



Hybrid external fixation via a minimally invasive method for tibial pilon fractures – Technical note



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HIGHLIGHTS

- We achieved a relatively higher functional ankle range of motion with near total plantar flexion with our technique.
- The mean operative duration was 45 min, and only one permanent operation was indicated in our patients.
- Nonunion and malunion were not observed in any of the patients, and good alignment was achieved, with a mean lateral distal tibial angle of 89°.

ARTICLE INFO

Article history:

Received 18 August 2015

Received in revised form

31 August 2015

Accepted 11 September 2015

Keywords:

Tibial fracture
External fixators
Sequelae

ABSTRACT

Introduction: We aimed to present the clinical and radiological outcomes of patients with tibial pilon fractures who were treated with hybrid external fixators. Schanz screws were applied synchronously and used as joysticks for fracture reduction. Radiological evaluations were conducted on roentgenograms at the second week, sixth week, third month and first year.

Material and methods: The study group included 42 patients with tibial pilon fractures that were classified as 43C according to the AO/OTA classification system. We used 2-hydroxyapatite-coated Schanz screws for the tibial pilon reduction. Schanz screws fixated to two separate motors were synchronously passed through the fracture fragments. An external fixator was applied after the fracture was stabilized with Schanz screws.

Results and discussion: The mean operation duration was 45 min. Fracture healing was observed in all patients, and the mean fracture healing time was 17 (range, 12–32 weeks) weeks. The mean lateral distal tibial angle was 89°. Joint surface irregularity was not observed in any patient. All of the patients had 0–15° of ankle dorsiflexion. None of the patients had restricted ankle plantar flexion. No wound complications were observed. According to the AOFAS scoring system, the clinical evaluation was excellent in 26 patients, good in 14 patients and fair in 2 patients. Malunion and nonunion may necessitate additional surgical procedures, delay the return to activities of daily living, and increase treatment costs. Good alignment was achieved, with a mean lateral distal tibial angle of 89 (range, 84–92) degrees.

Conclusion: Permanent hybrid external fixator applied using Schanz screws via a mini open technique is a fast, easily applied alternative with low morbidity and satisfying results.

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1. Introduction

Tibial pilon fractures affect the bottom of the tibia (shinbone) at the ankle joint. Tibial pilon fractures constitute 1% of all lower extremity fractures and are one of the most difficult fracture types to manage [1]. Motor vehicle accidents and falls from a height are the

most frequent injury mechanisms [2,3]. Most tibial pilon fractures are the result of axial loading, and fast axial loading disseminates an excessive amount of energy. This energy release causes severe soft tissue injuries in tibial fractures [3,4].

Both the intra-articular nature of the fracture and the severe soft tissue injury complicate the management of these fractures. A combination of open reduction and internal fixation was accepted as the gold standard treatment however; this approach has fallen into disfavor because of its high complication rates as 37–54% [5,6]. Since the development of external fixators, the applicability of distraction and ligamentotaxy and their minimal soft tissue

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<http://dx.doi.org/10.1016/j.amsu.2015.09.006>

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damage have made these techniques increasingly popular [7–9].

In this report, we aimed to present the clinical and radiological outcomes of patients with tibial pilon fractures who were treated with hybrid external fixators. Schanz screws were applied synchronously and used as joysticks for fracture reduction.

2. Material and methods

Patients who underwent surgical repair for tibial pilon fractures between 2010 and 2013 were evaluated retrospectively via electronic medical records. Gustilo Andersen type C fractures, fractures that were infected after the operation, an operation type other than using a hybrid external fixator, patients who did not attend follow-up visits, patients with follow-up intervals shorter than 12 months, and patients who could not complete the rehabilitation period were excluded. Ultimately, the study group included 42 patients (29 males, 13 females) with unilateral tibial pilon fractures that were classified as 43C according to the AO/Orthopedic Trauma Association (OTA) classification system. Patients with open fractures were evaluated according to the Gustilo-Andersen type [10]. Lateral malleolus fractures in 34 patients were treated with open reduction and osteosynthesis with internal fixation. All patients were informed about the surgical treatment options and the rehabilitation after the treatment, and all patients gave written informed consent. Radiological evaluations were conducted on roentgenograms at the second week, sixth week, third month and first year and data collected based on the electronic hospital record system.

