Is External Fixation Effective in Pediatric Femur Fractures?

Eksternal Fiksasyon Pediatrik Femur Kırıklarında Etkili Bir Tedavi Metodu mudur?

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Abstract

Backgrounds: Pediatric femur fractures comprise a major portion of fractures that are repaired in emergency rooms. Treatment options include conservative methods, and surgical methods. Different problems such as angulation, malrotation and shortening may be observed both treatment methods.

Methods: In this study twenty-two pediatric femoral fractures which treated with external fixators in past five years were evaluated retrospectively. Advantages, and disadvantages of external fixation were investigated.

Results: Results were satisfactory. In conclusion, external fixator application is an easy to perform and quick method.

Conclusions: Despite some disadvantages, it may be one of the treatment methods that should be considered in the first plan in pediatric femoral fractures due to reasons such as short length of hospital stay, early mobilization, ease of family care, rapid child and family compliance, early return to school, and reduced treatment costs.

KEYWORDS: External Fixation, Femur, Closed Fractures, Child

Öz

Amaç: Pediatrik femur kırıkları acil servislerde karşılaşılan kırıkların önemli bir bölümünü oluşturmaktadır. Tedavi seçenekleri arasında konservatif yöntemler ve cerrahi yöntemler bulunmaktadır. Açılanma, malrotasyon ve kısalık gibi farklı sorunlar her iki tedavi yönteminde de görülebilir.

Metot: Bu çalışmada son beş yıl içinde eksternal fiksasyonla tedavi edilen 22 pediatrik femur kırıklı hasta retrospektif olarak değerlendirilip, eksternal fiksatör tedavisinin avantajları ve dezavantajları incelenmiştir.

Bulgular: Çalışmada elde edilen sonuçlar tatmin edici idi. Eksternal fiksatör uygulaması kolay ve hızlı bir yöntemdir.

Sonuç: Bazı dezavantajlarına rağmen, hastanede kalış süresinin kısa olması, erken mobilizasyon, aile bakımı, çocuk ve aile uyumu, kısa sürede okula geri dönebilme ve maliyet etkin bir yöntem olması gibi nedenlerle çocuk femur kırıklarında ilk planda uygulanabilir bir tedavi yöntemi olabilir.

Anahtar Kelimeler: Eksternal Fiksasyon, Femur, Kapalı Kırıklar, Çocuk

Introduction

Pediatric femur fractures comprise a major portion of fractures that are repaired in emergency rooms (1, 2). Most of these fractures are caused by falls and traffic accidents, while a minority is due to child abuse and non-traumatic causes (3).Today, a variety of treatment methods are used, while these fractures were previously treated conservatively until the last 20 years (4-7). Treatment options include conservative methods such as direct pelvipedal casting, pelvipedal casting following bed rest with skin or skeletal traction and external fixation as well as several internal fixation methods (4, 8-17).

Problems such as angulation, malrotation and shortening may be observed, particularly following traction and cast treatments and the correction of these problems can sometimes be very difficult. Today, surgical treatment has become the major management option for both early mobilization and reduction in length of hospital stay and treatment costs. Surgical treatment has become more preferred in recent years due to reasons such as family and patient compliance, costs, efficacy, and early return to school (3, 18).

Titanium elastic nailing procedures (TEN) has been the treatment method of choice in children between 6-12 years of age for the last 15-20 years (19), although external fixator applications still remain popular due to reasons including associated tissue defect, compartment syndrome, the need to provide early fixation or temporary fixation and the ease of access to implants (4).

In this study, pediatric femoral shaft fractures managed with external fixation and followed-up at our clinic over the past five years were retrospectively evaluated and the advantages and disadvantages of this method were investigated.

Materials And Methods

The study was initiated after receiving approval from the local ethics committee of Gaziantep University. Twenty-two pediatric femoral fractures treated with external fixators at the Orthopedics and Traumatology Clinic of Gaziantep University between January 2007 – December 2012 were retrospectively evaluated. Among the etiological factors, traffic accidents were the most common with a rate of 45.5%, traumas that occurred during sports and playtime activities were the second most common with a rate of 40.9%, falling from a height was the third most common with a rate of 9.1%, and gunshot wounds were the fourth most common with a rate of 4.5%. The mean age of the patients was 8 years (range, 3-13 years). Seventeen patients were male and five patients were female. Nine patients had right femoral fractures and 13 had left femoral fractures. Six (27.3%) fractures were in the proximal 1/3, two (9.1%) were in the distal 1/3 and 14 (63.6%) were in the femoral shaft. Nine (40.9%) of the fractures were transverse fractures, nine (40.9) were oblique fractures and four (18.2%) had a complex fracture pattern. Seven fractures were open fractures (31.8%). Open fractures were classified according to the Gustilo Anderson classification. Of the open fractures, one was Type I (Figure I), four were Type II, and two were Type III. The subtype of one of the Type III open fracture cases was IIIC and vascular repair was performed concurrently with bone fixation in this case. The other case was type IIIB and repeated debridements were done following emergency bone fixation. Free flap was performed when it was feasible. The growth plates of all patients were open.

