



## The treatment of femoral shaft fractures in adults with hybrid Ilizarov external fixator

### Erişkin femur cisim kırıklarının hibrid ilizarov eksternal fiksator ile tedavisi

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#### Objectives

The aim of this study was to evaluate the results of femoral shaft fractures treated with hybrid Ilizarov external fixator.

#### Patients and methods

Patients with femoral fractures (n=30) treated by hybrid Ilizarov external fixator were evaluated. There were 8 (26.7%) females and 22 (73.3%) males and the mean age was 34.6 (18-56) years. There were 25 open fractures. According to Gustillo-Anderson classification; 9 were Grade II, 7 were Grade III A and 9 were Grade III B. In all cases, while two rings were placed distal to the fracture line using connectors and different numbers of 90°-120° femoral arches, these rings were fixed to the proximal segment by using the half pins.

#### Results

All patients were evaluated in accordance with functional and radiographic results; 43.3% were excellent, 33.3% good, 16.6% intermediate and 6.6% poor.

#### Conclusion

Applying a standart frame configuration may not be possible in proximal femur fractures due to the complex anatomical structure and rich neurovascular configuration. While using K-wires, there will be a risk of introducing K-wires to crucial neurovascular areas, so hybrid external fixators are preferred. We choose hybrid fixators for their safety and ease of application for femoral shaft fractures.

*Key words:* Femur shaft fractures, External fixator, Hybrid Ilizarov fixator

#### Amaç

Bu çalışmanın amacı; hibrid İizarov eksternal fiksatorü ile tedavi edilen femur cisim kırıklarının sonuçlarını değerlendirmektir.

#### Hastalar ve yöntemler

Hibrid İizarov eksternal fiksatorü ile tedavi edilmiş femur kırıklı hastalar (n=30) değerlendirildi. Olguların 8'i kadın ve 22'si erkekti. Ortalama yaş 34.6 (18-56) idi. Olguların 25'i açık kırık ve Gustillo-Anderson sınıflamasına göre; 9 olgu Tip II, 7 olgu Tip III A ve 9 olgu Tip III B idi. Olguların tümünde kırık hattının distaline 2 adet halka yerleştirilirken değişik sayılardaki 90°-120°'lik femoral ark ve konnektörler yarım yivli çiviler ile proksimal segmente tespit edildi.

#### Bulgular

Hastaların tümü, radyolojik ve fonksiyonel sonuçlara göre değerlendirildi. % 43.3 mükemmel, %33.3 iyi, %16.6 orta ve %6.6 kötü sonuç elde edildi.

#### Çıkarım

Standart çerçeve sistemi uygulaması, femur proksimalinin kompleks anatomik yapısından ve zengin damar-sinir ağından dolayı mümkün olmayabilir. K-teli uygulanırken önemli damar-sinir bölgelerinde giriş riskli olabilir. Bu nedenle hibrid eksternal fiksatorler tercih edilir. Biz femur shaft kırıklarında uygulama kolaylığı ve daha güvenli olması nedeniyle hibrid fiksatorleri tercih ettik.

*Anahtar sözcükler:* Femur cisim kırıkları, Eksternal fiksator, Hibrid İizarov fiksator

### INTRODUCTION

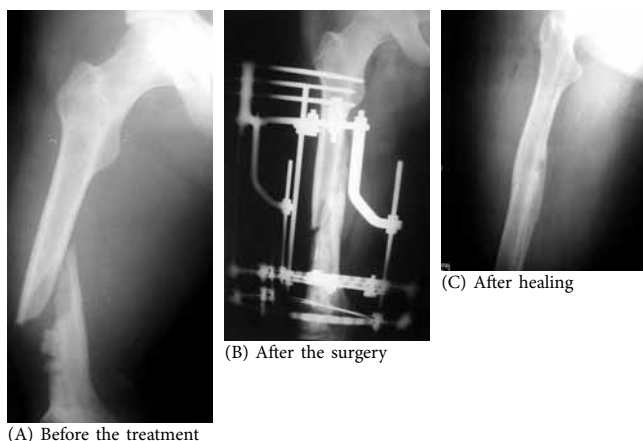
A wide variety of treatment protocols have been developed for fixation of the femoral fractures. Internal fixation including intramedullary nailing and plate osteosynthesis has been described extensively in the literature. Some complicated femoral shaft fractures however, are not suitable for internal fixation and external fixation is preferred in these situations.<sup>[1]</sup>