Fracture healing was followed on direct roentgenograms after the operation. The American Orthopedic Foot and Ankle Society (AOFAS) scoring system was used for clinical evaluation [11].

3. Surgical technique

Patients were placed in the supine position on fluoroscopy-compatible beds. Cephazolin antibiotic prophylaxis was preoperatively applied to patients. Surgery was conducted under sedation with spinal anesthesia. No tourniquets were applied in any patient.

Prior to the reduction of the tibial pilon fracture, open reduction and internal fixation through a longitudinal incision over the lateral

malleolus were applied in patients with concomitant lateral malleolus fractures. We used 2-hydroxyapatite-coated Schanz screws of 6.5 mm thickness and 50 mm groove length for the tibial pilon reduction. Schanz screws were positioned into the major fracture fragments as determined on axial computerized tomography sections in the anteroposterior plane and perpendicular to the medial and lateral fracture fragments. The schanz screws were positioned under fluoroscopic guidance, and the screws were controlled to prevent arriving at the fracture zone. Using the joystick method, optimal anatomical reduction was obtained. After confirming optimal anatomical reduction with fluoroscopy, Schanz screws fixated to two separate motors were synchronously passed through the fracture fragments. An external fixator was applied after the fracture was stabilized with Schanz screws.

Block movement of the tibia in the anteroposterior and lateral planes was observed under fluoroscopy, and after deciding the appropriate joint regularity, the screws were fixated to 5/8-sized rings.

Previously selected monolateral external fixators were applied with 3 Schanz screws. A lengthening cube of size 4 was applied from a suitable hole on the medial side of the proximal ring. The, 2-hydroxyapatite-coated Schanz screws of 6.5 mm thickness and 50 mm groove length were fixated to the lower holes of the lengthening cube (Figs. 1–2).

After providing a final reduction of the system through distraction and compression, the system was stabilized completely. The screw bottoms were cleaned with hydrogen peroxide, and sterile medical dressing was applied. Radiological evaluations were conducted on roentgenograms at the third week, sixth week, third month, sixth month, and first year postoperatively.

4. Results

The mean age of the population was 37.7 years old (range, 22–47 years old), and the mean follow-up interval was 21.4 months (range, 12–44 months). 4 patients lost the follow up at 12 months, 3 patients lost the follow up at 18 months. All patients experienced tibial pilon fractures as a result of high energy trauma. Twenty-two (52.4%) patients experienced closed fractures. Of the open fractures, 11 (26.2%) were Gustilo Andersen type 1, 8 (19%) were Gustilo

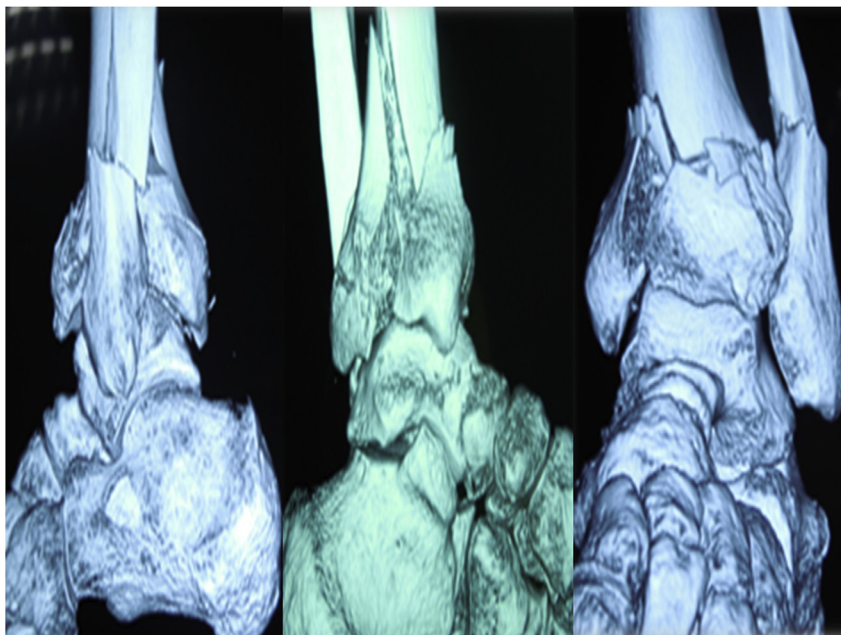


Fig. 1. Pre-operative three dimensional evaluation of a male patient.