Surgical Technique: Patients were administered prophylaxis with Cefazolin Na in the preoperative period. The operation began with the patient under general anesthesia and in the supine position in all cases. The surgical area was cleaned with 10% povidone iodine solution. Reduction was done under scopic control and through 5mm incisions opened lateral to the femur with scalpel, three Schanz Screws were inserted in the proximal and distal regions of the fractures of each (Figure II). Attention was paid to

avoid shortening and rotation during reduction and fixation was achieved with one unilateral external fixator. The pin tracts were sterilely covered and the operation was terminated. Parenteral antibiotherapy was continued for 24 hours postoperatively in patients with closed fractures and for 72 hours postoperatively in patients with open fractures. During hospitalization, caregivers received training on cleaning the external fixator and the pin tracts. Passive and active joint movements were commenced on the first postoperative day. Mobilization was started as soon as the patient could tolerate it. The implants were removed when adequate union was established on the x-ray images of the patients returning for control visits (Figure III).

Evaluation of Results: Times to surgery, operation times, lengths of hospital stay, the problems encountered during follow-up, union times, refracture rates, length imbalances following union and final functional status of the patients were evaluated. Student's t-test was used for statistical analysis.

Results

Time to operation was ≤12 hours in five patients (22.7%), 12-24 hours in six patients (27.3%), 1-3 days in ten patients (45.5%) and >3 days in one patient (4.5%).

The mean duration of surgery was 46.4 minutes (range, 27 – 68 minutes). The mean length of hospital stay was 8.5 days (range, 5 – 50 days).

No complications were observed in 16 patients (72.7%) during the follow-up period. The most common complication was pin tract infection and it was found in only two (9.1%) patients. Osteomyelitis was observed only in one patient (4.5%) with open fracture.

Refracture was observed in one patient (4.5%) and one patient (4.5%) had malunion. Re-reduction was performed in one patient (4.5%) after loss of position was observed. No patients had implant failure. No technical complications occurred during or after the operations.

Implants were removed in cases with union on their control x-rays. The mean time to implant removal of the patients was 73 days (range, 50-180 days). For implant removal, 14 patients (63.6%) required sedation, while sedation was not required in eight patients (36.4%).

Knee and hip joint range of motion was full in all patients during the control visit on the 15th day following implant removal.

Discussion

Until the last 15 years, conservative treatment methods were commonly preferred treatment methods in pediatric patients. In recent years, however, surgical treatments began to be preferred due to the increasing popularity of child- and family-focused treatment options and the cost of hospital stay. Among these surgical techniques, plating, intramedullary fixation techniques and external fixator applications have become more popular. The disadvantages of conservative treatment methods may include prolonged hospital stay, reduction loss, joint stiffness due to immobilization, difficulty of family and child compliance with treatment, and difficulty of cast care (20, 21).Intramedullary nailing, plating and TEN procedures provide good reduction. However, there is an increased risk of femoral head avascular necrosis after nailing (22).Moreover, disadvantages may include increased infection rates following intramedullary nailing, TEN and plating procedures, and the need for general anesthesia and an additional surgical procedure during implant removal(23). In our study, pin tract infection was found only in one patient and considered to be due to inappropriate care by the family.

External fixator application is preferred as a cost-effective method due to no need for additional anesthetic intervention for implant removal, longer intervals between x-ray controls, and short

length of hospital stay (20, 24,25).

External fixator applications are preferred in multitraumas and patients with grade 2-3 open fractures (26-28) and accompanying vascular-nerve injuries (17, 29-31), as well as in cases with isolated closed fractures (4, 14, 16, 27, 32).Among the 22 patients in the current study, 15 (68.2%) had isolated closed femoral fracture. Seven patients (31.8%) had open fractures. In only two of those seven patients, external fixator application was required as the definitive first option due to extensive tissue defect and vascular injury. However, external fixator application was also preferred in the other patients.

