our study, the patients with isolated, unilateral, closed femoral shaft fractures unaccompanied by other traumas were included.

Complications such as unequal leg length, angular deformity, rotational deformity, delayed union, non-union, and infection can be seen in the treatment of pediatric femoral shaft fractures, depending on the patient's demographic characteristics, fracture type, and treatment modality. One of the complications is the avascular necrosis of the femoral head developing after antegrade nailing (14). In our study, the retrograde IM nailing method was used for all fractures.

Previous studies have shown that pediatric femoral shaft fractures treated with IM elastic nails have high complication rates in larger children (28). In the previously performed studies, it has been demonstrated that the post-treatment complication rates of femoral shaft fractures in children older than 10 years are higher than in those younger than 10 years.

In another study performed by Gogi et al. (29), the complication rate after the treatment of femoral shaft fractures with TEN was reported to be higher in children over 50 kg. In our study, when the weight and body weight percentiles of the patients operated by us were evaluated in terms of complication rates, it was found that the complication rates were higher in patients with high weight and body weight percentiles, particularly in those with the body weight percentile between 90% and 100%, than in other groups.

Although the use of TEN has become widespread in pediatric femoral shaft fractures, studies on complications still have to be conducted. In a study performed by Flynn et al. (27), complications such as alignment disorder in 7 patients, pin-tract irritation in 4 patients, and return of nail in 1 patient were reported.

In a study by Luhmann et al. (30), 43 patients with femoral shaft fractures were evaluated, and 21 of these patients were stated to have complications. Most of these complications were reported to be pin-tract irritation and pain. In our study, complications were observed in 20 of 50 patients included in the study. Of these patients, 12 had pain due to pin-tract irritation, 6 had superficial wound site infection, and 2 had shortness less than 2 cm.

In this study, different from previous studies on the factors such as age and weight for the possible postoperative complications and functional outcomes in patients operated with a TEN for pediatric femoral shaft fractures, complications were evaluated considering the body weight percentiles of the patients. Although the complication rates of the group with a body weight of 50 kg and above were similar to those of the group with body weight percentiles between 90% and 100%, the same results were not obtained.

CONCLUSION

This study showed a significant relationship between the body weight percentile and complication rates, and we think that orthopedic surgeons should also take this factor into consideration in the selection of patients and treatment, and the parents of overweight and obese patients should also be informed on this issue. We believe that this study will contribute to the complication rates of obese patients who are planned to be operated with TEN for the treatment of pediatric femur shaft fractures. Alternative treatment methods should be developed particularly for this patient group with a high risk of complications.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

Informed Consent: Written informed consent was obtained from the parents of the patients who participated in this study.

Peer-review: Externally peer-reviewed.

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