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THE ROLE OF EXTERNAL FIXATION IN DISPLACED PILON FRACTURES OF DISTAL TIBIA

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SUMMARY – Results of treatment in patients with high-energy displaced pilon fractures are presented. During five years, 15 patients with displaced pilon fractures (AO type C2 and C3) were treated. All other types of fracture were excluded from the study. Fractures were identified using standard radiographs and computed topography scanning. The method and timing of the operation were dictated by the status of soft tissues. In all fractures, external fixation was placed immediately and was left until the initial callus bridged the fracture fragments. In case of moderate contusion of soft tissues, limited incision and minimal internal osteosynthesis was done in the same act. In patients with more severe soft tissue damage, limited open reduction and restoration of articular surface was undertaken in second procedure after 7 days on average. All fractures united and the average time of healing was 4 months. Two patients had superficial infections that resulted in prolonged wound healing, and another four patients had pin site infection. There were no cases of deep infection, nonunion or malunion, but we had five cases of secondary osteoarthritis. Results were evaluated by Teeny and Wiss rating system. The results were as follows: 5 excellent results, 10 good and fair results, and no poor results. This study showed that external fixation with open reduction and limited internal osteosynthesis, with or without bone grafting, could be an option in the management of displaced multifragmentary pilon fractures with soft tissue injury. It was followed by significantly less complications with better functional results compared to open reduction and internal plate fixation.

Key words: *Tibial fractures; Pilon fractures; Fracture fixation; External fixators*

Introduction

Pilon fracture of the ankle is an intra-articular fracture of distal tibia metaphysis that accounts for approximately 7% of tibia fractures[1,2]. Pilon is a French word for pestle (little hammer) and it was used to describe this injury in 1911 by Destot, a French radiologist[3].

The mechanism of injury usually involves axial compression of the talus into distal tibia, with or without rotational or angular forces. Depending on the forces, a wide variety of injuries can occur. At one end of the spectrum are low-energy injuries that follow activities such as skiing and result in minimal soft tissue injury. At the other end there are high-energy injuries such as fall from height or high-speed motor vehicle accident[4,5]. This mechanism can produce significant comminution with multiple displaced fracture fragments and contused or crushed soft tissue. The fibula is usually fractured in high-energy injuries.

Numerous methods of treatment have been proposed, e.g., casting, calcaneal pin traction, external fixation, open reduction and internal fixation with plates and screws, minimal internal fixation combined with either plaster immobilization or external fixation, minimally invasive plate osteosynthesis (MIPO)[6,7],

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and finally primary arthrodesis. In the history, emphasis was on non-operative means for treating these fractures, however, usually with poor result. In the late 1960s, Ruedi and Allgower set up the principles for the treatment of tibial pilon fractures with open reduction and internal fixation (ORIF) with plates and screws, including restoration of the anatomic joint reconstruction, lateral and medial column buttressing and early bone grafting[8]. This method provides good outcomes only in low-energy injuries. When the higher-energy injuries are treated in this manner, poor results and skin complications predominate[2,5,9-13]. Complications after ORIF in Reudi types II and III injuries included wound slough in up to 37%, deep infections, osteomyelitis in up to 55%, nonunion in 27%, malunion in 27%[12], secondary osteoarthritis in 55%, and below-knee amputation in 16% of cases[13].

The aim of this article is to present the results of treatment in patients with high-energy pilon fractures with poor soft tissue condition treated with external fixation, open reduction and limited internal fixation.

Material and Methods

Between January 2006 and January 2011, 15 patients with displaced pilon fractures (AO types C2 and C3, Reudi types II and III) were treated with external fixation, open reduction and screw or K-wire fixation. Pilon fractures Reudi type I, and AO type A, B, C1 were excluded from the study. The mean patient age was 56 (range 34-71) years. Open fractures occurred in two patients. According to the classification set by Gustilo and Anderson[14], one patient had grade II and grade IIIa injury each, while the remaining 13 patients had closed fractures; according to the classification of soft tissue injury in closed fractures proposed by Tscherne and Oestern[15], four patients had grade II and nine patients grade III injury. Isolated injury was found in 14 patients, while one patient sustained polytrauma.

