



## Chaput Fragment Percutaneous Plating and Ankle-Spanning External Fixation in Pilon Fractures: Hypothesis for Superior Early Outcomes

Nayan Shrivastav<sup>1</sup>,  
Rajeev Joshi<sup>1</sup>,  
Sahil Sanghavi<sup>1</sup>,  
Mahavir Dugad<sup>1</sup>,  
Darshan Sonawane<sup>1</sup>,  
Ashok Shyam<sup>1</sup>,  
Parag Sancheti<sup>1</sup>

<sup>1</sup>Sancheti Institute of for Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India.

### Address of Correspondence

Dr. Nayan Shrivastav,  
Sancheti Institute of for Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India.

**Email:** [nayanshri93@gmail.com](mailto:nayanshri93@gmail.com)

### Abstract

**Background:** Distal tibial intra-articular (pilon) fractures are serious injuries that commonly follow high-energy axial impacts or lower-energy twisting events. They often cause joint fragmentation, metaphyseal collapse and damage to the surrounding soft tissues. Because the ankle is the primary weight-bearing joint, imperfect reduction or fixation can lead to persistent pain, loss of motion and early post-traumatic arthritis that interfere with daily activities and the ability to return to work. These injuries therefore frequently require staged surgical strategies that balance accurate articular reconstruction with protection of fragile soft tissues.

**Hypothesis:** We hypothesize that selecting the operative technique according to fracture morphology and the condition of the soft tissues—using staged external fixation when soft tissues are unsuitable for immediate open exposure and performing open reduction and internal fixation (ORIF) when local conditions permit—will produce comparable mid-term functional outcomes across approaches, provided that articular congruity, limb alignment and stable fixation are achieved.

**Clinical importance:** This study compares commonly used treatment pathways using validated patient-reported outcome instruments and clinician-rated scores, objective ankle range of motion, complication and reoperation rates, and length of hospital stay. By clarifying which injury patterns and patient characteristics predict better recovery or higher risk of wound problems, clinicians can make more individualized treatment choices, counsel patients about realistic recovery timelines, tailor rehabilitation plans and reduce avoidable complications, readmissions and the longer-term socioeconomic burden for patients and families. Clearer evidence will also help surgeon's priorities soft-tissue management without sacrificing joint reconstruction.

**Future research:** Larger, prospective multicenter trials with longer follow-up are needed to confirm comparative effectiveness and refine indications for each technique. Future work should evaluate targeted measures to prevent soft-tissue complications and early arthritis, and incorporate imaging biomarkers, gait and biomechanical analysis and registry data to improve prognostication and personalize care.

**Keywords:** Pilon fracture, Distal tibia, Intra-articular, Open reduction and internal fixation, External fixation, Functional outcome, Soft-tissue management.



Dr. Nayan Shrivastav



Dr. Rajeev Joshi  
Hip & Knee Replacement  
& Reconstructive



Dr. Sahil Sanghavi  
Knee And Hip Surgeon



Dr. Mahavir Dugad  
Hip Surgeon



Dr. Darshan Sonawane



Dr. Ashok Shyam



Dr. Parag Sancheti

DOI: <https://doi.org/10.13107/jmt.2023.v09.i02.212>

© The Author(s). 2023 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

## Background

Pilon fractures, involving the distal tibial plafond, produce a unique clinical challenge because they damage both joint cartilage and the surrounding soft tissues. Although they represent a relatively small proportion of tibial injuries, their impact on an individual's gait and quality of life is disproportionately large. Mechanisms range from low-energy torsional injuries that cause limited comminution, to high-energy axial loading — commonly seen in road traffic collisions or falls from height — that shatters the plafond and frequently compromises soft tissues. Recognizing this spectrum is essential; fracture morphology and skin condition together determine technical strategy and prognosis [1].

Early in the modern era these injuries were often managed nonoperatively, with disappointing results: malunion, persistent pain, stiffness and progressive arthritis were common. That experience drove the move toward operative reconstruction of the articular surface to restore joint mechanics. However, early enthusiasm for immediate ORIF revealed a serious downside: when surgery is performed through swollen or blanched skin the risk of wound dehiscence and deep infection is high. This led to the now-familiar staged approach — immediate provisional external fixation to restore length and alignment while soft tissues recover, followed by definitive reconstruction — which seeks to capture the advantages of anatomical reduction without provoking soft-tissue complications [2–5].

