



Functional and Radiological Outcomes after Surgical Management of Intra Articular Distal Tibial Fractures– A Retrospective and Prospective Cohort Study

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Abstract

Background: Pilon fractures are complex intra-articular injuries of the distal tibia associated with significant soft tissue damage. Optimal surgical strategy remains controversial.

Methods: A combined retrospective and prospective study of 34 adult patients with closed distal tibial intra-articular fractures treated between October 2018 and October 2020 was performed. Patients were classified according to Ruedi–Allgöwer and AO/OTA systems and managed by one of three strategies: staged external fixation followed by delayed ORIF, external fixation with limited internal fixation, or primary open reduction and internal fixation with plating. Outcomes were assessed using AOFAS, FADI and SF-36 at six and twelve months; complications and radiographic union were documented.

Results: At six months, group means for FADI favoured primary ORIF and staged treatment over limited internal fixation; by twelve months most patients showed substantial improvement with mean cohort FADI of 85 and mean AOFAS approximating 87. Complications included delayed wound healing, pin-tract and superficial infections, and non-unions that were largely managed conservatively.

Conclusion: When soft tissue conditions permit, anatomical restoration via ORIF yields superior functional recovery; staged external fixation remains a valuable strategy when soft tissue status is poor. Clinicians should individualise treatment based on fracture pattern and soft tissue condition to optimise outcomes.

Keywords: Pilon fracture; distal tibia; Open reduction and internal fixation (ORIF); External fixation; Functional outcome

Aims:

To review incidence, treatment modalities, complications and functional outcomes of surgically treated Pilon fractures and to compare effectiveness of staged external fixation, external fixation with limited internal fixation and primary ORIF. Objectives: Analyse functional scores, radiographic union and complications at six and twelve months and inform surgical decision making.

Review:

Pilon fractures represent a challenging subset of distal tibial injuries for which contemporary management strategies are well described in the orthopaedic literature. High-energy axial impaction and torsional mechanisms produce articular comminution leading to variable soft tissue injury and complex metaphyseal patterns; management paradigms emphasize either anatomic open reconstruction or staged strategies that prioritize soft tissue recovery [1]. Classification systems



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including Rüedi–Allgöwer and AO/OTA aid consistent description and planning [2, 3], while detailed mapping of the tibial plafond has informed fragment-targeted approaches to reduction and fixation [4]. Early operative series documented both the benefits of anatomic restoration and the high wound complication rates when definitive surgery was attempted in swollen or compromised soft tissues [5, 6]. Complications remain common and were detailed in prior series emphasizing infection, wound breakdown and non-union as key concerns [9]. Provisional external fixation and techniques of external articular transfixation were developed to stabilise the limb and protect soft tissues prior to definitive reconstruction [10, 11]. Debate continues regarding immediate ORIF versus staged management; nomenclature and conceptual distinctions have been clarified in modern reviews [12, 14–16]. Minimally invasive plating techniques, percutaneous fixation strategies and lateral approach variations aim to minimise soft tissue insult while achieving stable fixation [17–20]. Overall, the literature supports individualized strategy selection based on fracture morphology and soft tissue status rather than a universal single best technique [1, 5, and 16].

Introduction

An intra-articular, vertically impacted fracture of the distal tibial plafond — commonly termed a Pilon fracture — poses significant reconstructive challenges because of the frequent combination of articular comminution and soft tissue compromise. Historically, nonoperative management led to high rates of malunion and late arthritis, prompting a shift toward surgical strategies that emphasize anatomic reduction when feasible [7, 8, 13]. The mechanism typically involves axial loading of the talus against the tibial plafond or torsional forces that create a spectrum of fracture patterns described by Rüedi–Allgöwer and the AO/OTA classifications, which remain central to decision-making [2, 3]. Recent literature highlights the role of staged management using an ankle-spanning external fixator to permit soft tissue recovery prior to definitive ORIF for high-energy injuries, with improved wound outcomes compared with immediate ORIF in severely swollen limbs [5, 11, and 16]. At the same time, primary ORIF performed under favourable soft tissue conditions can restore anatomy and yield superior early functional recovery, a benefit emphasized in several series and surgical reviews [1, 4, and 15]. Advances in fixation technology and minimally invasive techniques have broadened options to reduce soft tissue insult while maintaining stable internal fixation [17–19]. The present study seeks to compare outcomes among staged external fixation with delayed plating, external fixation combined with limited internal fixation, and primary ORIF in a single-centre cohort, to clarify relative functional outcomes and complication profiles and inform treatment planning consistent with current evidence [1, 4, 16–18].