The fractures were classified according to the AO classification[16] and Reudi and Allgower classification[17]. All fractures were identified using standard radiographs (Fig. 1) and computed tomography scanning obtained in the emergency department. After necessary preoperative preparing, surgery was performed. The patients were operated in supine position on a radiolucent table. The method and timing of the operation was dictated by the status of soft tissues. In all fractures, external fixator was placed immediately. Then, if the skin and muscle were deep contaminated but with localized contusion (Tscherne grade II) and in the patient with open fracture, minimal internal osteosynthesis was done in the same maneuver. Tibial reduction was performed by the application of external fixator with 3 pins. Two 5-mm pins were inserted in transverse projection in the tibia proximal to the fracture and one 5-mm pin in the talus. If fibular fracture was associated, it was stabilized first, with 1/3 tubular plate and screws. After short anteromedial incision,

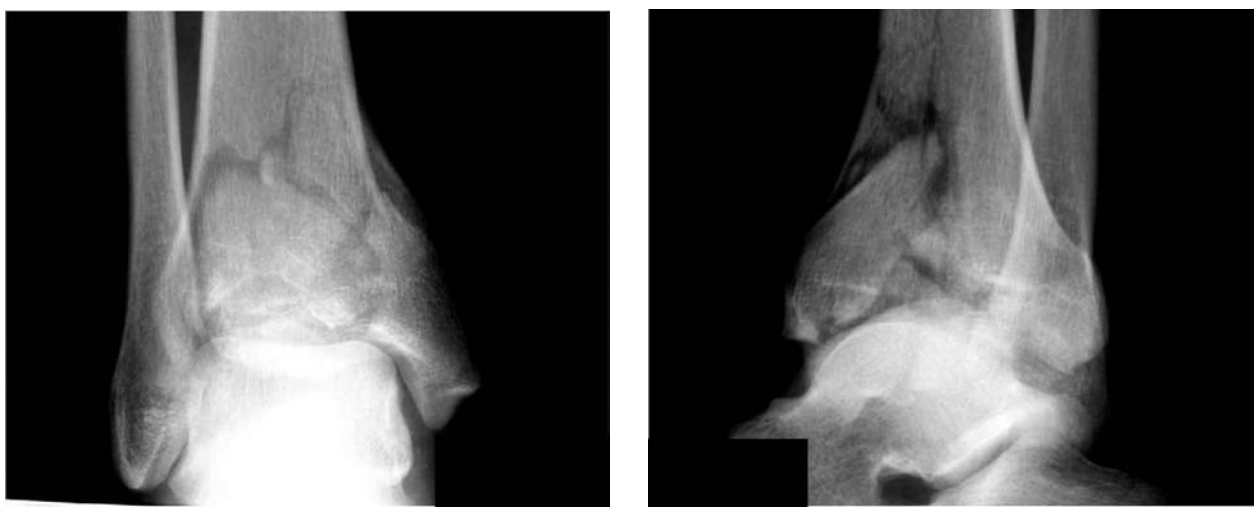

Fig. 1. Displaced pilon fracture of distal tibia before operation; fibula was not fractured.