Fracture classifications such as Rüedi–Allgöwer and AO/OTA help stratify injury severity and guide expectations; high-grade injuries tend to have greater comminution, worse soft-tissue trauma and poorer outcomes. CT imaging is widely used because it reveals the fragment patterns that largely determine surgical approach: principal fragments such as Chaput, Volkmann and posterolateral fragments are best identified and addressed when they are mapped on axial and reconstructed CT images. This fragment mapping informs incision choice, fixation sequence and the feasibility of minimally invasive techniques [3,4].

Surgical options include primary ORIF with buttress or locking plates, minimally invasive percutaneous plating, limited open fixation combined with external stabilization, and circular external fixation. Each has trade-offs. Primary ORIF offers the best opportunity for precise anatomic reconstruction and the application of stable constructs that permit early controlled motion — when the soft tissues tolerate the exposure. Minimally invasive plating reduces additional soft-tissue insult but can be limited by fragment complexity. External fixation techniques preserve the skin and soft-tissue bed but may accept some residual articular incongruity unless combined with limited internal fixation. Thus technique choice is not about which implant is best in abstraction, but about matching the implant and approach to the biology and anatomy of the individual case [5–11].

Patient comorbidities also shape decisions and outcomes. Diabetes, peripheral vascular disease, smoking and obesity increase the risk of wound complications and infection and thus lower the threshold for staged, soft-tissue-respecting strategies. Timing of surgery is critical: operating before swelling has subsided or while blisters are tense is a recognized risk for wound failure; delaying definitive internal fixation until local biology improves reduces that risk and often preserves options for later reconstruction [6,9,11,12].

Beyond the operation itself, postoperative care — early controlled range of motion, edema control and graded weight bearing tied to fixation stability — is essential to translate radiographic success into meaningful function. Systems-level coordination, including timely CT imaging, access to soft-tissue/plastic surgery expertise where needed and structured physiotherapy, improves outcomes and is why results may differ between centres. The contemporary management goal, then, is to restore joint congruity where safely possible while always prioritizing soft-tissue health — a balance that aims to minimize complication risk while maximizing the chance of a pain-limited, functional ankle [7–13].

## Hypothesis

### Primary hypothesis:

- A soft-tissue-guided treatment pathway optimizes patient outcomes in pilon fractures: when the soft tissues are favorable, primary ORIF targeting anatomic articular restoration yields superior early functional recovery; when soft tissues are hostile, staged provisional external fixation followed by delayed definitive reconstruction reduces wound complications while permitting satisfactory intermediate functional outcomes.

### Rationale:

Restoring the articular surface and mechanical alignment is the biomechanical imperative for a weight-bearing joint. Anatomic reduction reduces focal cartilage overload and thereby lowers the risk of symptomatic post-traumatic arthritis; ORIF performed through healthy soft tissues provides the most reliable means to achieve this reduction and to apply stable constructs that enable early, supervised rehabilitation. However, this mechanical goal must be tempered by biological reality. Performing extensile exposures in the presence of swelling or compromised skin dramatically increases wound complications, which can require repeated surgery, hardware removal or even compromise limb salvage. The staged approach reconciles these competing demands: provisional external fixation restores alignment and length while allowing soft tissues to settle, and definitive ORIF is performed later under safer conditions when indicated [14–16].

### Supporting propositions:

1. CT-guided fragment mapping drives approach selection. Axial and 3D CT reconstructions identify principal fragments

and the approaches most likely to reduce them effectively. Using CT mapping to plan incisions and fixation sequences reduces unnecessary soft-tissue dissection and improves the chance of anatomical reduction [4, 17].

2. Technique must match pattern and biology. Minimally invasive plating is appropriate when fragment patterns permit and when it reduces exposure-related soft-tissue insult; more extensile exposures are reserved for cases where CT shows fragments not reconstructable by less invasive means. Where reconstruction is not practical, external fixation with limited internal fixation or a circular frame supports alignment and soft-tissue healing without the risk of a wound catastrophe [16–19].

3. Postoperative rehabilitation is a co-determinant. Stable fixation that allows early controlled range of motion and progressive weight bearing is associated with better ankle motion and higher patient-reported functional scores. Therefore, optimal outcome depends on both surgical technique and a planned, staged rehabilitation pathway [17–20].

