

# Evaluation of complications in patients with open fractures of the upper and lower extremity treated with internal fixation after the external fixation

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## ABSTRACT

**BACKGROUND:** Open fractures constitute an important mortality and morbidity cause among all musculoskeletal system injuries and bring along many social and economic problems. The cost occurring due to both long treatment duration and the delay in returning to work made these conditions more complicated. The present study aims to evaluate of the complications which may occur in cases with an application of internal fixation following external fixator in upper and lower extremity open fractures retrospectively.

**METHODS:** Forty-nine patients, who applied to the emergency service between 2007 and 2013, participated in this study. Thirty-two of these patients consisted of the patients to whom external fixator was first placed, and then internal fixation was performed by us, while 17 patients were treated in another center with the external fixator, and then their treatments were performed by us. All patients' injury mechanism, duration of follow-up with an external fixator, whether debridement was performed after external fixator, the period between external fixation and internal fixation, pin site infection, duration of the union, delayed union, nonunion, whether bone graft was used during internal fixation, internal fixation type, reoperation, development of osteomyelitis and follow-up parameters were recorded.

**RESULTS:** Results were evaluated separately for radius, humerus, tibia and femur fractures. Of the 49 patients, 39 were male, and 10 were female. Mean follow-up time for tibia 28.6 months, for femur 34, for humerus 26.9, for Radius 27 months. Of the 49 patients who participated in this study, 15 applied with upper extremity (11 humeri, 4 Radius) injury and 34 applied with lower extremity (25 tibias, 9 femora) injury. Of the 49 patients, 32 had pin tract infection, 11 had nonunion, 11 had delayed union, two had osteomyelitis.

**CONCLUSION:** Open fractures are always hard to treat. After external fixation to the internal fixation process have some complications, physicians should be aware of all these problems and plan according to the situation.

**Keywords:** External fixation, gunshot; internal fixation; open fracture.

## INTRODUCTION

Open fractures frequently occur as a result of high-energy traumas. Therefore, they are cases open to many complications, such as soft tissue problems, deep infections and non-union. With the rapid development of societies and industry, the incidence of open fractures is increasing each passing day.

[1] Open fractures are not only characterized by bone tissue injury but also a type of trauma in which soft tissues, such as

skin, muscle, nerve and vein, can be injured.[2] The presence of additional injuries makes the treatment even more complicated.

Recent studies have shown that infection rates following closed fractures are 1%, while this rate may range between 15–55% in open fractures.[3,4] These rates clearly show that open fractures need to contain severe treatment principles. Questions, such as what to do when they first arrive, what

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kind of a treatment method should be determined, when to treat and which implant should be used, are in the minds of all clinicians. In addition, the high complication rates seen in these patients prolong the duration of hospital stay and lead to an economically increased cost.

In this study, our aim is to investigate the complications that occur after the treatment of the patients with open fractures who applied to our clinic and to provide the literature with the data regarding how to manage them.

## MATERIALS AND METHODS

Forty-nine patients, who applied to the emergency service between 2007 and 2013, participated in this study. Thirty-two of these patients consisted of the patients to whom external fixator was first placed and then internal fixation was performed by us, while 17 patients were treated in another center with an external fixator and then their treatments were performed by us.

All patients were firstly evaluated in the emergency service. In all patients admitted with an open fracture, isotonic sodium and debridement were applied in the emergency service. Nerve, vascular and soft tissue injuries were noted. Consultations were demanded by the relevant departments. All patients were evaluated for antibiotics and tetanus prophylaxis in the emergency service. According to Gustilo-Anderson, cefazolin prophylaxis was given to Type 1 and 2 fractures, and additionally, aminoglycoside prophylaxis was given to Type 3 open fractures. Tetanus prophylaxis was performed in all patients. The patients were grouped according to the region with fractures in the lower extremity and upper extremity. All patients were directed to the relevant unit for their radiographies after the first debridement procedure and antibiotic prophylaxis in the emergency service. All patients received antibiotics for three days following the external fixator in line with the open fracture classifications. Then, internal fixation was performed in the patients deemed appropriate. All patients' injury mechanism, duration of follow-up with an exter-

nal fixator, whether debridement was performed after external fixator, the period between external fixation and internal fixation, pin site infection, duration of the union, delayed union, nonunion, whether bone graft was used during internal fixation, internal fixation type, reoperation, development of osteomyelitis and follow-up parameters were recorded.