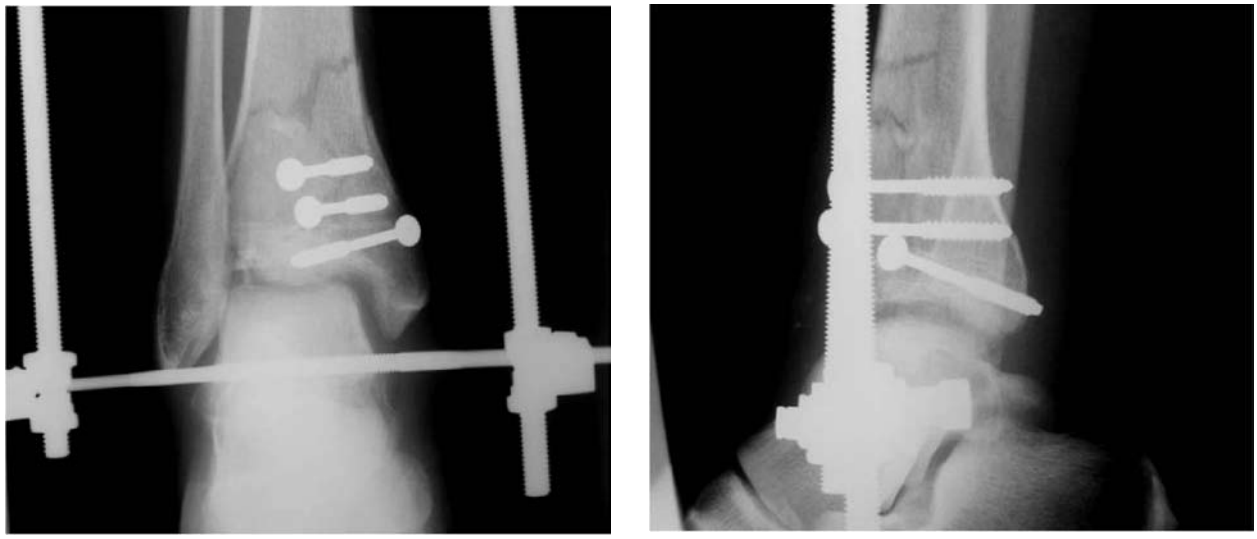

Fig. 2. Displaced pilon fracture after operation; tibia was reduced by the application of external fixator; the fractured fragments were stabilized with screws.

open reduction of articular surface was performed and fractured fragments were stabilized with K-wires and/or screws. Finally, bone defect was fulfilled with autologous bone graft (Fig. 2).

In the patients with extensive, severe soft tissue contusions or crush (Tscherne III), external fixator was installed immediately and reduction with ligamentotaxis was done. Restoration of the articular surface was undertaken in the second procedure when the condition of soft tissues was sufficient for plating of fibular malleolus (if it was fractured) and limited open reduction of tibial articular surface with minimal invasive fixation by K-wires and/or screws. The average delay time of definitive surgery was 7 days (range, 5 to 11 days).

Fibular fracture fixation was very important because it was used to restore the length of the leg and provided additional strength to the entire reconstruction[18,19]. During reposition, we insisted on anatomic restoration of articular surface. Posterolateral and posteromedial fragments are usually biggest and less displaced, so they were restored first. Then, after reposition of central impaction, the anterolateral fragment was finally fixed[20]. Defect of bone in tibial metaphysis was fulfilled with autologous bone graft from iliac crest. Autologous bone grafting was done in 12 of 15 patients.

We had two main reasons why we did not perform classic stage protocol of treatment[21] and we left external fixator until the fractures healed. Soft tissues in all followed patients were in so bad condition that even 3-4 weeks after the injury there were not sufficient for classic incision and larger metal implants. At the same time, although fulfilled with autologous bone graft, large bone defects in the tibial metaphysis were not adequate for stable fixation only with plate and screws[20].

Before, during and after the operation, antibiotic and antithrombotic prophylaxis was administered. Intraoperative and postoperative standard radiography was routinely performed to confirm good reduction of fracture fragments.

