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Open tibial pilon fractures: treatment with ankle-spanning Ilizarov fixator

Ercan Şahin[1], Mahmut Kalem[2]

[1]Department of Orthopedics and Traumatology, Bülent Ecevit University School of Medicine, Zonguldak, Turkey
[2]Department of Orthopedics and Traumatology, Ankara University School of Medicine, Ankara, Turkey

ABSTRACT

Objectives. The aim of this retrospective study was to report the treatment results obtained with the ankle-spanning Ilizarov fixator technique in the treatment of complex OTA/AO type 43C3 open tibial pilon fractures. ***Methods.*** A total of 14 patients with open OTA/AO type 43C3 tibial pilon fractures were evaluated. The demographics and fracture characteristics, preoperative and postoperative radiological evaluations, duration of follow-up (months), time to union (months) and complications were recorded. After collection of operative data, patients were invited for functional and radiological outcome evaluation. American Orthopaedic Foot and Ankle Society (AOFAS) scores and range of movement (ROM) of the ankle joint were investigated. Also radiologically the ankle osteoarthritis level according to the Bargon et al. criteria was noted. ***Results.*** The mean age of the patients was 48.7 years (range, 26-72 years). The mean follow-up period was 32 months (range, 25-46 months). The clinical and radiological time to union was mean 6.5 months (range, 5-11 months). On the postoperative ankle CT images, the separation within the ankle was measured as < 2mm in all patients and in 3 patients, stepping was measured as > 2mm. Following removal of the external fixator, dorsiflexion was measured as mean 15.5° (range, 0°-23°) and plantar flexion as mean 26.14° (range, 13°-36°). The mean AOFAS was 80.35 (range, 56-92). ***Conclusion.*** Satisfactory results can be obtained with the Ilizarov external fixator passing the ankle in the permanent treatment of AO-43C3 type open tibial pilon fractures.

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Keywords: pilon fracture, open fracture, Ilizarov, external fixation

Introduction

Intra-articular fractures of the distal tibia (pilon fractures) generally occur as a result of torsional movement combined with axial forces. They constitute 3%-10% of tibial fractures and 1% of all lower extremity fractures [1]. As there is thin soft tissue coverage on the tibia and when there is concomitant severe soft tissue damage, especially in complex OTA/AO type 43C3 fractures, difficulties in treatment are experienced [2, 3].

According to the soft tissue injury, there are various treatment options such as staged management with primary external fixator followed by open reduction and internal fixation, early open reduction and internal fixation, plate application with minimally invasive approachesandusing external fixators with minimally invasive reduction and fixation techniquesfordefinitive treatment [4-6]. In the current treatment of pilon fractures with concomitant soft

Address for correspondence:
Ercan Şahin, MD., Bülent Ecevit University School of Medicine, Department of Orthopedics and Traumatology, 67100 Zonguldak, Turkey E-mail: dr_erc_sah@yahoo.com.tr Phone: +903722613055
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tissue damage, the treatment option of external fixation with or without minimally invasive techniques is often selected because it creates fewer complications such as deep or superficial wound infection, osteomyelitis or amputation [7-9].

The aim of this study was to report the treatment results obtained with the ankle-spanning Ilizarov fixator technique in the treatment of complex OTA/AO type 43C3 open tibial pilon fractures.

Methods

This retrospective study was carried out by approval and supervision of Local Ethical Committee. Using the hospital data system, the radiographs and information forms of 113 patients who underwent surgery for tibial fractures between January 2009 and December 2015 were investigated. A total of 34 patients aged > 16 years had an acute, unilateral, open distal tibial intra-articular fracture extending to the metaphysis (OTA/AO type 43C3 tibial pilon fracture) were analyzed (Figure 1a). After exclusion of 5 patients with less than 2 years follow-up, 7 patients whose preoperative or postoperative ankle tomography images were not available and 8 patients who were treated with a technique other than ankle-spanning Ilizarov fixator technique, a total of 14 patients were included in the study for evaluation.