External fixation of femoral fractures in adults has rarely been reported.<sup>[2]</sup> Depending on the nature of the clinical condition and its location and the specific mechanical demands, a wide variety of fixator frames are used which ranged from unilateral to circular frames.<sup>[3]</sup>

We evaluated the Ilizarov hybrid external fixator application for femoral shaft fractures.

### PATIENTS AND METHODS

From December 1998 to 2003, we treated 30 patients with femur diaphysal fractures using the Ilizarov hybrid external fixator (Figure 1).

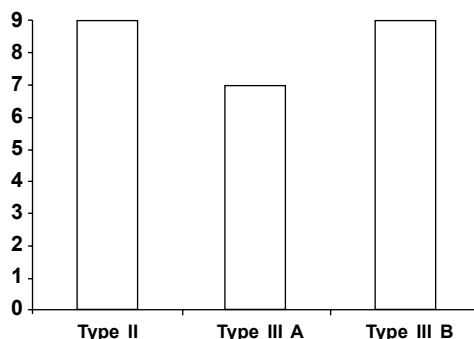


**Figure 1.** Radiographs of a patient treated by hybrid Ilizarov method. There were 22 male (73.3%) and eight female (26.6%) patients. The mean age was 34.6 (18-56) years. Thirty-two associated injuries were observed in 21 patients (Table 1).

Associated injuries	Number of injuries
Head injury	8
Thoracic injury	5
Abdominal injury	4
Pelvic fracture	1
Neurovascular lesion	1
Upper extremity fracture	6
Lower extremity fracture	7

**Table 1.** Associated injuries in femoral shaft fractures

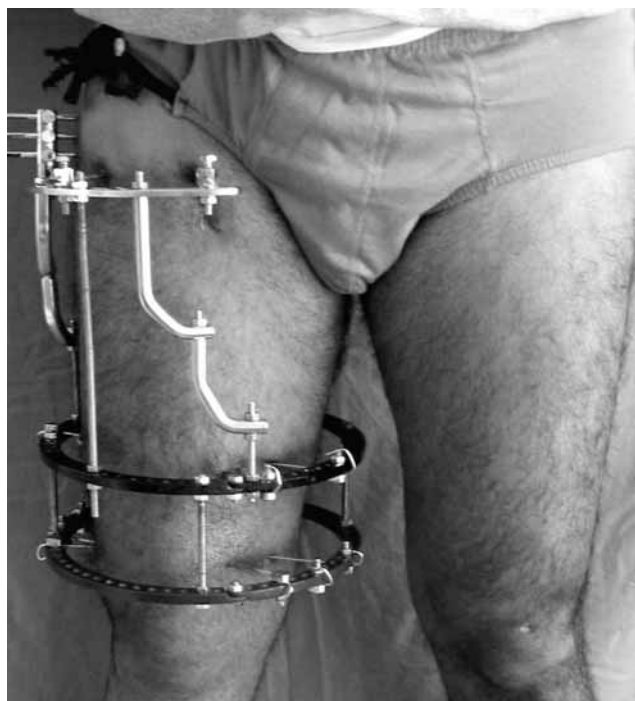
All fractures were classified according to Winquist.<sup>[4]</sup> According to this classification, five (16.6%) patients were Type II, seven (23.3%) were Type III and 18 (60%) were Type IV. There were 25 open fractures classified according to Gustillo-Anderson<sup>[5]</sup> (Figure 2).



**Figure 2.** Soft-tissue damage in open femoral fractures (N=25).

In five patients, closed segmental and multipart femur shaft fractures (Winquist type III) were seen and these were multitrauma patients. Therefore, in terms of both the fracture's being segmented/multipart and prevention of the hemodynamic stabilities of the patients, we preferred to use the technique of hybrid Ilizarov external fixation.