In their study, Weinberg et al. reported that the mean length of hospital stay of 121 children was 5.1 days (4). Platz A. et al. reported a mean length of hospital stay of 9.1 days for 30 pediatric patients who were treated with external fixator (33). Aranson et al. reported in their study a mean length of hospital stay of 6.9 days in 139 patients with femoral shaft fractures who were treated with external fixators (14). In the current study, the length of hospital stay was 8.5 days (range, 5-50 days). We thought that the longer than expected hospital stay in our study was due to the fact that the length of hospital stay was 50 days in one of our patients who required prolonged debridement and flap and 40 days in one of our patients who required prolonged follow-up.

Some studies report longer follow-up times in the hospital for pediatric femoral fractures treated with other methods (34, 35).This period was reported to be longer in cases undergoing traction followed by casting (34, 36).It is likely that a shorter length of hospital stay causes external fixator applications to be a more preferable option.

In the study of Hanne Hedin et al., it was reported that 83 of 98 (85%) pediatric femoral shaft fracture cases were operated on within 24 hours (37).In the current study, time to operation was ≤12 hours in five patients (22.7%), 12-24 hours in six patients (27.3%), 1-3 days in ten patients (45.5%) and >3 days in one patient (4.5%) due to additional systemic problems.

In their study, Weinberg et al. reported that the mean operation time was 66 minutes, the mean number of control x-rays was 4.3 and the mean length of scopic control was 1.2 minutes (4).In the current study, the mean operation time was 46.4 minutes (range, 27-68 minutes), the total intraoperative scopic control duration was 1.4 minutes and the mean number of control x-rays until implant removal was five (range, 3-8). While this difference in operation time is related to surgery experience and fracture localization, it is also caused by open reduction procedures that may be required in some cases (38).

The proponents of plate fixation reported that they minimized scopic exposure as far as possible (39).Previous studies in the literature report that the mean number of x-rays performed during the control period range from 5-15 regardless of the surgical method (34).This number may be even greater than 20, especially in patients undergoing closed reduction and casting.

The advantages of external fixator applications include a more rigid fixation, earlier mobilization, faster patient compliance, and shorter length of hospital stay (25,30).The disadvantages include pin tract infection (24-26), slow union, refracture, and scarring (17, 39).

One of the most important reasons for the decrease in the popularity of external fixators is pin tract infection (24-26, 40).Weinberg et al reported a rate of pin tract infections of 7.4% in 121 pediatric femoral fracture patients who were treated with external fixators (4). Blasier et al. reported that this rate was 36% in 139 patients (24). In their study, Aranson et al. reported that this rate was 36% in 139 patients with femoral shaft fractures who were treated with external fixator application (14). In the current study, however, only two patients (9.1%)had pin tract infection and

recovered with oral antibiotherapy. In their studies, Weinberg et al. (4) and Blasier et al. (24) reported no cases of osteomyelitis. In the current study, osteomyelitis was observed inonly one patient; this was the patient with Type 3C open fracture

External fixation method has little similarity to the other surgical methods in terms of implant removal. Weinberg et al reported that they removed external fixators after a mean period of 55.3 days (range, 36-94 days) (4). In the current study, the median time to implant removal was 73 days (range, 5-180 days). External fixator replacement was performed on one patient due to loss of position within one week. During implant removal, 63.6% of the patients required no medication, while 36.4% of the patients were administered sedation. All patients were discharged on the same day of the procedure.

The cultural level of the patient and family should be considered in determining the time to allow full weight-bearing on the extremity with fracture after external fixator applications. Weinberg et al. switched to full weight-bearing in week 2. Particularly in patients in the learning period, exercises were administered to recover knee and hip movements and increase the muscle strength in the lower extremities in the first 3 weeks (4). We switched to full weight-bearing in the postoperative 3rd week.

Consolidation time may vary depending on the fracture type, whether it is an open or closed fracture and the reduction and fixation method. Weinberg et al. reported that the consolidation time was 57.6 ± 21.1 days in 52 cases with transverse fracture pattern and 44.8 ± 23.3 days in 50 cases with oblique fracture pattern and there was no statistically significant differences between the two groups (4). Schmittenbecher et al. reported that the consolidation time ranged from 50-65 days in cases in which they performed intramedullary fixation (38). In their study, Weinberg et al. reported a consolidation time of 55.3 ± 22.8 days. Klein et al. reported similar results in their study (41). It was reported that the mean consolidation time was 6-8 weeks in patients that underwent plate fixation(34). In the current study, the mean consolidation time was 75.5 days (range, 50-180 days). The consolidation time in the current study was 101.9 ± 31.3 days in eight transverse fracture cases, while it was 80.6 ± 37.7 days in nine oblique fracture cases. No significant differences were observed between transverse and oblique fractures in terms of fracture pattern (p=0.227, *t*-test). Among the cases in the current study, the mean consolidation time was 97.6 ± 36.8 days in open fractures and 95.5 ± 41.7 in closed fractures. The lack of difference in consolidation times between open fractures and closed fractures to the low number of our cases (p=0.227, *t*-test).