Results

Our patients were dismissed from the hospital between 7 and 16 days (average 10 days) after the surgery, depending on their general condition and status of the wound. The non-weight bearing crutch-walking was started immediately after operation and was continued for 1 month postoperatively. At the end of the first month, the patients were allowed to start gradually increasing weight bearing. External fixators were removed 6-8 weeks after the operation when radiologic imaging showed initial callus bridging between fracture fragments (Fig. 3). After that, the patients could start with intense physical therapy. On

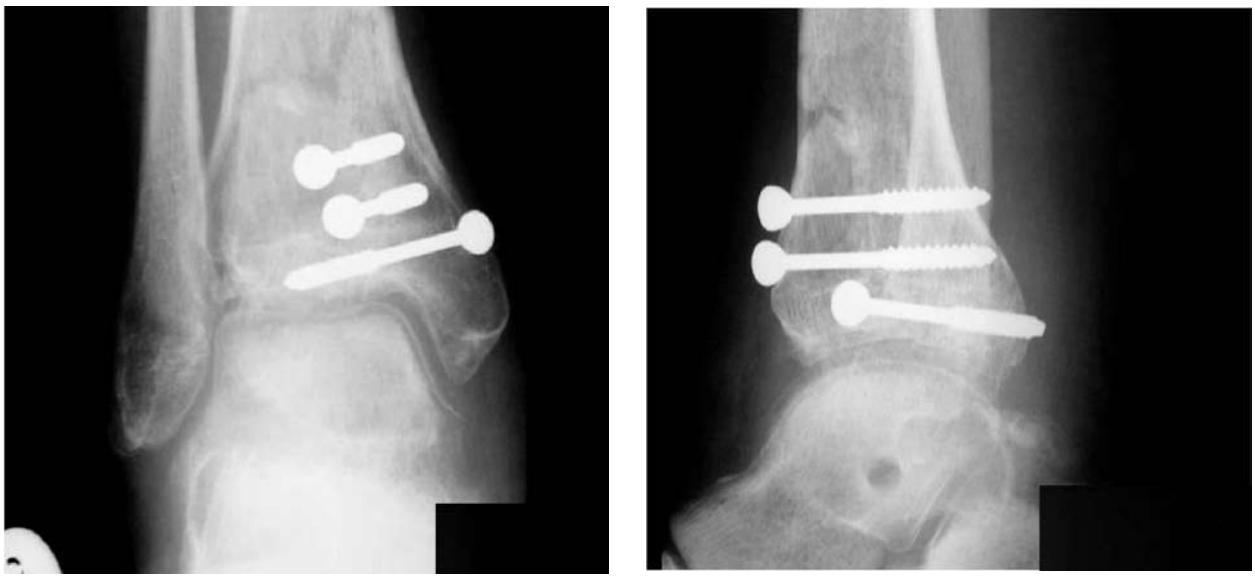

Fig. 3. Displaced pilon fracture 8 weeks after the operation; external fixator was removed.

average two months after removal of external fixators (10-12 weeks postoperatively), they were able to walk pain-free and drop the crutches. Other osteosynthesis materials were removed 18-24 months after the surgery (Fig. 4).

All 15 operated patients were evaluated prospectively for an average of 24 (range 12-36) months and all fractures united. Healing was definite by the presence of bridging callus on follow-up radiographs. The average time of healing was 4 (range 3-6) months. Two patients had prolonged wound healing because the wounds were complicated by superficial infections. They healed after prolonged antibiotic therapy and extensive surgical debridement. Another four

Fig. 4. Displaced pilon fracture 2 years after the operation with good outcome.

Table 1. Teeny and Wiss clinical rating

Rating	Results
Excellent (>92 patients)	No pain, normal gait, normal ROM, no swelling
Good (87-92 patients)	Minimal pain, ¾ normal ROM, normal gait, trivial swelling
Fair (65-86 patients)	Aching with use, ½ normal motion, normal gait, NSAID, mild swelling
Poor (<65 patients)	Pain with walking or rest, ½ normal motion, limp, swelling

ROM = range of motion; NSAID = nonsteroidal antiinflammatory drugs

patients had pin infection, which slightly prolonged bone healing and disappeared upon removal of pins. There were no cases of deep infection, nonunion or malunion, but we had five (33%) cases of secondary osteoarthritis. There was no need of arthrodesis of the ankle.