Demographic data including age, gender and mechanism of injury (fall from height, traffic accident, mining accident, and others) were recorded. From the emergency department examination forms and operation notes, open fractures were classified according to the Gustillo and Anderson [10]. The size of gap (measured on the preoperative and postoperative axial CT images, mm) and the size of step (measured on the preoperative and postoperative sagittal CT images, mm) between two largest fracture fragments (with using Centricity PACS-IW software, General Electric healthcare) (Figure 1b, 1c), presence/type of fibula fixation (plate, K-wire), duration of follow-up (months), time to union (months) and complications (pin site infection, malunion, osteomyelitis) were recorded. After collection of operative data, patients were invited (with phone call) for functional and radiological outcome evaluation at least one year postoperatively. At this final follow-up examination, functional evaluation using American Orthopaedic Foot and Ankle Society (AOFAS) scores and range of movement (ROM) of the ankle joint were investigated. Also radiologically the ankle osteoarthritis level according to the Bargon *et al.* [11] criteria was noted.

Figure 1. A 29-year-old miner (Case 4) with Gustillo and Anderson type 3a, OTA/AO-43C3 tibial pilon fracture. Lateral radiograph of the left ankle showing metaphyseal comminution (a), preoperative axial CT image of the ankle showing the gap between two largest fracture fragments (b), preoperative sagittal CT image of the ankle (c), postoperative AP radiograph after application of the ankle-spanning Ilizarov fixator (d), AP radiograph of the tibia 4 months after fixation (e), AP and lateral radiographs of the tibia six months after injury. The frame was removed. The patient was free of pain over the fracture line, with no complaints during weight-bearing. Radiological union was delayed (f and g) and active dorsiflexion of the ankle was about 0° (h).

Surgical Technique

The operations were performed by the same orthopedic surgeon. Within 8 hours of admission to the emergency department, the patients were prepared for the surgery. The frame was constructed before beginning of the surgery in the operating room. The ring sizes are selected according to the circumference of the limb allowing about two finger widths to the skin. The first two rings were arranged for placing proximal to the fracture and the third ring was arranged for placing just proximal to the ankle joint. The 3 rings were connected to each other with 4 threaded rods. With the patient in supine position, following wound debridement with saline, soft tissue was closed. Firstly the fibula was fixed closely with 2 intramedullary K-wire or openly with a 1/3 tubular plate to maintain alignment. The preconstructed Ilizarov frame was applied to the limb and fixed with wires and 5 mm Schanz screws to the tibia under fluoroscopic control. The fracture reduction of the ankle was tried to achieve closely with olive wires and ligamentotaxis and the frame was used an indirect reduction device also. The ring, which was placed just proximal to the ankle joint, was connected laterally to calcaneus with a Schanz screw (Figure 1d).

Postoperative Follow-up

Prophylactic antibiotherapy was administered to all patients for two days. The leg was elevated to decrease soft tissue swelling. Pin and wound care was done with iodine. Following the reduction of the leg edema, the patients were mobilized, but not allowed to weight bear until the 6th week postoperatively. At 6th week the Schanz screw was removed from the calcaneus and full weight-bearing was permitted with ankle exercises (Figure 1e). Clinical and radiological follow-ups were repeated every 3 weeks until union was achieved. In patients with no pain in the fracture line during the follow-up examinations and findings of union in at least 3 cortices on direct radiographs, the fixator was removed and a short-leg circular plaster cast was applied. Weight-bearing was continued with the plaster cast, which was removed after 1 month. Statistical data were expressed by the mean and range values or number and percent (Figure 1f, 1g).

Results

A total of 14 patients (9 males, 5 females) with AO-43C3 type open tibial pilon fractures were evaluated. The mean age of the patients was 48.7 years (range, 26-72 years). According to the Gustillo and Anderson classification, 4 fractures were type 3a, 3 were type 2 and 7 were type 1 open fractures. The mechanism of injury was a fall from height in 3 cases, a traffic accident in 7 and a mining accident in 3. The mean follow-up period was 32 months (range, 25-46 months). All the patients had a concomitant fibula fracture and while fixation with plate or K-wire was applied to 9 patients, fixation was not applied in 5 cases. Bone union was obtained in all patients. The clinical and radiological time to union was mean 6.5 months (range, 5-11 months) (Table 1).

In 12 (85.7%) patients there was large separation of > 2 mm and in 10 (71.4%) patients there was large stepping of > 2 mm on preoperative axial and sagittal CT images. On the postoperative ankle CT images, the separation within the ankle was measured as < 2 mm in all patients and in 3 patients, stepping was measured as > 2 mm.