Methods

Combined retrospective and prospective observational study conducted at a single tertiary centre between October 2018 and October 2020. Thirty-four skeletally mature patients with closed distal tibia-fibula intra-articular fractures were enrolled after informed consent. Inclusion criteria comprised closed distal tibia-fibula intra-articular fractures; exclusion criteria included pathological fractures, congenital anomalies, open injuries and associated talus or calcaneum fractures. Patients underwent AP, lateral and mortise radiographs and CT scans to delineate articular involvement and were classified by Rüedi–Allgöwer and AO/OTA. Depending on soft tissue condition and reconstructibility, patients received one of three protocols: (A) staged management with primary ankle-spanning external fixator followed by delayed plating, (B) external fixator with limited internal fixation of articular fragments, or (C) definitive ORIF with plating. Fibular fixation employed one-third tubular plates, precontoured LCPs or titanium elastic nailing when indicated. Postoperative care comprised limb elevation, drain removal after 48 hours where applicable, early ankle and knee mobilization, suture removal at two weeks, radiographic monitoring, and graduated weight bearing starting at approximately six weeks guided by healing. Functional assessment used AOFAS, FADI and SF-36 at six and twelve months. Data were analysed using SPSS v20 with descriptive statistics, chi-square and ANOVA; $p < 0.05$ considered significant. Complications were recorded and managed per standard protocols, and external fixators were retained until soft tissue recovery permitted conversion to internal fixation or cast immobilization.

Results

Thirty-four patients met inclusion criteria. Treatment distribution was: Group A (staged external fixation → delayed plating) 6 patients (17.6%); Group B (external fixation + limited internal fixation) 5 patients (14.7%); Group C (primary ORIF and plating) 23 patients (67.7%). The cohort comprised 22 males (64.7%) and 12 females (35.3%). At six months the overall mean FADI was 75.62; group means were A 76.33 ± 11.04 , B 63.66 ± 13.96 , and C 78.04 ± 9 , with an intergroup difference reaching significance ($p = 0.02$). By twelve months mean FADI rose to about 85; group means were A 86.8 ± 3.14 , B 77.8 ± 11.9 , and C 86.14 ± 7.28 ($p = 0.08$). AOFAS and SF-36 scores showed parallel improvement over time; the average final AOFAS was approximately 87. Radiographic union was achieved in the majority by three to four months. Complications occurred in 15 patients and included delayed wound healing, prolonged swelling, superficial and pin-tract infections, a few deep infections, and several non-unions; most complications were addressed with conservative care or minor procedures. Overall, primary ORIF gave the best functional results in this cohort, while external fixation combined with limited internal fixation had less favourable outcomes.

Discussion

This series reinforces the practical balance clinicians must strike between restoring joint anatomy and protecting the soft tissue envelope. When soft tissue conditions are favourable, primary ORIF allows anatomic reduction of the articular surface and restoration of alignment — factors that translate into superior functional scores in this and other series [1, 4, 15, 20]. However, immediate open surgery through swollen or compromised soft tissues exposes patients to higher risks of wound breakdown and infection; staged management using provisional external fixation reduces this risk by allowing time for soft tissue recovery before definitive fixation [5, 9–11, 16].

Cases treated with external fixation plus limited internal fixation in our cohort generally had worse functional outcomes, likely due to selection of fractures that were too comminuted for anatomic reconstruction and the known limitations of prolonged external fixation such as pin-tract problems and delayed rehabilitation [10, 17, and 19]. Minimally invasive plate osteosynthesis and other low-profile techniques provide alternatives that combine stable fixation with less soft tissue insult and can be useful for selected fracture patterns [17–19]. Consistent fracture classification and CT-based planning facilitate choosing the optimal approach for each case [2, 3, and 18].

Limitations of this study include the modest sample size, single-centre design, and follow-up limited to one year for many patients — factors that constrain generalisability and long-term assessment of post-traumatic arthritis. Nonetheless, the findings align with broader literature advocating individualized treatment: aim for anatomic reconstruction when soft tissues permit, and favour staged strategies when they do not [12–16]. Future multicentre, randomized studies with extended follow-up would better define long-term joint survivorship and refine indications for each technique.

Conclusion

In this single-centre cohort of 34 surgically treated Pilon fractures, individualized management that respected the soft tissue condition while pursuing anatomic reconstruction when feasible produced generally favourable one-year functional outcomes. Primary ORIF, when performed under good soft tissue conditions, yielded the best recovery. Staged external fixation with delayed plating is a reliable alternative when soft tissues are compromised. External fixation combined with limited internal fixation showed less favourable outcomes and should be reserved for fractures not amenable to anatomic reconstruction. Complications such as delayed wound healing and superficial/pin-tract infections were common but mostly manageable. Larger randomized multicentre trials with longer follow-up are needed to refine treatment algorithms and long-term expectations.

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