This study was conducted after obtaining the approval of the ethics committee of Gaziantep University.

## RESULTS

Of the 49 patients who participated in this study, 15 applied with upper extremity (11 humeri, 4 Radius) injury and 34 applied with lower extremity (25 tibias, 9 femur) injury. Of the 49 patients, 39 were male, and 10 were female. Mean follow-up time for tibia 28.6 months, for femur 34, for humerus 26.9, for Radius 27 months. Of the 49 patients who participated in this study, 15 applied with upper extremity (11 humeri, 4 radius) injury and 34 applied with lower extremity (25 tibias, 9 femora) injury. Of the 49 patients, 32 had pin tract infection (65%), 11 had nonunion (22%), 11 had delayed union (22%), two had osteomyelitis (4%). Separated patients demographics can be seen in Table 1.

### Tibia

The mean age of patients, who had open tibial fracture and underwent internal fixation following external fixator, was 28.6 (9–50), seven were female, and 18 were male. The patients were followed for 18.1 (5–38 months) months on average. Nine patients were operated due to motor accident, 10 patients firearm injuries, four patients occupational accidents and two patients falling down from the height. Four patients were classified according to Gustilo-Anderson, two patients applied due to Type two injuries, eight patients 3A, 9 patients Type 3B and six patients Type 3C.

The mean duration between the arrival of the patients and the external fixator application was 2.1 days (0–4).

**Table 1.** Patients demographics according to fracture sides

	Tibia	Femur	Humerus	Radius
Mean age	28.6 (9–50)	34 (6–76)	26.9 (15–48)	27 (24–34)
Gender	18m/7f	8m/1f	9m/2f	4 m
Follow period	18.1 (5–38)	13.1 (1–36)	10.6 (2–24)	9.5 (5–16)
Etiology	Mixed	Mixed	Mixed	Mixed
Ef to lf	12.5 days	9.8 days	5.81 days	16.2 days
Pin tract infec.	18 patients	6	4	4
Nonunion	6 patients	1	2	2
Delayed union	9 patients	–	2	–
Osteomyelitis	2 patients	–	–	–

The mean transition time to internal fixation following external fixation was 12.5 days.

Fifteen of the patients who underwent internal fixation were treated with an intramedullary nails and 10 with plate screw fixation.

Ten patients had tibial shaft fractures, seven patients had plateau fractures and eight patients had tibial distal fractures. Bone graft was used in 22 patients with internal fixation. Before internal fixation, 18 patients had a pin site infection, while seven patients did not have a pin site infection. Debridman were performed on 10 patients before internal fixation. In the follow-ups after internal fixation, nonunion was observed in six patients. Three patients were excluded from follow-up since they did not visit the hospital for their follow-ups. The other three patients were reoperated.

Uneventful union was observed in 16 patients (mean: 3.9 months). Delayed union was observed in 9 patients (mean union duration: 6.2 months).

Soft tissue reconstruction and vascular repair were performed in the patients with Type 3C.

Osteomyelitis developed in two patients.

## Femur

The mean age of the patients who had open femoral fracture and underwent internal fixation after the external fixator was 34 (6–76) and eight patients were male and one patient was female. The mean follow-up duration was 13.1 months (1–36). Four patients were operated due to motorcycle accidents and five patients were operated due to firearm injury. Two patients were classified according to Gustilo-Anderson, two patients applied due to Type 2 injuries, three patients 3A, two patients Type 3B and 2 patients Type 3C.

The mean duration between the arrival of the patients and the external fixator application was 2.1 days (0–4). The mean transition time to internal fixation following external fixation was 9.8 days. Two of the patients who underwent internal fixation were treated with the intramedullary nail and two with plate screw fixation. Eight patients had femoral shaft fracture, and one patient had a proximal femoral fracture.

Bone graft was used in seven patients with internal fixation. Before internal fixation, six patients had a pin site infection, while three patients did not have a pin site infection. Debridman were performed on six patients before internal fixation. In the follow-ups after internal fixation, nonunion was observed in one patient. Uneventful union was observed in eight patients (mean: 4.7 months). No patient had a delayed union. Vascular repair was performed in the patients with Type 3C injury, and four patients with Type 3B and 3C inju-

ries underwent soft tissue reconstruction. Osteomyelitis did not develop in any patient.

