



JOURNAL  
Of Universal Applied  
Research

ISSN (Online): XXX  
Vol. 01, Issue 02 (2026)  
<https://universalappliedresearch.com/index.php/JUAR/issue/archive>

# Hip Early Weight Bearing After Operative Fixation of Lower-Extremity Fractures: From Fracture Protection to Construct-Driven Rehabilitation

**Dr Nishant**

M.S. Ortho, D-Ortho, F.A.G.E. Assistant Professor, Department of Orthopaedic Surgery, NSMCH, Bihta, Bihar, India  
Email: [nishantorthspine2014@gmail.com](mailto:nishantorthspine2014@gmail.com)  
Orcid ID: <https://orcid.org/0000-0002-6206-7732>

Received:- 29/07/2026 Revised:- 02/09/2026 Accepted:- 15/09/2026  
Published:- 25/09/2026

## Abstract

Postoperative weight-bearing restrictions have traditionally been prescribed after lower-extremity fracture fixation to protect healing bone and prevent loss of reduction or implant failure. Contemporary fixation constructs, however, may provide sufficient stability to permit earlier functional loading, whereas prolonged non-weight bearing can contribute to muscle atrophy, joint stiffness, impaired gait, loss of independence, and poor compliance. This narrative review evaluates contemporary evidence for early weight bearing after operative treatment of ankle, tibial shaft, tibial plateau, and distal femur fractures. The strongest evidence concerns ankle fractures: a large multicenter randomized trial and subsequent meta-analysis of randomized trials support weight bearing beginning approximately 2 weeks after stable fixation, with improved early function and no clear increase in complications in appropriately selected patients. Randomized and meta-analytic data also support immediate weight bearing as tolerated after intramedullary nailing of selected tibial shaft fractures. More recent randomized evidence suggests that immediate loading can be safe after stable fixation of selected Schatzker I-IV tibial plateau fractures, although extrapolation to complex bicondylar injuries is not justified. For distal femur fractures, observational and meta-analytic evidence is increasingly reassuring, particularly when fixation is deliberately constructed to tolerate early loading, but the certainty of evidence remains lower. The emerging principle is not universal immediate loading, but individualized rehabilitation based on fracture morphology, reduction quality, bone quality, fixation mechanics, soft-tissue constraints, and patient factors. Postoperative weight-bearing prescriptions should increasingly be construct driven rather than diagnosis driven.

**Keywords:** early weight bearing; fracture fixation; ankle fracture; tibial shaft fracture; tibial plateau fracture; distal femur fracture; rehabilitation

## INTRODUCTION

The objective of fracture fixation is restoration of alignment and stability sufficient to permit biological healing while recovering function. Despite substantial advances in implant design and fixation strategy, postoperative rehabilitation protocols have evolved comparatively slowly. Six or more weeks of non-weight bearing remains common after many lower-extremity fractures, often because of concern for loss of reduction, articular subsidence, implant deformation, implant failure, delayed union, or nonunion.

These concerns remain valid, but mechanical unloading is not biologically or clinically neutral. Prolonged non-weight bearing can produce muscle loss, joint stiffness, impaired proprioception, altered gait, and delayed recovery of independence. The consequences are particularly important in older adults, who may be unable to comply with unilateral weight-bearing restrictions and may become wheelchair dependent or require institutional rehabilitation.

The clinical question has therefore shifted. Rather than asking whether loading is inherently dangerous after fixation, contemporary orthopaedic trauma practice increasingly asks whether the achieved construct can tolerate anticipated physiologic loading. This review summarizes current evidence for accelerated postoperative weight bearing after fixation of ankle, tibial shaft, tibial plateau, and distal femur fractures and proposes a practical construct-driven framework for prescribing postoperative loading.