4. Patient optimization matters. Active management of diabetes, smoking cessation where possible and vascular assessment in at-risk patients reduces the risk of wound complications and helps determine which patients are safe candidates for early ORIF versus staged management [15, 16]. These hypotheses can be tested in prospective cohorts stratified by AO/Rüedi–Allgöwer grade and soft-tissue status, using standardized CT descriptors and validated outcome measures (AOFAS, FADI, and SF-36). The overarching aim is not merely to compare implants but to define context-specific strategies that align anatomical possibility with biological safety [14–20].

## Discussion

The practical management of pilon fractures is guided by a single surgical truth: biology determines timing and extent. When the soft tissues are healthy and swelling minimal, primary ORIF gives the best pathway to anatomic restoration and earlier functional recovery. But when soft tissues are compromised, forcing definitive open exposure risks wound dehiscence and deep infection — complications that often produce worse long-term outcomes than a temporary, conservative approach. The staged pathway — external fixator to restore length and alignment followed by delayed ORIF — is a biologically respectful compromise that preserves reconstructive options while minimizing early wound morbidity [21].

External fixation with limited internal fixation, and circular frame techniques, have an essential place for highly comminuted fractures or when soft tissues cannot tolerate further insult. These approaches emphasize limb preservation and soft-tissue healing; clinicians must accept that they may not always restore perfect articular congruity, but they reduce the immediate risk of soft-tissue catastrophe and often allow acceptable, pain-limited function. That trade-off must be

communicated to patients clearly during shared decision making [22, 23].

Operational refinements that consistently improve outcomes include CT-based planning to map fragments and guide approach selection; avoiding incision placement that undermines vascularized skin bridges; selective use of minimally invasive plate osteosynthesis where feasible; and temporary fragment fixation to sequence reduction before plate application. Postoperative care — edema control, early supervised motion as fixation allows, and staged weight bearing — is critical to convert a technically successful reconstruction into usable function [4, 17–20].

Limitations in the evidence base reflect case heterogeneity, variable rehabilitation protocols and the predominance of single-center series. Randomized trials are difficult in this heterogeneous field, but multicenter prospective registries with standardized CT descriptors and rehabilitation protocols would permit more robust subgroup analysis, clarify long-term incidence and impact of post-traumatic arthritis, and refine indications for immediate versus staged strategies. Patient-level factors such as diabetes and smoking must be actively managed to improve outcomes across strategies [24].

In sum, while anatomic articular restoration remains the biomechanical ideal, it must not be pursued at the cost of the soft tissues. A strategy that integrates CT-driven planning, biology-led timing, and coordinated rehabilitation offers the best chance to return patients to functional, pain-limited activities [21–24].

## Clinical importance

For practicing surgeons: prioritize the soft tissues. When skin and swelling permit, pursue primary ORIF to optimize early restoration of joint congruity and function. When soft tissues are hostile, use provisional external fixation and delay definitive internal fixation to lower wound complications while preserving the option for later reconstruction. Reserve combined external/internal fixation or circular frames for unreconstructible patterns or cases with severe soft-tissue compromise. CT-guided fragment mapping, careful incision planning, and structured, early rehabilitation are central to converting anatomical repair into a functional ankle. Clear preoperative counselling about staged care and realistic recovery timelines improves patient expectations and satisfaction.

## Future directions

Priorities are multicenter prospective registries using standardized CT fragment descriptors, uniform rehabilitation protocols and minimum two-year follow-up to capture post-traumatic arthritis and functional trajectories. Comparative effectiveness work stratified by fracture grade and soft-tissue status, together with objective gait analysis and patient-reported outcome mapping, will translate radiographic success

into patient-centered metrics and help refine subgroup-specific recommendations.