Clinical evaluation consisted of rating the symptoms and functional abilities of each patient according to Teeny and Wiss rating system[12] (Table 1). The results were as follows: 5 excellent results, 10 good and fair results, and no poor result.

Discussion and Conclusion

During treatment of displaced pilon fractures, the following objectives should be considered: reconstruction of the articular surface, maintaining bone axis, rotation, length, and soft tissue preservation. These goals should be achieved with a technique that is as minimally invasive as possible. Without open reduction, it is hard to achieve anatomic restoration of the articular surface and just this point is most important in the treatment of articular fractures of distal tibia. External fixator by ligamentotaxis supports closed reduction and after minimal fixation of the fracture fragments, prevents second fragment movement.

Open reduction and internal fixation with plate and screws as introduced by Reudi and Allgower[8,17] provide good results[22-24] and permit accurate reduction of the articular surface but with a high rate of deep infections, wound dehiscence and soft tissue problems. Other authors had the same results in high-energy trauma[1,2,4,12,25]. Bourne *et al.* report only 44% of acceptable results when using this technique in patients with Reudi type III fracture[1]. McFerran *et al.* also describe a high rate of complications that can occur with operative treatment of these injuries using plating technique. In their study, 40% of patients suffered some complication with deep infection, osteomyelitis occurred in 43% of fractures and wound breakdown requiring soft tissue coverage in 62% of fractures[2]. Teeny and Wiss report on 60 pilon fractures in patients who were treated with ORIF with plates and screws; 50% of these injuries were Reudi type III and only 40% of patients had acceptable outcomes[12].

Many complications with ORIF in high-energy pilon fractures have led some surgeons to consider external fixation as a method of treatment[4,5,11,26-32]. The use of limited open reduction and minimal osteosynthesis combined with external fixation limits the amount of soft tissue dissection necessary for the placement of large plates with the increased risk of skin slough and deep infection. Their greatest advantages are in open fractures where wounds are left open. It is also a good device in severely comminuted fractures that do not allow stable fixation with the plate[4].

Tornetta *et al.* report on 81% of good to excellent results overall and 69% of good to excellent results in patients with Reudi type III injuries using limited open reduction and internal fixation in combination with a hybrid circular external fixator[32]. Endres *et al.* had 87% of good to excellent results after external fixation with circular Ilizarov frame compared with 38% of good to excellent results after internal fixation for AO type C2 and C3 pilon fractures[27]. Leung *et al.* report on 76% of subjectively good and fair results in patients with AO C2 and C3 tibia pilon fractures treated with limited open reduction and Ilizarov external fixation[29].

The timing of the surgery and delicate, atraumatic handling of soft tissues are of vital importance in fracture management[20,33]. When classic protocols of treatment cannot be used because of poor condition of soft tissues, which are insufficient for greater skin incision and metal implantation even after several weeks, and large bone metaphyseal defect, although filled with bone marrow, does not allow stable fixation with plate alone, external fixator is a reasonable device for treatment. External fixation with open reduction and limited osteosynthesis with or without bone grafting

plays a role in the management of displaced, intensely contused tibia fractures. Compared to the ORIF, it is followed by significantly less complications with better functional results.