## TERMINOLOGY AND MECHANICAL RATIONALE

Interpretation of the literature is complicated by inconsistent terminology. Immediate weight bearing generally denotes loading during the first postoperative days. Early weight bearing usually denotes meaningful loading within approximately 2 to 3 weeks, whereas delayed weight bearing commonly denotes restriction for 6 weeks or longer. Weight bearing as tolerated (WBAT) permits loading according to pain and functional capacity without a predetermined quantitative limit.

The distinction matters. Evidence supporting loading at 2 weeks after ankle fixation does not establish the safety of unrestricted loading on postoperative day 1. Similarly, results from simple metaphyseal patterns should not be extrapolated to highly comminuted articular injuries.

Fracture healing is mechanically responsive. Relative-stability constructs permit controlled interfragmentary motion and secondary healing, while excessive strain can inhibit union. The relevant determinant is therefore not the implant label alone. Working length, plate span, screw density, cortical contact, medial or posteromedial support, nail diameter and interlocking configuration, metaphyseal voids, reduction quality, and bone quality collectively determine construct behavior. The postoperative loading prescription should be viewed as an extension of the fixation plan.

## ANKLE FRACTURES

Operatively treated ankle fractures currently provide the strongest contemporary evidence for earlier loading. Traditional protocols frequently delayed weight bearing for approximately 6 weeks. The multicenter WAX trial randomized 561 adults undergoing surgery for unstable ankle fractures at 23 hospitals to early weight bearing beginning approximately 2 weeks after surgery or delayed weight bearing. Early weight bearing was noninferior for ankle function and was clinically and economically favorable, without evidence of a clinically important increase in complications.<sup>1</sup>

A 2026 meta-analysis restricted to randomized controlled trials included 5 studies and 1,030 patients. Early weight bearing, defined as initiation within 3 weeks, improved Olerud-Molander Ankle Scores at 6 weeks and 3 months and shortened return to work, while complication rates were similar. Importantly, several constituent trials excluded higher-risk patients, including subsets with obesity, trimalleolar fractures, or syndesmotic injuries; therefore, the conclusions are most secure for lower-risk patients treated with contemporary stable fixation.<sup>2</sup>

The practical implication is that routine 6-week non-weight bearing after an anatomically reduced ankle fracture with stable fixation is increasingly difficult to justify. Early loading should nevertheless remain conditional on soft-tissue status, fixation security, bone quality, and associated reconstructions. Evidence for early weight bearing should not be interpreted as evidence for indiscriminate immediate unrestricted loading in every ankle fracture.

## TIBIAL SHAFT FRACTURES

Intramedullary nailing provides a load-sharing construct and is a logical setting for accelerated loading. In a randomized controlled trial of tibial shaft fractures treated with locked intramedullary nails, immediate WBAT was compared with 6 weeks of non-weight bearing. No significant difference was identified in time to union, complications, functional outcomes, or loss of reduction. The investigators concluded that immediate WBAT was safe for OTA/AO 42-A and 42-B fractures treated with intramedullary nailing.<sup>3</sup>

A subsequent systematic review and meta-analysis of 8 studies found a modest reduction in mean union time with early weight bearing and no significant increase in delayed union, nonunion, malunion, or reoperation. The authors emphasized that the evidence base remained limited and that high-risk patterns were underrepresented.<sup>4</sup>

Accordingly, immediate WBAT is reasonable for many simple and wedge tibial shaft fractures after satisfactory locked intramedullary fixation. Greater caution remains appropriate with segmental injuries, substantial comminution or bone loss, poor cortical contact, metaphyseal extension, compromised fixation purchase, or other features that convert a load-

sharing construct into a mechanically vulnerable one.

## **TIBIAL PLATEAU FRACTURES**

The tibial plateau represents a more demanding test of accelerated rehabilitation because the consequence of failure may be articular subsidence rather than simply delayed union. Traditional protocols commonly restrict loading for 6 to 12 weeks to protect condylar width, alignment, and the reconstructed joint surface.