Pin site infection was observed in 5 (35%) of the 14 patients and all recovered with oral antibiotic treatment. The wires were removed in 2 patients. No deep tissue infection or osteomyelitis was observed in any patient. Malunion was seen in 2 (14%) patients. Valgus angulation of approximately 11° was seen in 1 patient and posterior angulation of approximately 15° in 1 patient. No additional surgery was performed on either patient.

Following removal of the external fixator, dorsiflexion was measured as mean 15.5° (range, 0°-23°) and plantar flexion as mean 26.14° (range, 13°-36°). At the final follow-up examination, the mean AOFAS was 80.35 (range, 56-92).

On the ankle radiographs taken at the final follow-up examination, arthrosis was evaluated as grade 4 in 1 patient, grade 3 in 2 patients, grade 2 in 5 patients and grade 1 in 6 patients.

Discussion

In the treatment of high-energy pilon fractures, although the use of an Ilizarov fixator passing the ankle joint has advantages such as providing indirect reduction with ligamentotaxis, allowing the fixation of intra-articular fragments with very small incisions, no need for soft tissue dissection and allowing the possibility of stable and permanent fixation, there can also be said to be the disadvantage of discomfort for

Table 1. Data of the patients

Number	Age/sex	Mechanism of injury	Open fracture type*	Presence/type of fibula fixation	Follow-up (months)	Ankle movement (dorsiflexion/ plantar flexion)	AOFAS	Union time (months)	Ankle osteoarthritis level**	Complication
1	47/m	fall from height	1	plate	28	7/16°	65	6	4	Pin-track infection.
2	49/m	other	3a	plate	32	9/14°	56	11	3	Pin-track infection.
3	68/m	traffic accident	1	none	41	18/24°	86	5	1	malunion
4	29/m	mining accident	3a	K wire	26	0/13°	76	9	2	Pin-track infection.
5	49/m	traffic accident	1	plate	46	22/32°	92	5	1	none
6	43/m	mining accident	2	plate	25	21/34°	90	5	1	none
7	38/f	traffic accident	1	none	27	19/28°	84	6	2	none
8	58/f	fall from height	1	K wire	25	21/36°	92	5	1	none
9	26/m	traffic accident	2	none	33	17/27°	78	6	2	Pin-track infection.
10	38/f	traffic accident	3a	K wire	29	10/25°	70	6	3	malunion
11	55/m	fall from height	3a	plate	42	11/23°	74	10	2	Pin-track infection.
12	67/f	traffic accident	1	none	44	18/28°	82	7	2	none
13	72/f	traffic accident	1	none	25	23/32°	90	5	1	none
14	43/m	mining accident	2	plate	25	21/34°	90	5	1	none

*According to the Gustillo-Anderson Classification,**According to the Bargon *et al.* [11] criteria. (Grade 1: no osteophytes, no joint space narrowing; Grade 2: small osteophytes, no joint space narrowing; Grade 3: moderate osteophytes, joint space narrowing; Grade 4: large osteophytes, severe joint space narrowing)

the patient [12, 13]. Due to the frequent occurrence of complications such as wound problems, infection and osteomyelitis in high-energy open pilon fractures, anIlizarovexternal fixation method was selected in the permanent treatment of the patients in this study [14-16].

Although there are few studies that have reported the joint reduction quality following surgery of high-energy pilon fractures, in a study of 30 patients treated with Ilizarov external fixator, Osman *et al.* [17] reported that acceptable reduction was obtained in 46.6% and poor reduction in 20%. In another study of 17 patients, Kapoor *et al.* [13] reported that in 4 patients with AO-43C3 type open tibial pilon fractures, acceptable joint reduction was obtained with Ilizarov external fixator passing the joint. In the current study, although the patient number was greater, while small separation of < 2mm was achieved in all, stepping in the joint of >2 mm could not be prevented in 3 patients.

Prospective randomized studies which have compared internal fixation and external fixation in high-energy pilon fractures have reported that significantly fewer complications were seen in patients applied with external fixation [14, 18, 19]. Following treatment made with Ilizarov external fixator in 21 cases of complex tibial pilon fracture, 9 of which were open fractures, Vidyadhara and Sharath [20] reported that superficial pin site infection developed in 7 patients and deep pin site infection in 1, but no information was given about whether or not these were patients with open fractures. Okcu and Aktuglu [9] compared 44 patients with AO-43C3 type tibial pilon fractures treated with Ilizarov external fixator passing and not passing the ankle joint. It was reported that 12 patients had an open fracture and no osteomyelitis developed in any patient without differentiation of open and closed fractures, malunion developed in 10 patients and pincer toe developed in 6 patients [9]. In the current study, no osteomyelitis was observed, but there was pin site infection in 5 patients and malunion in 2.