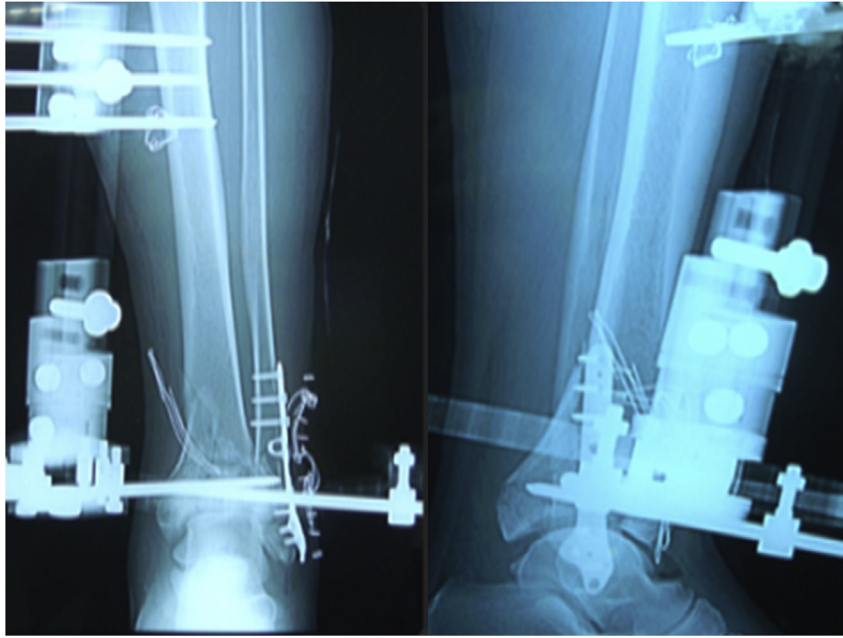


Fig. 2. Control roentgenograms on the first post-operative day.

Andersen type 2, and 1 (2%) was Gustilo Andersen type A. There was no significant difference between the results for open and closed fractures. The mean operation duration was 45 min (range, 30–70 min). Blood transfusion was not indicated in any of the patients. Fracture healing was observed in all patients, and the mean fracture healing time was 17 weeks (range, 12–32 weeks) (Fig. 3). The mean lateral distal tibial angle was 89° (range, 84° – 92°). Joint surface irregularity was not observed in any patient. All of the patients had 0° – 15° of ankle dorsiflexion. None of the patients had restricted ankle plantar flexion. No wound complications were observed. According to the AOFAS scoring system, the clinical

evaluation was excellent in 26 patients, good in 14 patients and fair in 2 patients.

Complex regional pain syndrome was observed in one of the cases and was treated with physical therapy. Delayed union was observed in 3 patients, but no extra treatment was indicated in these patients. Pin bottom infection was observed in 8 patients, and they were treated with oral antibiotics.

Early active and passive range of motion exercises were recommended, and partial weight bearing as tolerated with crutches was allowed in the first 6 weeks after the operation. Full weight bearing without crutches was achieved after the sixth week (Fig. 4).