A 2025 randomized clinical trial compared immediate WBAT with 6 weeks of non-weight bearing after open reduction and internal fixation of Schatzker I-IV tibial plateau fractures. Forty-five patients completed follow-up. Immediate loading produced better clinical Rasmussen scores, walking capacity, pain scores, and knee range of motion at 6 months, with no significant difference in radiographic outcomes. Four patients developed intra-articular collapse: 3 in the non-weight-bearing group and 1 in the immediate-weight-bearing group.<sup>5</sup> A related randomized gait analysis also reported improved spatiotemporal gait parameters with immediate loading.<sup>6</sup>

A 2025 systematic review and meta-analysis including 10 studies and 940 patients found no significant increase in pain, delayed union, nonunion, or time to union with early loading, while several included studies reported earlier functional recovery.<sup>7</sup> However, heterogeneity in fracture morphology, fixation strategy, rehabilitation protocol, and study quality limits the strength of generalized recommendations.

The central limitation is extrapolation. A split lateral plateau supported by robust subchondral rafting is mechanically different from a bicondylar fracture with metaphyseal comminution, coronal-plane instability, posteromedial fragmentation, and poor bone. Current randomized evidence for Schatzker I-IV injuries should not be generalized to all OTA/AO 41-C injuries. Early loading is most defensible when articular reduction is anatomic or near anatomic, alignment is restored, all mechanically important columns are stabilized, subchondral support is robust, and metaphyseal defects are adequately supported.

## **DISTAL FEMUR FRACTURES**

Distal femur fractures expose the tension between mechanical caution and the harms of immobility. These injuries frequently occur in older patients who are least able to comply with non-weight-bearing instructions, yet osteoporotic bone and metaphyseal comminution may make fixation vulnerable to varus collapse and fatigue failure.

A 2025 systematic review and meta-analysis of 10 comparative studies, including native and periprosthetic distal femur fractures, found no significant difference in revision or overall complication rates between early and restricted weight-bearing groups. Most patients were elderly. The authors nevertheless judged the available evidence insufficient to recommend unrestricted early loading for all patients because of heterogeneity and predominantly nonrandomized evidence.<sup>8</sup>

Construct design is particularly important in this region. A lateral locked plate spanning a large medial metaphyseal defect may function as an unprotected load-bearing device and remain susceptible to fatigue. In contrast, restoration of medial cortical support, retrograde intramedullary fixation, dual plating, nail-plate combinations, or other augmentation strategies may increase the mechanical reserve available for early mobilization. In geriatric trauma, where noncompliance with restriction is foreseeable, fixation should whenever feasible be designed around the loading that is likely to occur.

## **WHY PARTIAL WEIGHT-BEARING PRESCRIPTIONS ARE PROBLEMATIC**

Quantitative partial weight-bearing prescriptions appear mechanically precise but are difficult to reproduce during ordinary ambulation. Patients may substantially exceed prescribed loads despite instruction, particularly when older, frail, cognitively impaired, or dependent on walking aids. A nominal restriction may therefore provide less protection than intended while simultaneously delaying mobility.

A simpler clinical vocabulary may be more useful. When a construct can tolerate physiologic loading, WBAT is practical and understandable. When it cannot, the restriction should be linked to a defined mechanical or biological vulnerability rather than an arbitrary percentage of body weight. This approach also facilitates communication among surgeons, therapists, patients, and rehabilitation facilities.

## **A CONSTRUCT-DRIVEN FRAMEWORK**

Postoperative loading can be organized around six domains. First, fracture morphology defines the anticipated mode and consequence of failure. In a shaft fracture, shortening or implant fatigue may dominate; in an articular fracture, millimeters of subsidence may be clinically consequential.

Second, reduction quality influences load sharing. Cortical contact, restoration of alignment, interfragmentary compression where appropriate, and articular congruity can materially change construct behavior.

Third, fixation mechanics should be assessed as a system rather than by implant name. Plate span and working length, screw number and distribution, multiplanar fixation, medial support, nail diameter, interlocking configuration, and augmentation of defects all influence cyclic stability.