Ankle dorsiflexion movement > 10° is usually sufficient for walking [21]. Kapoor *et al.* [13] reported that of 17 patients with high-energy pilon fractures treated with Ilizarov external fixator passing the ankle, 75% had ankle dorsiflexion of > 10°, dorsiflexion was 0° in 2 patients, plantar flexion was > 30° in 11 patients and < 20° in 1. With a mean functional score of 79.8, 4 patients with C3 fractures were reported as

acceptable. In the current study, the mean dorsiflexion was measured as 15.5° (range, 0°-23°) and plantar flexion as mean 26.14° (range, 13°-36°) and the mean AOFAS was 80.35 (range, 56-92). The ROM values and functional scores of the patients in the current study are consistent with literature. Bone *et al.* [22] stated that ankle ROM remaining at an acceptable levelafter Ilizarov external fixator treatment was associated with the distraction made to the joint by the fixator during treatment causing tension in the ligaments and prevents shortening in the ligaments.
In 30 patients with high-energy tibialpilon fractures treated with Ilizarov external fixator by Osman *et al.* [17], arthrosis developed in the joint in 11 patients, but no information was given about the grade of arthrosis. Fırat *et al*. [23] compared the Ilizarov external fixator techniques of fixed to the ankle and jointed at the ankle in 34 patients operated on for tibial pilon fracture. Post-traumatic arthrosis was reported in 31.3% of the patients with Ilizarov external fixator jointed at the ankle and in 55.5% of the patients with the Ilizarov external fixator fixed at the ankle. Again, no information was given about the degree of arthrosis. Wyrsch *et al.* [14] treated 20 of 38 patients with pilon fractures with external fixator combined with internal fixation using a minimal incision and while no osteoarthritic change was determined in only 1 patient, osteoarthritic changes were observed at a mild level in 6 patients, at an evident level in 8 and at a severe level in 4. Similarly, Guo *et al.* [24] applied external fixator combined with internal fixation with a minimal incision to 26 patients with Rüedi-Allgöwer type 3 fractures and reported osteoarthritic changes in all the patients. Calori *et al.* [1] reported that the osteoarthritic changes that developed following high-energy pilon fractures were associated with the cartilage damage that was created during the trauma and arthrosis could develop despite anatomic joint reconstruction obtained radiographically. Elsoe *et al.* [23] indicated that35% of their patients had osteoarthritis at the ankle joint following a distal intra-articular fracture 12 months after frame removal. In the current study, osteoarthritic changes of varying degrees were seen in all patients and were graded.

The Limitations of the Study

Limitations of this study can be said to be that it was retrospective, that despite a sufficient number of patients with pilon fractures, a small number of patients had open AO-43C3 type fracture, and because there was no comparison with any other treatment option, there was insufficient statistical evaluation.

Conclusions

Although several techniques have been compared in the treatment of high-energy pilon fractures, there is no standard surgical technique that is applied. The results of this study have demonstrated that satisfactory results can be obtained with the Ilizarov external fixator passing the ankle in the permanent treatment of AO-43C3 type open tibial pilon fractures.

Authorship declaration

All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and all authors are in agreement with the manuscript.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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References