References

1. BOURNE RB, RORABECK CH, MACNAB J. Intra-articular fractures of the distal tibia: the pilon fracture. J Trauma 1983;23:591-5.
2. McFERRAN MA, SMITH SW, BOULAS HJ, SCHWARTZ HS. Complications encountered in the treatment of pilon fractures. J Orthop Trauma 1992;6:195-200.
3. DESTOT E. Traumatismes du pied et rayons X, malleoles, astrangale, calcaneum, avant-pied. Paris: Masson, 1911.
4. BARBIERI R, SCHENK R, KOVAL K, AURORI K, AURORI B. Hybrid external fixation in the treatment of tibial plafond fractures. Clin Orthop Relat Res 1996;332:16-22.
5. WATSON JT, MOED BR, KARGES DE, CRAMER KE. Pilon fractures: treatment protocol based on severity of soft tissue injury. Clin Orthop 2000;375:78-90.
6. HASENBOEHLER E, RIKLI D, BABST R. Locking compression plate with minimally invasive plate osteosynthesis in diaphyseal and distal tibial fracture: a retrospective study of 32 patients. Injury 2006;38:365-70.
7. SALTON HL, RUSH S, SCHUBERTH J. Tibial plafond fractures: limited incision reduction with percutaneous fixation. J Foot Ankle Surg 2007;46:261-9.
8. RUEDI TP, ALLGOWER M. Fractures of the lower end of the tibia into the ankle joint. Injury 1969;1:92-9.
9. DILLIN L, SLABAUGH P. Delayed wound healing, infection, and non-union following open reduction and internal fixation of tibial plafond fractures. J Trauma 1986;26:1116-9.
10. OVADIA DN, BEALS RK. Fractures of the tibial plafond. J Bone Joint Surg Am 1986;68:543-51.
11. RAMMELT S, ENDRES T, GRASS R, ZWIPP H. The role of external fixation in acute ankle trauma. Foot Ankle Clin 2004;9:455-74.
12. 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.
13. WYRSCH B, McFERRAN MA, McANDREW M, LIMBIRD TJ, HARPER MC, JOHNSON KD. Operative treatment of fractures of the tibial plafond. A randomized prospective study. J Bone Joint Surg Am 1996;78:1646-57.
14. 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 1976;58(4):453-8.
15. TSCHERNE H, OESTERN HJ. A new classification of soft-tissue damage in open and closed fractures. Unfallheilkunde 1982;85(3):111-5.
16. MULLER ME, ALLGOWER M, SCHNEIDER R, WILLENEGGER J. Manual of internal fixation. 3rd edn. Berlin: Springer, 1991:3-14.
17. RUEDI TP, ALLGOWER M. The operative treatment of the intra-articular fractures of the lower end of the tibia. Clin Orthop 1979;138:105-10.
18. LEE YS, CHEN SW, CHEN SH, CHEN WC, LAU MJ, HSU TL. Stabilisation of the fractured fibula plays an important role in the treatment of pilon fractures: a retrospective comparison of fibular fixation methods. Int Orthop 2009;33(3):695-9.
19. WILLIAMS TM, MARSH JL, NEPOLA JV, DECOSTER TA, HURWITZ SR, BONAR SB. External fixation of tibial plafond fractures: is routine plating of the fibula necessary? J Orthop Trauma 1999;12(1):16-20.
20. STEPHEN D. Fractures of the distal tibial metaphysis involving the ankle joint: the pilon fracture. In: SCHATZKER J, TILE M, editors. The rationale of operative fracture care. Berlin, Heidelberg, New York: Springer, 2005.
21. PATTERSON MJ, COLE JD. Two-staged delayed open reduction and internal fixation of severe pilon fractures. J Orthop Trauma 1999;13:85-91.
22. BLAUTH M, BASTIAN L, KRETTE C, KNOP C, EVANS S. Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques. J Orthop Trauma 2001;15:153-60.
23. EGOL KA, WOLINSKY P, KOVAL KJ. Open reduction and internal fixation of tibial pilon fractures. Foot Ankle Clin 2000;5:873-5.
24. MANCA M, MARCHETTI S, RESTUCCIA G, FALDINI A, FALDINI C, GIANNINI S. Combined percutaneous internal and external fixation of type-C tibial plafond fractures. J Bone Joint Surg 2002;84A:109-15.
25. BOURNE RB. Pylon fractures of the distal tibia. Clin Orthop Relat Res 1989;240:42-6.
26. BONE L, STEGEMANN P, McNAMARA K, SEIBEL R. External fixation of severely comminuted and open tibial pilon fractures. Clin Orthop 1993;292:101-7.
27. ENDRES T, GRASS R, BIEWENER A, ILLERTT, ZWIPP H. Minimally invasive treatment of pilon fractures of the tibia. Trauma Berufskrankh 2003;5:258-68.
28. GAUNDINEZ RF, MALLIK AR, SZPORN M. Hybrid external fixation in tibial plafond fractures. Clin Orthop 1996;329:223-32.
29. LEUNG F, KWOK HY, PUN TS, CHOW SP. Limited open reduction and Ilizarov external fixation in the treatment of distal tibial fractures. Injury 2004;35:278-83.
30. MARSH JL, BONAR JV, NEPOLA TA, DECOSTER TA, HURWITZ SR. Use of an articulated external fixator for fractures of the tibial plafond. J Bone Joint Surg 1995;77A:1498-509.