Fourth, bone quality modifies the failure interface. Osteoporosis increases the risk of fixation loss within bone, but older

patients may simultaneously derive the greatest systemic benefit from immediate mobilization. Poor bone should therefore prompt consideration of stronger fixation rather than reflexive immobility when stronger fixation is technically achievable.

Fifth, soft-tissue and associated injuries may supersede bony stability. Flap coverage, tendon repair, vascular reconstruction, wound compromise, or ipsilateral injuries may require restriction even when fracture fixation is mechanically secure.

Sixth, patient factors determine whether a prescribed restriction is realistic. Frailty, cognition, body habitus, balance, contralateral-limb function, upper-extremity strength, and preinjury mobility should be incorporated into the operative and rehabilitation plan.

### WHEN EARLY WEIGHT BEARING SHOULD NOT BE ROUTINE

Accelerated rehabilitation should not become a new dogma. Delayed loading remains appropriate when the consequence of construct failure is high and mechanical reserve is limited. Examples include fixation recognized intraoperatively as marginal; substantial segmental or metaphyseal bone loss without adequate structural support; severe osteopenia with poor purchase; complex articular reconstructions dependent on small marginal fragments; residual instability or malalignment; constructs functioning as unprotected load-bearing devices across large gaps; and soft-tissue reconstructions that require protection.

The most defensible interpretation of current evidence is therefore not that every patient should bear weight immediately. Rather, a postoperative restriction should have an identifiable mechanical, biological, or soft-tissue rationale.

### PRACTICAL DECISION ALGORITHM

A three-question sequence can link operative strategy to rehabilitation. First, is the reconstruction mechanically stable under anticipated physiologic loading? If not, weight bearing should be restricted or the construct strengthened when feasible. Second, is there an articular, biological, or soft-tissue reason to restrict loading despite adequate implant stability? If so, the restriction should protect that specific vulnerable structure. Third, can the patient realistically comply with the proposed restriction? If not, the surgeon should reconsider whether controlled loading is safer than an unachievable prescription and whether additional fixation is required.

This framework shifts postoperative rehabilitation from a diagnosis-based protocol toward an individualized mechanical prescription.

### RESEARCH GAPS

Future trials should standardize definitions of immediate, early, permissive, and delayed weight bearing. Fixation constructs should be reported in sufficient mechanical detail to permit meaningful interpretation rather than relying on fracture classification alone. Complex periarticular fractures, severe osteoporosis, obesity, diabetes, neuropathy, syndesmotic fixation, periprosthetic fractures, and high-energy injuries remain underrepresented.

Outcomes should also extend beyond radiographic union. Independence, discharge destination, return to work, gait recovery, falls, sarcopenia, venous thromboembolism, health-related quality of life, and cost are important endpoints when comparing rehabilitation strategies. Multicenter randomized trials stratified by fracture morphology and construct characteristics are needed to determine where early loading is genuinely safe and where restriction remains protective.

### CONCLUSIONS

Contemporary evidence supports a progressive departure from routine prolonged non-weight bearing after stable fixation of selected lower-extremity fractures. Evidence is strongest for operatively treated ankle fractures and tibial shaft fractures treated with locked intramedullary nails. Selected tibial plateau fractures can also tolerate immediate or early loading after robust fixation, while evidence for distal femur fractures is increasingly reassuring but remains less definitive. The central principle is not universal immediate weight bearing. It is that rehabilitation should reflect the mechanics of the achieved reconstruction, the biology and morphology of the injury, soft-tissue constraints, and the patient's capacity to comply. Postoperative weight-bearing prescriptions should increasingly be construct driven rather than diagnosis driven. Non-weight bearing remains appropriate when mechanically necessary, but it should be prescribed for a defined reason rather than by tradition alone.