The refracture rate was 3% in the study by Weinberg et al. (4) and 2.9% in the study by Aranson et al. (14). In the current study, re-fracture was observed in only one case (4.5%). The fact that the implant of the patient was removed after 50 days and re-fracture occurred within one week of implant removal suggested that early implant removal significantly increases the re-fracture risk (4).

In their study, Blasier et al. reported that they did not observe nonunion in any their patients treated with external fixators and found extremity imbalance in only 18 patients (24). They reported that 15 of these patients had overgrowth (8.7 mm) and 3 had shortening (7.7 mm). None of these patients required additional surgical treatment for their extremities during the following years. The current study revealed lower extremity imbalance in a total of 11 cases among 22 children and 9 of these had overgrowth (7 mm) and 2 had shortening (8.4 mm). None of the patients required additional surgical intervention.

Angulation values lower than 15 degrees are not

clinically significant (33, 42) and values between 10-25 degrees can be tolerated during the recovery (42); however, angulations of ≥25 degrees require surgical correction. Malkawi et al. reported that angulations on the sagittal plane have a faster remodeling capacity compared to angulations on the frontal plane (36).Long-term follow-up revealed malangulation of <15 degrees in 10 patients (45.5%) and none of these cases required additional surgical intervention. Only one patient (4.5%) had a sagittal malangulation of 20 degrees and this case was monitored.

Scarring of the pin tracts is another complication that may develop following external fixator applications (37).The current study revealed scarring in one patient (4.5%) with pin tract infection but no surgical intervention was required.

Conclusion

In conclusion, external fixator application is an easy to perform and quick method. External fixator application is the first option particularly in segmental, complicated and open fractures, in fractures with accompanying vascular-nerve injury, and in patients with polytrauma, while it can also be reliably preferred in isolated closed pediatric femoral fractures. Despite several disadvantages, it may be one of the treatment methods that should be considered in the first plan in pediatric femoral fractures due to reasons such as short length of hospital stay, early mobilization, ease of family care, rapid child and family compliance, early return to school, and reduced treatment costs.

Figure I: Radiographic Image of Femoral Shaft Fracture (preoperatively)

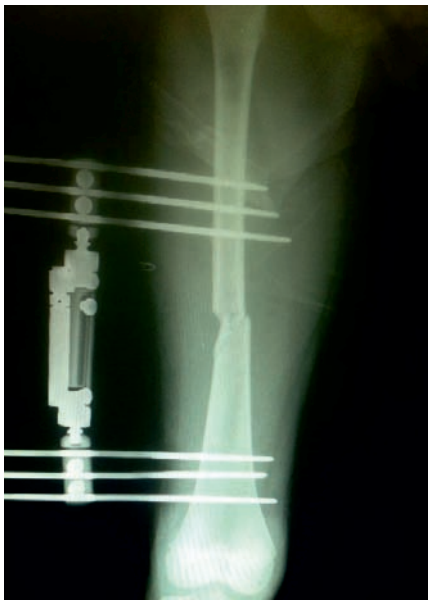

Figure II: Radiographic Image of Femoral Shaft Fracture

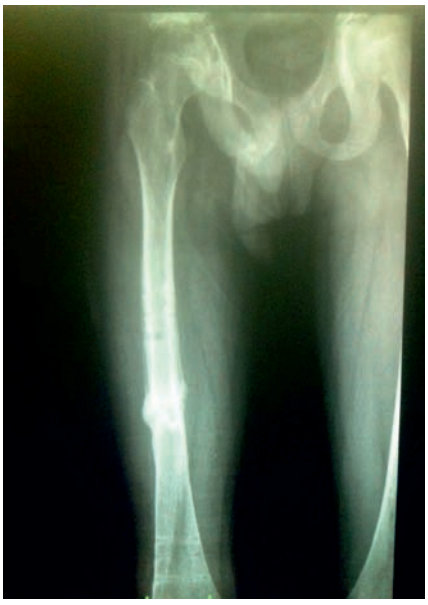

Figure III: Radiographic Image After Removing İplants. Adequate Union was Established.

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