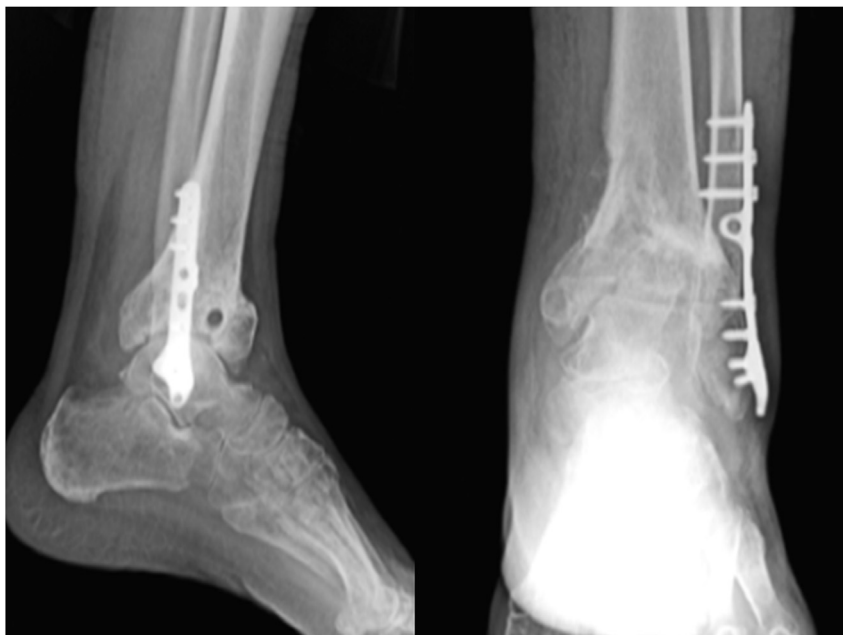


Fig. 3. Control roentgenograms 12 months after the operation.



Fig. 4. Ankle range of motion 12 months after the operation.

5. Discussion

Tibial pilon fractures are severe injuries with high complication rates with the range of 11.4–54% [6,12]. The risk is related to the mechanism of injury, although it can also be attributed to the preferred the surgical technique. The risk of complications is as high as 37–54% in open reduction techniques [5,6]. As a result, the application of open reduction along with internal fixation (depending on biological principles) has been particularly popularized for tibial pilon fractures [13]. Careful soft tissue dissection is necessary to cause the least amount of harm and preserve the periosteum of the fracture fragments as much as possible. Indirect reduction techniques have also been emphasized according to biological principles [2,13]. Stable treatment with minimal soft tissue dissection was achieved using the technique that we applied.

Unlike tibiotalar and tibiocalcaneal fixators, the hybrid external fixators that are used in biological treatment do not pass through the joint. Firat A et al. reported a mean of 25 degrees of plantar flexion in tibial pilon fractures treated with hybrid external fixators [22]. We achieved a relatively higher functional ankle range of motion with near total plantar flexion and 0–15° of dorsiflexion.

Wound site problems and infections constitute major surgical issues, especially in patient series treated with internal fixation, and rates as high as 67% have been reported [14–16]. Developments in low-profile internal fixator technology and external fixation techniques may be able to decrease this rate to 10% [12–17]. Pin bottom infection was observed in 8 patients in our study group following treatment with mini open reduction and hybrid external fixation. Antibiotic therapy was administered to these patients.

The incidence of various types of malunion and nonunion, such as angular deformity, translation, and rotational deformity, is 25% [18–20]. Petterson and Cole reported an indication for arthrodesis in 9% of patients during the post-operative period [19]. Malunion and nonunion may necessitate additional surgical procedures, delay the return to activities of daily living, and increase treatment costs. Nonunion and malunion were not observed in any of the patients, and good alignment was achieved, with a mean lateral distal tibial angle of 89°. Only 3 patients experienced delayed

union, one of these patients had diabetes mellitus as comorbidity. But surgical intervention was not indicated and these fractures were healed at the end of the 6 months.

Another important point in the treatment of distal tibial fractures is delaying permanent surgery to decrease complication rates [21]. Prolonged surgical durations and decreased postoperative comfort are the expected results. The mean operative duration was 45 min, and only one permanent operation was indicated in our patients. All of the patients were operated on within 24 h after the fracture. These results are significant, and to our knowledge, no similar investigations have been reported from this point of view.

The retrospective nature is the major limitation of our study. A lack of data on long-term results and the absence of a comparison group are the other limitations.

6. Conclusion

Permanent hybrid external fixator applied using schanz screws via a mini open technique is a fast, easily applied alternative with low morbidity and satisfying results.

Conflicts of interest

All authors declared that they have no conflict of interest.

Sources of funding

We have not any sources of funding.

Ethical approval

Retrospective study and do not need any ethical approval.

Author contribution

MB- writing.
EK- data collecting, writing.
FS-data analysis.

AK-data analysis.
ME-study design.

Guarantor

Ersin Kuyucu-EK.

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