**TABLE 1. EVIDENCE-BASED CLINICAL SUMMARY**

| Injury                                     | Evidence                              | Pragmatic loading approach after stable fixation                                         |
|--------------------------------------------|---------------------------------------|------------------------------------------------------------------------------------------|
| Ankle fracture after ORIF                  | Large RCT plus 2026 RCT meta-analysis | Early loading, commonly from ~2 weeks, is reasonable in appropriately selected patients. |
| Tibial shaft fracture after locked IM nail | Level I RCT plus meta-analysis        | Immediate WBAT is reasonable for many OTA/AO 42-A and 42-B                               |

|                                            |                                                         |                                                                                                           |
|--------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|                                            |                                                         | patterns with satisfactory fixation.                                                                      |
| Selected tibial plateau fracture           | 2025 RCT plus heterogeneous meta-analysis               | Immediate/early loading may be considered when articular reduction and construct stability are robust.    |
| Complex bicondylar tibial plateau fracture | Limited direct high-level evidence                      | Individualize; restriction remains appropriate when subsidence or column failure is a meaningful concern. |
| Distal femur fracture                      | 2025 meta-analysis, predominantly nonrandomized studies | Early loading is increasingly defensible when the construct is intentionally designed to tolerate it.     |

FIGURE 1. PROPOSED CONSTRUCT-DRIVEN WEIGHT-BEARING ALGORITHM

1. Can the achieved fixation tolerate anticipated physiologic loading?
  - No → restrict loading and/or strengthen the construct when feasible.
  - Yes → proceed to Question 2.
2. Is there an articular, biological, soft-tissue, or associated-injury reason to restrict loading?
  - Yes → prescribe a restriction directed at the vulnerable structure.
  - No → early WBAT can be considered.
3. Can the patient realistically comply with the proposed restriction?
  - No → reconsider the restriction, assistive strategy, and whether additional construct strength is required.

## REFERENCES

1. Bretherton CP, Achten J, Jogarah V, et al; WAX Investigators. Early versus delayed weight-bearing following operatively treated ankle fracture (WAX): a non-inferiority, multicentre, randomised controlled trial. *Lancet*. 2024;403(10446):2787-2797. doi:10.1016/S0140-6736(24)00710-4.
2. Egu C, Akil H, Hakim RA, et al. Early vs late weight bearing after ankle fracture fixation: a meta-analysis of randomized controlled trials. *Foot Ankle Int*. 2026;47(2):174-183. doi:10.1177/10711007251392223.
3. Gross SC, Galos DK, Taormina DP, Crespo A, Egol KA, Tejawani NC. Can tibial shaft fractures bear weight after intramedullary nailing? A randomized controlled trial. *J Orthop Trauma*. 2016;30(7):370-375. doi:10.1097/BOT.0000000000000598.
4. Bhanushali A, Kovoov JG, Stretton B, et al. Outcomes of early versus delayed weight-bearing with intramedullary nailing of tibial shaft fractures: a systematic review and meta-analysis. *Eur J Trauma Emerg Surg*. 2022;48(5):3521-3527. doi:10.1007/s00068-022-01919-w.
5. Ibrahim MA, Moustafa MMA, Brismée JM, et al. Immediate weight-bearing after tibial plateau fractures internal fixation results in better clinical outcomes with similar radiological outcomes: a randomized clinical trial. *Int Orthop*. 2025;49(5):1245-1253. doi:10.1007/s00264-025-06443-1.
6. Ibrahim MA, Brismée JM, Farouk O, et al. Immediate weight-bearing after tibial plateau fractures enhances spatiotemporal gait parameters and minimizes fall risk: a randomized clinical trial. *J Biomech*. 2025;184:112668. doi:10.1016/j.jbiomech.2025.112668.
7. Elsenosy AM, Yousef AS, Hassan E, et al. Early versus delayed weight-bearing following tibial plateau fracture surgery: a systematic review and meta-analysis. *Cureus*. 2025;17(10):e95185. doi:10.7759/cureus.95185.
8. Aebischer AS, Gouk CJC, Steer R. Early weight-bearing following distal femur fracture fixation: a systematic review and meta-analysis. *ANZ J Surg*. 2025;95(6):1108-1114. doi:10.1111/ans.19288.