## References

- Jacob N, Amin A, Giotakis N, Narayan B, Nayagam S, Trompeter AJ. Management of high-energy tibial Pilon fractures. *Strategies Trauma Limb Reconstr.* 2015 Nov; 10(3):137–47.
- Fialka C, Vécsei V. Anatomical and Radiological Classification of Pilon Tibial Fractures. *Fractures of the Tibial Pilon.* 2002. p. 13–8.
- Stephen D. Fractures of the Distal Tibial Metaphysis Involving the Ankle Joint: The Pilon Fracture. *The Rationale of Operative Fracture Care.* p. 523–50.
- Cole PA, Mehrle RK, Bhandari M, Zlowodzki M. The Pilon Map. *J Orthop Trauma.* 2013; 27:e152–6.
- Conroy J, Agarwal M, Giannoudis PV, Matthews SJE. Early internal fixation and soft tissue cover of severe open tibial pilon fractures. *Int Orthop.* 2003; 27:343–7.
- I R, Allgöwer M, Matter P. Intra-articular fractures of the distal tibia. *J Trauma.* 1969; 9:640.
- Johnson A. Distal Tibial Fractures. *Atlas of Orthopedic Surgical Procedures of lower limb.* p. 198–9.
- Bonnin JG. Injuries to the ankle. William Heinemann (Medical Books) Ltd. 1950. (British Journal of Surgery review).
- McFerran MA, Smith SW, Boulas HJ, Schwartz HS. Complications encountered in the treatment of pilon fractures. *J Orthop Trauma.* 1992; 6(2):195–200.
- Rogge D. External Articular Transfixation for Joint Injuries with Severe Soft Tissue Damage. *Fractures with Soft Tissue Injuries.* 1984. p. 103–17.
- Rüedi T, Allgöwer M. The operative treatment of intraarticular fractures of the lower end of the tibia. *Orthopedic Trauma Directions.* 2011; 9:23–5.
- Michelson J, Moskovitz P, Labropoulos P. The Nomenclature for Intra-articular Vertical Impact Fractures of the Tibial Plafond: Pilon versus Pylon. *Foot Ankle Int.* 2004; 25:149–50.
- Rockwood CA Jr., Green DP, Bucholz RW, Heckman JD, editors. *Fractures in Adults.* 4th ed. Lippincott-Raven; 1996.
- Pilon Fracture. *Encyclopedia of Trauma Care.* 2015:1252.
- Helfet DL, Koval K, Pappas J, Sanders RW, Dipasquale T. Intraarticular Pilon Fracture of the Tibia. *Clin Orthop Relat Res.* 1994; 221–228.
- Tarkin IS, Clare MP, Marcantonio A, and Pape HC. An update on the management of high-energy pilon fractures. *Injury.* 2008 Feb; 39(2):142–54.
- Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. *J Orthop Trauma.* 2007 Jul; 21(6):355–61.
- Zhao Y, Wu J, Wei S, Xu F, Kong C, Zhi X, et al. Surgical approach strategies for open reduction internal fixation of closed complex tibial Pilon fractures based on axial CT scans. *J Orthop Surg Res.* 2020 Jul 27; 15(1):283.
- Collinge CA, Sanders RW. Percutaneous plating in the lower extremity. *J Am Acad Orthop Surg.* 2000 Jul; 8(4):211–6.
- Grose A, Gardner MJ, Hettrich C, Fishman F, Lorich DG, Asprinio DE, et al. Open reduction and internal fixation of tibial pilon fractures using a lateral approach. *J Orthop Trauma.* 2007 Sep; 21(8):530–7.
- 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.
- Amorosa LF, Brown GD, Greisberg J. A Surgical Approach to Posterior Pilon Fractures. *J Orthop Trauma.* 2010; 24:188–93.
- Korkmaz A, Çiftdemir M, Özcan M, Çopuroğlu C, Sarıdoğan K. The analysis of the variables, affecting outcome in surgically treated tibia pilon fractured patients. *Injury.* 2013; 44:1270–4.
- Assal M, Ray A, Stern R. The Extensile Approach for the Operative Treatment of High-Energy Pilon Fractures: Surgical Technique and Soft-Tissue Healing. *J Orthop Trauma.* 2007; 21:198–206.

Conflict of Interest: Nil  
Source of Support: None

Institute Where Research was Conducted: Department of Orthopaedics, Sancheti Institute of Orthopaedics and Rehabilitation, Shivajinagar, Pune, Maharashtra, India.  
University Affiliation: MUHS, Nashik, Maharashtra, India.  
Year of Acceptance of Thesis: 2021

**How to Cite this Article:** Shrivastav N, Joshi R, Sanghavi S, Dugad M, Sonawane D, Shyam A, Sancheti P. Chaput Fragment Percutaneous Plating and Ankle-Spanning External Fixation in Pilon Fractures: Hypothesis for Superior Early Outcomes. *Journal of Medical Thesis.* July-December 2023; 9(2):13-16.