Outcomes of high energy tibial fractures with different fixation systems

Authors:

Orhan Büyükbebeci [(1)]

Burçin Karslı [(2)]

Sezgin Bahadır Tekin [(3)]

Mustafa Nihat Koç [(4)]

Ünsal Baylar [(5)]

1. Prof. Dr. in Gaziantep University Orthopeadics and Traumatology

2. Asst. Prof. Dr. in Gaziantep University Orthopeadics and Traumatology

3. Dr. in Gaziantep University Orthopedics and Traumatology

4. Asst. Prof . Dr. in Gaziantep University Plastic Surgery Department

5. Op. Dr. in Iskenderun Hospital

Key words: High energy tibial fractures.

Correspondence address:

Orhan Büyükbebeci

E-mail: sezgintekin1988@hotmail.com

Abstract

Background: Gunshot and blast injuries still continue to be a major problem for public health and economy. Blast injuries can also disrupt many systems on the body with many different effect mechanisms.

Patients and methods: In our study, we had definitely treated 21 patients with high energy tibial fracture (including open fractures) that were complicated and firstly treated in Syria during 2011-2015 years.

Results: All fractures healed at a median time of 9.1 months (min. 5-max. 8 months). The fracture of 11 patients healed at reasonable time (between 5-8 months). Nonunion occurred in the other 10 fractured patients (45 %), all of these were treated by different fixation materials. Patients were followed-up at a median time of 22,1 months (min.5- max.50 months)**.**

Only one case was treated with the monolateral external fixator without changing (case 7). All of the remaining patients were treated with different implant replacements for definitive treatment at different times. Twenty-six additional operations (in 21 patients), including non-union treatments, were performed during the hospital stay time. The fracture of one patient who was treated by intramedullary nail had not healed within 8 months but after that the bone healing was achieved by using Ilizarov external fixator (case 6). A patient with an open fracture had the major myocutaneous flap done by a plastic surgeon of high energy tibia fractures treated by staging with different fixation systems.

1. INTRODUCTION

Gunshot and blast injuries still continue to be a major problem for public health and economy. Blast injuries can also disrupt many systems on the body with many different effect mechanisms **(8, 9, 12)**. Gunshot and blast injuries can cause together serious extremity trauma, which may result in amputation. It is very difficult to give a decision about extremity amputation or extremity salvage surgery. **(13, 14, 15, 16, 18).** Therefore, the different scheduling criteria for limb salvage surgery have been described by many authors.

Gunshots or blasts have caused many penetrating injuries in Syria. Many injured persons were transferred to Şahinbey Hospital of Gaziantep University of Turkey. This hospital is also close to the North Border of Syria (60 km away). So we have treated many tibial fractures with high energy trauma in our clinic.

In our study, we had definitely treated 21 patients with high energy tibial fracture (including open fractures) that were complicated and firstly treated in Syria.

2. MATERIAL and METHOD

We have admitted 21 patients with high energy tibial fracture to be transported from war hospitals during 2011-2015 years. All patients had undergone previous surgery with different purchase materials in their hospital. The patients with implant failure, non-union, malunion, infection or osteomyelitis, insufficient skin covering the bone, were included to study. Pediatric fractures and pathologic fractures were excluded from this study. Transtibial amputation was performed in the two cases caused by bad soft tissue coverage of lower leg and untreatable bone infection. These patients were also excluded from this study.

Fifteen patient with blast injury and six patients with gunshot injury were referred to our clinic with delays by 6-10 weeks, and which were initially treated in combat hospitals. Thirteen patient had been treated by monolateral external fixator, three patients had intramedullary nail, four patients had plate and one patient had a pinless external fixator in situ.

The microbiologic culture-antibiogram studies were performed taken from infected wounds and aggressive

antibiotic treatments were started. If there was abscess formation or infection findings, surgical drainage and debridement were performed and the local area was washed with serum physiological water.

All patients were operated under general or spinal anesthesia on radiolucent fracture table by C-arm scopy. A postoperative exercise program was planned by a clinical specialist physiotherapist 7 days after surgery. In patients with closed fracture, prophylactic antibiotic was given. Previous infected cases that were evaluated for clinic status were given postoperative antibiotics for a minimum of 2-3 weeks. X-ray and clinic follow-up of patients were performed every two months.