In all cases, two rings were placed to the distal of the fracture line and by using connectors and different numbers of 90°-120° femoral arches they were fixed to the proximal segment by using the half pins. (Figure 3).



**Figure 3.** Patient with the hybrid Ilizarov frame.

Postoperatively, knee and hip motion were started immediately. Pin sites were covered with steril gauze at surgery. The compressive dressing was removed on the postoperative first day. Patients were allowed unrestricted weight bearing as tolerated. The active, assisted active and passive range of motion exercises were used for rehabilitation. Isometric and isotonic muscle strengthening exercises were performed. The union was defined in the anteroposterior and lateral radiographs with no pain or mobility at the fracture site on weight bearing without fixator.

The external fixator was removed under general anesthesia for aggressive cleaning of pin tracts, scar release, and gentle knee manipulation if necessary. Patients were encouraged to use crutches (partial weight bearing on the affected side) for an additional 2-4 weeks after fixator removal, to decrease the risk of fracture through pin holes.

## RESULTS

The average follow up period was 23.6 months (range 8-40 months). The mean duration period of external fixator was 23 weeks.

Average hospitalisation (including preoperative traction) for all patients was 21.1 days. The main reason for the extended stay was associated injuries of the patients. Average operation time was 110 minutes (range 80-130 minutes). There was no mortality. Systemic complications were seen in 13 (43.3%) of our patients. Pin site inflammation occurred in all patients and responded well usually with dressing. Pin tract infection was seen in 16 (53.3%) patients and were treated criteria described by Dahl et al.<sup>[6]</sup> However, it was not severe enough to require removal of pin or to cause osteomyelitis or to alter the plan of management. Deep infection was seen in five (16.6%) patients. Cultures were taken and *Staphylococcus aureus* was the predominant organism. Appropriate antibiotics were administered to all patients. Angulation of more than 10° was not seen in any case. Seven degrees of valgus deformity was seen in one patient and 5° of anterior-posterior angulation was seen in another patient. There were no patients with rotational malalignment. Limb-length discrepancy over 2 cm was seen in two patients. Delayed union was seen in two (6.6%) patients. Knee stiffness was recorded in three (10%) patients at final follow up. All the fractures except one united successfully after the mean of 26.2 months. Because of delayed union and intolerance to the frame in a 74 years old patient, the frame was removed and plate osteosynthesis was applied.

Results were evaluated in accordance with functional and radiographic results described by Klemm and Börner<sup>[7]</sup>; 43.3% were excellent, 33.3% good, 16.6% intermediate and 6.6% poor.

## DISCUSSION

Prior to 1980, external fixation played a minor role in comparison to other open or closed procedures, generally being used to treat only major open fractures. Over the past few years, complex and sophisticated external fixation systems have been developed that have come to play a more active role in the treatment of skeletal trauma.<sup>[8]</sup>

External fixation of the femur with the hybrid Ilizarov ring seems to be the method of choice in the treatment of shaft fractures, especially in open and severely comminuted and segmental fractures.<sup>[8,9]</sup>

External fixation can be used as the primary and the definitive method of fracture stabilisation. It provides aggressive management of soft-tissue injuries in Grades II and III open femoral fractures. External fixation is also indicated in fractures with neurovascular injury and segmental bone loss.<sup>[9,10]</sup>

The operating time is shorter than for any other internal fixation procedures. It does not drain the fracture hematoma and it does not produce any further disruption of the blood supply to the soft tissue and periosteum. External fixation has offered an opportunity for early and stable fractures with minimum operative injury, which is important in seriously ill patients.<sup>[11]</sup> The benefits include decreased pulmonary complications, shorter hospitalisation, shorter intensive care unit stay, decreased health care costs and an increase in the predictability of fracture outcome.<sup>[12]</sup> Also the fixation achieved by this technique allows early mobilization of the patient.<sup>[13]</sup>