[1] Calori GM, Tagliabue L, Mazza E, de Bellis U, Pierannunzii L, Marelli BM, et al. Tibial pilon fractures: which method of treatment? Injury 2010;41:1183-90.
[2] Krettek C, Bachmann S. Pilon-Frakturen. Chirurg 2015;86:87-104.
[3] Mauffrey C, Vasario G, Battiston B, Lewis C, Beazley J, Seligson D. Tibial pilon fractures: a review of incidence, diagnosis, treatment, and complications. Acta Orthop Belg 2011;77:432-40.
[4] Sirkin M, Sanders R, DiPasquale T, Herscovici D Jr. A staged protocol for soft tissue management in the treatment of complex pilon fractures. J Orthop Trauma 2004;18:S32-S38.
[5] White TO, Guy P, Cooke CJ, Kennedy SA, Droll KP, Blachut PA, et al. The results of early primary open reduction and internal fixation for treatment of OTA 43.C-type tibial pilon fractures: a cohort study. J Orthop Trauma 2010;24:757-63.
[6] Joveniaux P, Ohl X, Harisboure A, Berrichi A, Labatut L, Simon P, et al. Distal tibia fractures: management and complications of 101 cases. Int Orthop 2010;34:583-8.
[7] Teeny SM, Wiss DA. Open reduction and internal fixation of tibial plafond fractures: variables contributing to poor results and complications. Clin Orthop 1993;292:108-17.
[8] Tornetta P 3rd, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, et al. Pilon fractures: treatment with combined internal and external fixation. J Orthop Trauma 1993;6:489-96.
[9] Okcu G, Aktuglu K. Intra-articular fractures of the tibial plafond. A comparison of the results using articulated and ring external fixators. J Bone Joint Surg Br 2004;86:868-75.
[10] 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.
[11] Bargon G. Röntgenmorphologische Gradeinteilung der posttraumatischen Arthrose im oberen Sprunggelenk. HefteUnfallheilkd 1978;133:28-34.

[12] Beals TC. Application of ring fixators in complex foot and ankle trauma. Orthop Clin North Am 2001;32:205-14.
[13] Kapoor SK, Kataria H, Patra SR, Boruah T. Capsuloligamentotaxis and definitive fixation by an ankle-spanning Ilizarov fixator in high-energy pilon fractures. J Bone Joint Surg Br 2010;92:1100-6.
[14] Wyrsch B, McFerran MA, McAndrew M, Limbird TJ, Harper MC, Johnson KD, et al. Operative treatment of fractures of the tibial plafond. A randomized, prospective study. J Bone Joint Surg Am 1996;78:1646-57.
[15] Marsh JL, Bonar S, Nepola JV, Decoster TA, Hurwitz SR. Use of an articulated external fixator for fractures of the tibial plafond. J Bone Joint Surg Am 1995;77:1498-509.
[16] McDonald MG, Burgess RC, Bolano LE, Nicholls PJ. Ilizarov treatment of pilon fractures. Clin Orthop 1996;325:232-8.
[17] Osman W, Alaya Z, Kaziz H, Hassini L, Braiki M, Naouar N, et al. Treatment of high-energy pilon fractures using the ILIZAROV treatment. Pan Afr Med J 2017;27:199.
[18] Pugh KJ, Wolinsky PR, McAndrew MP, Johnson KD. Tibial pilon fractures: a comparison of treatment methods. J Trauma 1999;47:937-41.
[19] Watson JT, Moed BR, Karges DE, Cramer KE. Treatment protocol based on severity of soft tissue injury. Clin Orthop 2000;375:78-90.
[20] Vidyadhara S, Sharath K. Ilizarov treatment of complex tibial pilon fractures. Int Orthop 2006;30:113-7.
[21] Brumback RJ, McGarvey WC. Fractures of the tibial plafond: evolving treatment concepts for the pilon fracture. Orthop Clin North Am 1995;26:273-85.
[22] Bone L, Stegemann P, McNamara K, Seibel R. External fixation of severely comminuted and open tibial pilon fractures. Clin Orthop Relat Res 1993;292:101-7.
[23] Fırat A, Tecimel O, Işık C, Ozdemir M, Oçgüder A, Bozkurt M. [Ilizarov external fixator in the management of tibial pilon fractures: ankle hinged vs ankle fixed frame]. Eklem Hastalik Cerrahisi 2013;24:133-8. [Article in Turkish]
[24] Guo Y, Tong L, Li S, Liu Z. External fixation combined with limited internal fixation versus open reduction internal fixation for treating Ruedi-Allgower type III pilon fractures. Med Sci Monit 2015;21:1662-7.
[25] Elsoe R, Larsen P, Petruskevicius J, Kold S. Complex tibial fractures are associated with lower social classes and predict early exit from employment and worse patient-reported QOL: a prospective observational study of 46 complex tibial fractures treated with a ring fixator. Strategies Trauma Limb Reconstr 2017 Nov 4. doi: 10.1007/s11751-017-0301-y.