3. RESULTS

Patients had referred to our clinic after 6-10 weeks following the first treatment in hospital. Because of delayed diagnosis, we didn't use the Gustilo-Anderson classification system for open fractures which is mainly widely used **(21).** All fractures were considered to be "infected" or not**.**

All fractures healed within a median time of 9.1 months (min. 5–max. 18 months). The fracture of 11 patients healed within a reasonable time (between 5-8 months). In the other 10 fractured patients (45 %) nonunion occurred, all of these were treated by different fixation materials. Patients were followed up at a median time of 22,1 months (min. 5- max. 50 months)**.**

Debridement of necrotic tissues was performed at intervals. There were different intensity infections (superficial or deep) in nine patients (43%)**.** After obtaining the results from the culture and sensitivity tests, different antibiotics were given for a long time. All of them were healed with antibiotics and also continued following repetitive surgical procedures**.**

Only one case was treated with the monolateral external fixator without changing **(case 7).** All of the remaining patients were treated with different implant replacements for definitive treatment at different times. Twenty-six additional operations (in 21 patients), including non-union treatments, were performed during the hospital stay time**.** The fracture of one patient who was treated by intramedullary nail was not healed within 8 months but after that the

bone healing was obtained by using the Ilizarov external fixator **(case 6).** A patient with an open fracture had the major myocutaneous flap done by a plastic surgeon **(case 18).**

Many patients did not demonstrate compliance during ROM (Range of Motion) exercise programs, so we haven't evaluated ROM of the knee and ankle joint (the patients were from Syria and hard to bring back to hospital again).

Seven cases (33 %) of all 21 patient have demonstrated unequal leg length between 1,5 and 6 cm, and 3 of these cases have had a leg lengthening surgery by the Ilizarov external Fixator system (or its hybrid) performed using the bone transport method. (Figures 1a-b-c-d-e-f-g-h-i-j). In two of the lengthened bones, leg lengthening was performed simultaneously with the fracture healing process (Figures 1 and 2). In the other case, the lengthening procedure was made after the fracture healing period. The lengthening could not be done in the other four cases and probably these four patients have gone to their homeland. A patient with a gunshot injury was transferred to us with pinless Ex. Fixator. After removing the pinless fixator, we performed the internal fixation with a plate and the fracture healing of this patient was obtained at 8 months **(Figure 3).**

4. DISCUSSION

External fixators (especially mono lateral systems) have already been used with open fractures with high energy trauma firstly. (11). They have also been thought to be an ideal selection for some fractures with bone loss and high infection risks. When the soft tissue is healed (2–3 weeks) with mono lateral external fixator systems then it is changed by an Ilizarov system or internal fixation system according to the type of fracture.

Post-treatment patients could only reach our clinic from war hospitals after a long time, such as 6-10 weeks. That's why many of the patients had had serious important problems and complications.

Biplanar or uniplanar *mono lateral* external fixators have already been used in patients *with open fractures* caused by *high-energy* trauma. External fixators are an essential part of damage control for multi-trauma management in patients with concomitant injury and stabilization for transport of injured person (carrol 20).

In many cases in this study, mono lateral external fixators have been

perfectly used in the hospitals in the war area. Because all patients had referred to our hospital too late (6—10 weeks), we couldn't benefit from Mangled Extremity Severity Score (MESS SCORE) or other "trauma score systems" for limb salvage surgery (14, 16, 18,). So the decision *to* salvage or amputate severely injured limb was made individually and in two of the cases has done the amputation instead of limb-sparing surgery.

High-energy injury fractures have a nonunion rate as high as 75% (22). In our series of 21 patients, nonunion rate was as high as 45 % (10/21 patients) and because of this, an infection may appear due to the fracture or late referral of patients or faulty implant selection or open fractures or fractures with high energy or mismatch of patient. One case in all 21 patients has had non union with the ıntramedullary nail following external fixation. Then we obtained the full union with Ilizarov external fixator. In literature, sufficient fracture healing has been indicated with intramedullary nail combined with plate fixation or external fixators in the complex tibial fracture including open fractures (1, 2). Besides firm fixation, the proper reduction, early soft tissue reconstruction, and early rehabilitation, are the most important factors that influence functional results (3).

Bone transport techniques are a reliable method in the treatment of bone defects of the tibia. The Ilizarov external fixators have been widely used to treat complex and/or open bone fractures and had successful results (4, 6). Despite our limited experience in this field (such as three cases), we have also obtained successful results with this method.

Locked intramedullary nails have also been used to treat open tibial fractures (5). We also obtained sufficient fracture healing with intramedullar nail in our cases only, excluding one case.

If there is a severe underlying osseous injury, free flap procedure can offer better functional results than the use of rotational flap (7). In only one of our cases, free flap was performed and achieved success.