## Humerus

The mean age of the patients who had open humerus fracture and underwent internal fixation after an external fixator, was 26.9 (15–48) and nine patients were male and two patients were female. The mean follow-up duration was 10.6 months (2–24 months). Five patients were operated due to car accidents, and five patients were operated due to firearm injury. Two patients applied according to Gustilo-Anderson, two patients applied due to Type 2 injuries, three patients 3A, two patients Type 3B and two patients Type 3C. The mean duration between the arrival of the patients and the external fixator application was 2.1 days (0–3). The mean transition time to internal fixation following external fixation was 5.81 days (0–15).

Plate screw fixation was performed in all patients who underwent internal fixation. All patients had a humerus shaft fracture. Bone graft was used in eight patients with internal fixation. Before internal fixation, four patients had pin site infection, while five patients did not have a pin site infection. Debridman were performed on four patients before internal fixation.

In the follow-ups after internal fixation, nonunion was observed in two patients. They were reoperated. Uneventful union was observed in eight patients (mean: 4.7 months). Delayed union was observed in two patients. No patient required vascular repair and soft tissue reconstruction was not performed. Osteomyelitis did not develop in any patient.

## Radius

The mean age of the patients who had open radius fractures and underwent internal fixation after the external fixator was 27 (24–34) and four patients were male. The mean follow-up duration was 9.5 months (5–16 months). Two patients were operated due to occupational accident and two patients were operated due to firearm injury. Two patients were classified according to Gustilo-Anderson, two patients Type 3A and two patients Type 3B. The mean duration between the arrival of the patients and external fixator application was 2.1 days (0–3). The mean transition time to internal fixation following external fixation was 16.2 days (0–90).

Plate screw fixation was performed in all patients who underwent internal fixation. Two patients had a Radius shaft and two patients had a proximal Radius fracture. Bone graft was used in four patients with internal fixation. Pin site infection was observed in four patients before internal fixation. In the follow-ups after internal fixation, nonunion was observed in two patients. They were reoperated. No debridement was performed before internal fixation. Uneventful union was observed in two patients (mean: 4.7 months). Delayed union

was not observed. No patient required vascular repair and soft tissue reconstruction was not performed. Osteomyelitis did not develop in any patient.

## DISCUSSION

Open fractures are generally accompanied by complications at a high rate and significantly cause morbidity. The current concept in the treatment of open fractures is the immediate classification of the injury, early antibiotic prophylaxis, early wound debridement and fixation.<sup>[5]</sup> Following the above-mentioned steps, additional operations are needed in these patients for the final treatment. In this respect, our aim is to investigate the complications emerging in the cases who received first arrival treatment, followed and underwent internal fixation.

In our study, open fractures of both the upper and lower extremities were examined. Our treatment method in these fractures progressed in the light of the current literature and complications that might arise were standardized.

Gustilo-Anderson classification is used in the classification of open fractures. Type 3 fractures involve an increased risk of complications, and this situation has generally been evaluated independently from implantation.<sup>[6,7]</sup> In our study, the patients were classified according to the Gustilo-Anderson classification and treatments were designed accordingly. Type 3C injuries required further treatments, and the rates of complications were higher compared to other open fractures.

Emergency medical intervention is very important in open fractures. Early debridement of the fracture and antibiotherapy should be performed early. However, there are articles in the literature stating that this situation is not very significant.<sup>[8-11]</sup> On the contrary, there is also information reporting that early debridement reduces the risk of future infections and has positive effects on recovery.<sup>[12]</sup> In our study, early irrigation and debridement were performed in our patients in the emergency service and the necessary antibiotherapies were applied. According to us, the reflection of this situation on infection parameters is also positive. In general, a small number of patients had permanent infection (i.e., osteomyelitis). This situation can be associated with many factors. We think that it cannot be explained only with first arrival debridement and antibiotherapy, and the first injury form of the patient has an effect on this issue.

It was documented by Harris et al.<sup>[13]</sup> that complex and high-energy open fractures are associated with severe complications. It has been reported that the most commonly seen complication is nonunion (31.5%) in the patients who are in the stage of extremity recovery and wound infection is then observed. In our study, although we did not struggle with nonunion considerably, the infection was an important problem. The low rate of nonunion can be attributed to the

success of internal fixation and the use of additional methods such as grafting.