31. PIPER.KJ, WON HY, ELLIS AM. Hybrid external fixation in complex tibial plateau and plafond fractures: an Australian audit of outcomes. Injury 2004;36:178-84.
32. TORNETTA P, WEINER L, BERGMAN M. Pilon fractures: treatment with combined internal and external fixation. J Orthop Trauma 1993;7:489-96.
33. MATEJČIĆ A, VIDOVIĆ D, IVICA M, TOMLJENOVIĆ M. Internal fixation with locking plate of 3- and 4-part proximal humeral fractures in elderly patients: complications and functional outcome. Acta Clin Croat 2013;52(1):17-22.

Sažetak

ULOGA VANJSKOG FIKSATORA U LIJEČENJU DISLOCIRANIH PILON FRAKTURA DISTALNE TIBIJE

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Prikazuju se rezultati liječenja bolesnika s dislociranim pilon prijelomima potkoljenice. Tijekom 5 godina liječili smo 15 bolesnika s dislociranim pilon frakturama distalne tibije (AO tip C2 i C3), a svi ostali tipovi prijeloma izuzeti su iz ovog promatranja. Prijelomi su dijagnosticirani standardnom radiografijom i kompjutorskom tomografijom. Vrijeme i metoda operacije ovisili su o stanju mekih česti. Kod svih fraktura odmah je postavljen vanjski fiksator i zadržan je do početnih znakova kalusnog premoštavanja prijeloma. U slučajevima kada su meka tkiva bila umjereno oštećena u istom aktu učinjena je ograničena otvorena repozicija s minimalnom unutarnjom osteosintezom. Kod bolesnika s izrazitim oštećenjima mekih tkiva otvorena repozicija i restauracija zglobne plohe učinjena je u drugom postupku u prosjeku 7 dana od ozljede. Svi promatrani prijelomi su zarasli u prosjeku za 4 mjeseca. Kod dva bolesnika zabilježeno je produženo cijeljenje rane zbog površinske infekcije, a kod 4 bolesnika bila je prisutna infekcija uz pinove fiksatora. Nije bilo slučajeva duboke infekcije, pseudoartroze ili loše sraslog prijeloma, ali je zabilježeno 5 slučajeva sekundarnog osteoartritisa. Rezultate smo analizirali u skladu s Teenyjevim i Wissovim sustavom ocjenjivanja. Ostvarili smo 5 odličnih te 10 dobrih i zadovoljavajućih rezultata, a loših rezultata nismo imali. Ovaj rad pokazuje da primjena vanjskog fiksatora s otvorenom repozicijom i minimalnom osteosintezom, sa spongioplastikom ili bez nje, može biti metoda izbora za dislocirane pilon frakture potkoljenice s ozljedom mekih tkiva. Usporedivo s otvorenom repozicijom i unutarnjom fiksacijom pločama praćena je sa značajno manjim brojem komplikacija i s boljim funkcionalnim rezultatom.

Ključne riječi: *Tibijalne frakture; Pilon-frakture; Frakture, fiksacija; Vanjski fiksatori*