REFERENCES

1. Yoon RS, Bible J, Marcus MS, Donegan DJ, Bergmann KA, Siebler JC, Mir HR, Liporace FA. Outcomes following combined intramedullary nail and plate fixation for complex **tibiafractures**: A multi-centre study.. Injury. 2015;46:1097.
2. Giovannini F, de Palma L, Panfighi A, Marinelli M. Intramedullary nailing versus external fixation in Gustilo type III open **tibial** shaft **fractures**: a meta-analysis of randomised controlled trials. Strategies Trauma Limb Reconstr. 2016 11:1-4.
3. Cho JH, Lee IJ, Bang JY, Song HK. Factors affecting clinical outcomes after treatment of extra-articular open **tibial fractures**. J Orthop Sci. 201621:63-7.
4. Azzam W, Atef A. Our experience in the management of segmental bone defects caused by gunshots. Int Orthop. 2016 40:233-8.
5. Melvin JS, Dombroski DG, Torbert JT, Kovach SJ, Esterhai JL, Mehta S. Open **tibial** shaft **fractures**: II. Definitive management and limb salvage. J Am Acad Orthop Surg. 2010 18:108-17. Review.
6. Bobroff GD, Gold S, Zinar D. Ten year experience with use of Ilizarov bone transport for **tibial** defects. Bull Hosp Jt Dis. 2003;61:101-7
7. Pollak AN, McCarthy ML, Burgess AR Short-term wound **complications** after application of flaps for coverage of traumatic soft-tissue defects about the tibia. The Lower Extremity Assessment Project (LEAP) Study Group. J Bone Joint Surg (Am.)2000 82:1681-91.
8. Mathews ZR, Koyfman A. Blast Injuries. *J* Emerg Med.2015 49:573-87.
9. Champion HR, Holcomb JB, Young LA. Injuries from explosions: physics, biophysics, pathology, and required research focus. J Trauma. 2009 66:1468-77
10. Moore JX, McGwin G Jr, Griffin RL. The epidemiology of firework-related injuries in the United States: 2000-2010.Injury.2014 45:1704-9.
11. Lerner A' Fodor L, Soudry M. Is staged external fixation a valuable strategy for war injuries to the limbs? Clin Orthop Relat Res. 2006, 448:217-24.
12. **Gordon W**, Kuhn K, Staeheli G, Dromsky D. Challenges in definitive fracture management of blast injuries.

Curr Rev Musculoskelet Med.2015 8:290-7.

13. Ege T, Unlu A, Tas H, Bek D, Turkan S, Cetinkaya A.Reliability of the mangled **extremity** severity score in combat-related upper and **lower extremity** injuries. Indian J Orthop. 2015 49:656-60.
14. **Helfet DL**, **Howey** T, Sanders R, Johansen. Limb salvage versus amputation. Preliminary results of the Mangled Extremity Severity Score. Clin Orthop Relat Res. 1990256:80-6.
15. MacKenzie EJ,**Bosse MJ**, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders R, Jones AL, McAndrew MP, Patterson B, McCarthy ML, Rohde CA; LEAP Study Group. Factors influencing the decision to amputate or reconstruct after high-energy lower extremity trauma. J Trauma. 2002 52:641-9.
16. **Bosse MJ**, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson BM, McCarthy ML, Cyril JK. A prospective evaluation of the clinical utility of the lower-extremity injury-severity scores. J Bone Joint Surg (Am). 2001 83:3-14.
17. Ficke JR, Pollak AN. Extremity War Injuries: Development of Clinical Treatment Principles. J Am Acad Orthop Surg. 2007 15:590-5.
18. McNamara MG, Heckman JD, Corley FG. Severe open fractures of the lower extremity: A retrospective evaluation of the Mangled Extremity Severity Score (MESS). J Orthop Trauma 1994;8:81–7.
19. Rajasekaran S, Naresh Babu J, Dheenadayalan J, Shetty AP, Sundarajan SR, Kumar M, et al. A score for predicting salvage and outcome in Gustilo type-IIIA and type-IIIB open tibial fractures. J Bone Joint Surg (Br) 2006;88:1351–60.
20. **Carroll EA**, Koman LA. External fixation and temporary stabilization of femoral and tibial trauma. J Surg Orthop Adv 2011 20:74-81.
21. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. J Bone Joint Surg Am. 1976;58:453–8
22. Csongradi JJ, Maloney WJ. **Ununited lower limbfractures**. West J Med. **1989**150(6):675-80. Review

FIGURES LEGEND

Figure 1a-b: After removal of external fixator, non-union.

Figure 1c-d: Treatment of non-union with Intra-medullary nail.

Figure 1e-g: Union wasn't obtained with Intra-medullary nail at a reasonable time.