Deep wound infection is among the most important problems of open fractures, and the wound environment is very suitable for the spread of bacteria.<sup>[14,15]</sup> This rate can reach 52% in Gustilo Type 3B injuries.<sup>[16]</sup> The place of antibiotherapy is very important in the accurate treatment of these patients. Recently, there are studies reporting that final fixation and flap application in one session reduces the risk of osteomyelitis and deep infection in patients with Type 3B-C injury.<sup>[17,18]</sup> In our study, the final fixation was always performed in two stages. As the correct method, we first performed external fixator treatment. After the risk of infection was removed and soft tissues were closed, we performed the final fixation; however, there are still patients in our series with osteomyelitis in all fracture groups.

In our study, there are some missing points. First of all, this is a retrospective study. In this study, our patients consisted of a heterogeneous group. It was not investigated whether the parameters, such as lifestyle, nutritional habits, weight, smoking and additional diseases of the patients, affected the results. On the other hand, we only scanned the complications. Functional scores of the patients are not among the parameters that we investigated. This may be the subject of further study. The number of the patients constituting the upper extremity is very low. A more comprehensive study could be conducted by increasing the number, but the low number of patients with open fractures in the upper extremity can be shown as a reason for this.

## Conclusion

Open fractures are difficult to treat and open to any complication. Obtaining preliminary information regarding the complications that can be seen while treating these injuries can make it easier to take precautions in advance and enable them to take different steps in treatment management.

**Ethics Committee Approval:** Gaziantep University Faculty of Medicine Ethics Committee granted approval for this study. (date: 17.09.2013/310).

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**Conflict of Interest:** None declared.

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## REFERENCES

1. Court-Brown CM, McBurnie J. The epidemiology of tibial fractures. *J Bone Joint Surg Br* 1995;77:417–21. [CrossRef]
2. Court-Brown CM, Bugler KE, Clement ND, Duckworth AD, McQueen

- MM. The epidemiology of open fractures in adults. A 15-year review. *Injury* 2012;43:891–7. [CrossRef]
3. Morgenstern M, Kuhl R, Eckardt H, Acklin Y, Stanic B, Garcia M, et al. Diagnostic challenges and future perspectives in fracture-related infection. *Injury*. 2018;49:S83–90. [CrossRef]
  4. Trampuz A, Zimmerli W. Diagnosis and treatment of infections associated with fracture-fixation devices. *Injury* 2006;37:S59–66. [CrossRef]
  5. Rotter T, Kinsman L, James E, Machotta A, Gothe H, Willis J, et al. Clinical pathways: effects on professional practice, patient outcomes, length of stay and hospital costs. *Cochrane Database Syst Rev* 2010;(3):CD006632. [CrossRef]
  6. Kim PH, Leopold SS. In brief: Gustilo-Anderson classification. [corrected]. *Clin Orthop Relat Res* 2012;470:3270–4. [CrossRef]
  7. Noumi T, Yokoyama K, Ohtsuka H, Nakamura K, Iroman M. Intramedullary nailing for open fractures of the femoral shaft: evaluation of contributing factors on deep infection and nonunion using multivariate analysis. *Injury* 2005;36:1085–93. [CrossRef]
  8. Pollak AN, Jones AL, Castillo RC, Bosse MJ, MacKenzie EJ; LEAP Study Group. The relationship between time to surgical debridement and incidence of infection after open high-energy lower extremity trauma. *J Bone Joint Surg Am* 2010;92:7–15. [CrossRef]
  9. Hull PD, Johnson SC, Stephen DJ, Kreder HJ, Jenkinson RJ. Delayed debridement of severe open fractures is associated with a higher rate of deep infection. *Bone Joint J* 2014;96-B:379–84. [CrossRef]
  10. Cross WW 3rd, Swiontkowski MF. Treatment principles in the management of open fractures. *Indian J Orthop* 2008;42:377–86. [CrossRef]
  11. Swiontkowski MF, Engelberg R, Martin DP, Agel J. Short musculoskeletal function assessment questionnaire: validity, reliability, and responsiveness. *J Bone Joint Surg Am* 1999;81:1245–60. [CrossRef]
  12. Enninghorst N, McDougall D, Hunt JJ, Balogh ZJ. Open tibia fractures: timely debridement leaves injury severity as the only determinant of poor outcome. *J Trauma* 2011;70:352–7. [CrossRef]
  13. Harris AM, Althausen PL, Kellam J, Bosse MJ, Castillo R; Lower Extremity Assessment Project (LEAP) Study Group. Complications following limb-threatening lower extremity trauma. *J Orthop Trauma* 2009;23:1–6. [CrossRef]
  14. Metsemakers WJ, Kuehl R, Moriarty TF, Richards RG, Verhofstad MHJ, Borens O, et al. Infection after fracture fixation: Current surgical and microbiological concepts. *Injury* 2018;49:511–22. [CrossRef]
  15. Morgenstern M, Vallejo A, McNally MA, Moriarty TF, Ferguson JY, Nijs S, et al. The effect of local antibiotic prophylaxis when treating open limb fractures: A systematic review and meta-analysis. *Bone Joint Res* 2018;7:447–56. [CrossRef]
  16. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. *J Trauma* 1984;24:742–6. [CrossRef]
  17. Jahangir N, Niazi N, Aljawadi A, Reid A, Wong J, Drampalos E, Pillai A. The use of adjuvant local antibiotic hydroxyapatite bio-composite in the management of open Gustilo Anderson type IIIB fractures. A prospective review. *J Orthop* 2019;16:278–82. [CrossRef]
  18. Wordsworth M, Lawton G, Nathwani D, Pearse M, Naique S, Dodds A, et al. Improving the care of patients with severe open fractures of the tibia: the effect of the introduction of Major Trauma Networks and national guidelines. *Bone Joint J* 2016;98-B:420–4. [CrossRef]