Because of the complex anatomical structure and rich neurovascular configuration, applying a standard frame configuration may not be possible in the shaft and proximal of the femur. While using K-wires, there will be a risk of introducing K-wires to crucial neurovascular areas and hybrid external fixators are therefore preferred. We choose hybrid fixators for their safety and ease of application. Hybrid ring fixation frames of various configurations are gaining clinical popularity. This is based both on patients improved acceptance of these frames and on easier insertion of Schanz screws into areas rich in neurovascular structures. In clinical practice the hybrid fixation frame is being used with increasing frequency.<sup>[14]</sup>

Stabilization of femoral fractures with hybrid Ilizarov external fixator can be achieved faster than plating and intramedullary techniques. In this study, soft tissue debridement, reduction and application of external fixator took a mean of 110 minutes. As long operation times increase the risk of infection, external fixation seems to offer advantages over internal stabilisation techniques.<sup>[15]</sup>

The external fixator is effective in fracture union. Few studies have reported rapid union rates with

external fixators. In communitated open fractures there are problems like soft tissue loss, loss of bone and decreased vascularity of tissues. According to studies in the literature, the mean time of femoral fracture union with hybrid external fixator share similar results with plate osteosynthesis or intramedullary fixation techniques. Dabazies et al.<sup>[9]</sup> reported mean union time of 144 days, Mohr et al.<sup>[16]</sup> reported 166 days. In our series, mean union time was 26 weeks. When we compared our results to the literature, the mean time of union is longer.

The studies in the literature show that, incidence of infections in open fractures directly correlates with the severity of soft tissue damage. In type II and type III open fractures, infection occurs 2%-10% and 10%-31%, respectively.<sup>[17]</sup> In this study, infection rate was %16.6 and occured predominantly in Type III open fractures. The infection has been successfully cured in all of our patients.

In the literature, femoral shortening of >2 cm has been reported for up to 7% of the cases after external fixation.<sup>[16]</sup> In this study, leg length discrepancy was only found in 2 (6.6%) patient with communitated fractures.

Nonunion following external fixation of femur fractures has been reported in 4.8%-9.4%.<sup>[18]</sup> In our series, nonunion was not observed but delayed union was seen in 2 cases.

The long standing treatment with external fixator is reported to have the risks, such as stiffness of the knee joint, malunion and pin tract infections. According to the literature, the most common complicaton of hybrid Ilizarov system is pin tract infection and reported incidence is between 0.5% to 30%.<sup>[19]</sup> The incidence of pin tract infection was 53.3% in the current study. However, no serious infection was developed, so there were no need for pin removal and changing the treatment plan.

Knee stiffness is another problem following Ilizarov surgery. The wires transfixing the quadriceps and long standing treatment with external fixators, all play a major role in knee stiffness. In this study, knee stifness was seen in three patients (10%). Active participation in rehabilitation of the patient is necessary for successful Ilizarov treatment. The cooperation of physician and patient is important since the patient must exercise the operated limb and joints.<sup>[17]</sup>

Ilizarov hybrid external fixator is generally indicated in patients with Grade II and III open fractures, communitated fractures and multipl injuries. This method is relatively atraumatic and periosteal circulation is not disturbed. We prefer Ilizarov hybrid fixators for their safety, ease of application and good results.

Ilizarov fixator is an alternative method to conventional treatment when soft tissue and bone

defects and contaminated wounds are present. Compared to the plate and intramedullary fixation methods, Ilizarov external fixation method is less invasive and protects both circulation of endosteum and periosteum.<sup>[20]</sup>

Ilizarov fixator achieves stability better in multipart and defective fractures than internal fixation. In some certain situations, such as the unstable patients with multitrauma or head trauma, external fixation must be one of the first treatment methods because of its time saving and easy application.<sup>[21]</sup>

Hybrid external fixators drastically reduce bending and axial stiffness, while not having much effect on torsional stability. However, hybrid Ilizarov external fixation models may be prefered in the area of rich neurovascular net and complex anatomic structure. In order to obtain suitable hybrid fixator stiffness, at least three femoral arch and four half-pins must be used and these half-pins should be placed at 90° and at different planes to each other.<sup>[14]</sup>

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