Figure 1g-h: With Ilizarov system, simultaneous proximally bone transport and treatment of non-union.

Figure 1i-j: Finally, leg lengthening and union was obtained.

Figure 2a: Roentgenography of tibial fracture taken in Combat hospital. Ends of fractured bone were necrotic.

Figure 2b-c: After removed of dead bone fragment, proximal bone transport and healing of the fracture was planned with Ilizarov hybrid fixator.

Figure 2d-e: Leg lengthening and bone union was obtained.

Figure 3a-b: A patient with gunshot injury. (A-P and Lateral X-ray)

Figure 3c-d: Fixation of the fracture with plate. (A-P and Lateral X ray)

Figure 3e-f: Full fracture healing (A-P and Lateral X-ray)

Figure 1a-b: After removal of external fixator, non-union.

Figure 1c-d: Treatment of non-union with Intra-medullary nail.

Figure 1e-g: Union wasn't obtained with Intra-medullary nail at a reasonable time.

With Ilizarov system, simultaneous proximally bone transport and treatment of non-union.

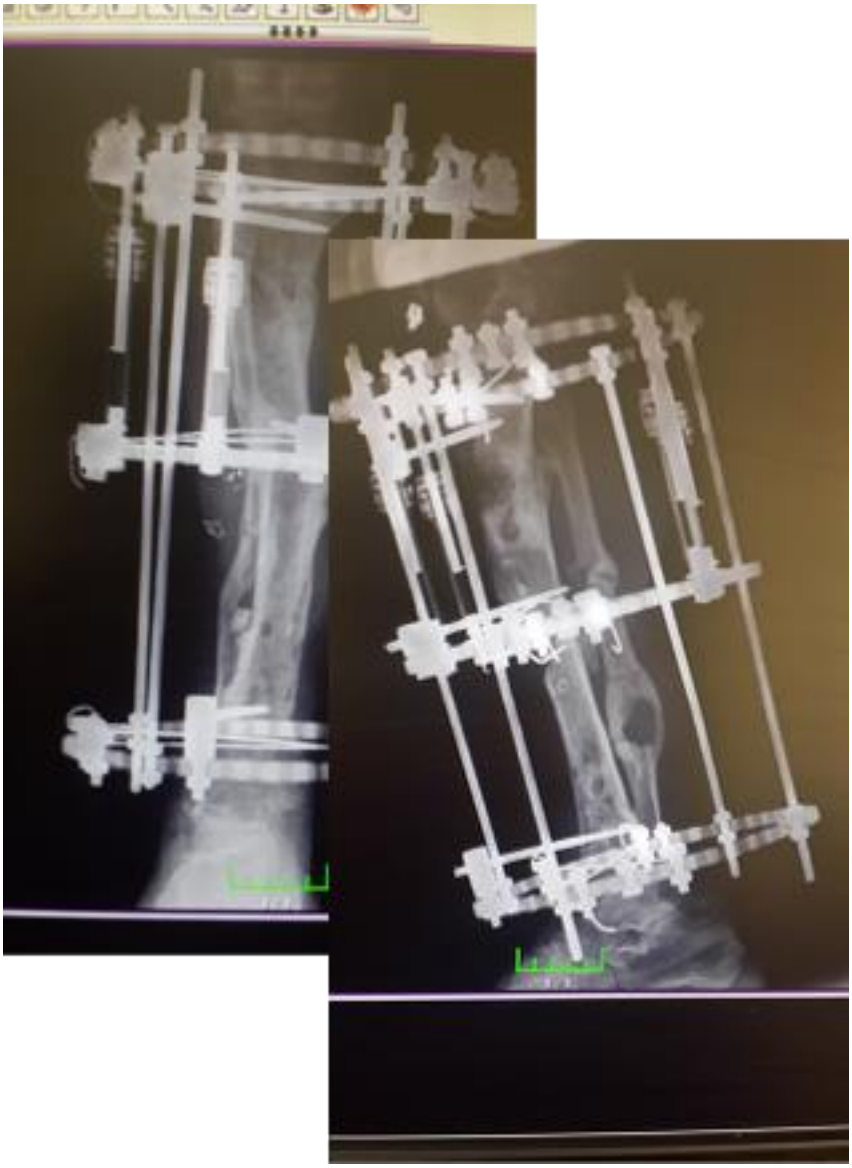

Figure 1i-j: Finally, leg lengthening and union was obtained.

Figure 2a

Figure 2a

Figure 2b

Figure 2c

Figure 2d

Figure 2e

Figure 3a-b

Figure 3c-d

Figure 3e

Figure 3 f

Figure 4a-b

Figure 4 c