## ORIJİNAL ÇALIŞMA - ÖZET

### Alt ve üst ekstremitenin açık kırıklarında eksternal fiksator uygulanmış internal fiksasyona geçilen olgularda komplikasyonların değerlendirilmesi

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**AMAÇ:** Açık kırıklar tüm kas-iskelet sistemi yaralanmaları arasında önemli bir mortalite ve morbidite nedenidir ve sosyal, ekonomik birçok problemi beraberinde getirir. Gerek uzun tedavi süreleri gerekse işe dönüşün gecikmesi ile oluşan maliyet, bu durumları daha komplike hale getirmiştir. Bu çalışmada alt ve üst ekstremitelerde açık kırıklarında eksternal fiksator uygulanmış internal fiksasyona geçilen olgularda görülebilen komplikasyonların geriye dönük olarak değerlendirilmesi amaçlanmıştır.

**GEREÇ VE YÖNTEM:** Çalışmaya 2007–2013 yılları arasında tedavi görmüş 49 hasta alındı. Bu hastaların 32'sine ilk yaralanmaları itibarıyla kliniğimizde eksternal fiksator uygulandı, geri kalan 17'si dış merkezde ilk tedavileri olan eksternal fiksator uygulandıktan sonra kliniğimize başvurdular. Tüm hastaların yaralanma mekanizmaları, eksternal fiksator ile takip periyodları, eksternal fiksator sonrası debrütman uygulanıp uygulanmadığı, eksternal fiksasyondan internal fiksasyona geçerkenki süre, pin dibi enfeksiyonu, kaynama zamanı, geç kaynama, kaynamama, internal fiksasyon sırasında greft kullanımı, internal fiksasyon türü, reoperasyonu, osteomyelit varlığı ve takip zamanları kaydedildi.

**BULGULAR:** Radius, humerus, tibia ve femur kırıkları için sonuçlar ayrı ayrı değerlendirildi. Kırık dokuz hasta içinde 39 erkek, 10 kadın mevcuttu. ortalama takip zamanı tibia için 28.6 ay, femur için 34, humerus için 26.9, radius için 27 aydı. Kırık dokuz hastanın 34'ü alt ekstremitede (25 tibia, 9 femur), 15'i üst ekstremitede (11 humerus, 4 radius) yaralanmasıydı. Kırık dokuz hastanın 32'sinde pin dibi enfeksiyonu, 11 olguda nonunion, 11 olguda gecikmiş kaynama, iki hastada ise osteomyelit bulguları mevcuttu.

**TARTIŞMA:** Açık kırıkları tedavi etmek daima zordur. Eksternal fiksasyon sonrası internal fiksasyona geçilen açık kırıklarda komplikasyonlara açıktır ve klinisyenlerin bu konunun bilincinde olup çıkabilecek sorunlara göre plan yapmaları gerekir.

**Anahtar sözcükler:** Açık kırık; eksternal fiksator; internal fiksasyon.

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