

Proximal tibia and tibial plateau nail-plate combinations: technical trick and case series

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Abstract

Proximal tibia fractures and combined tibial shaft-plateau injuries are increasingly common. Prolonged nonweightbearing may result in poor outcomes, particularly in elderly patients. Nail-plate combination constructs offer an attractive solution to facilitate early weight-bearing in these complex problems. We describe strategies and tips for these constructs and present the results of a small patient series treated with this technique.

1. Introduction

The incidence of proximal tibia fractures, including those of the tibial plateau, is 13.3 per 100,000 people per year, accounting for 5% to 11% of all tibia fractures.^[1,2] These injuries cause significant impairment in mobility and function and can have high rates of malunion and malalignment.^[2,3] Given the complexity of these injuries, both intramedullary nailing (IMN) and plating are routinely used for internal fixation, depending on injury characteristics and surgeon preference.^[3] Anail-plate double construct, which increases the amount of implant fixation, is a novel treatment option for these fractures. There is increased interest but a paucity of literature surrounding the use of nail-plate combinations in this fracture type.^[4–7]

When treated operatively, patients with proximal tibia fractures are typically prescribed a prolonged period of restricted weight-bearing of up to 8 to 12 weeks, as recommended by the Arbeitsgemeinschaft für Osteosynthesefragen guidelines.^[8] Surgeons tend to restrict weight-bearing in patients with these injuries to prevent fracture collapse and further articular damage. However, 72.1% of surgeons report recommending weight-bearing earlier than 12 weeks and 11.7% recommend immediate weight-bearing after operative fixation.^[9] Earlier weight-bearing leads to increased periosteal bone production, energy absorption, and blood flow compared with restricted weight-bearing.^[10,11] Patients themselves, particularly the

elderly, may experience difficulty restricting weight-bearing for extended periods of time.^[12] Additionally, quality of life is quantifiably improved in patients who experience early weight-bearing compared with those who remain restricted.^[13,14] For these reasons, early weight-bearing has gained popularity in the treatment course of several lower extremity injuries including hip fracture fixation, femoral and tibial IMN, and ankle fracture fixation.^[15,16]

The technique of using nail-plate combinations in the proximal tibia was first described by Dunbar et al as an adjunct for successful reduction prior to IMN, but has since been demonstrated as a successful definitive treatment modality.^[17–19] The advantages of this technique include protection of fixation and a more even distribution of energy through the bone and implants. By combining an IMN and a plate, forces may be more smoothly transitioned to accommodate early weight-bearing.^[20]

In this case series, we provide a technical guide to creating nail-plate combination constructs and describe the treatment course of 5 patients with proximal tibia fractures with plateau components that were treated with these constructs and early weight-bearing. Use of these principles in tandem can return these patients to high functioning without adverse effects.

2. Technique

The patient is positioned supine. Depending on surgeon preference, previous external fixator pins (if present) can be used for the femoral distractor, or new pins can be placed for fracture manipulation and articular surface evaluation. Standard instruments and implants are used for the tibial plateau and tibial nail portions of the procedure.

The order of fixation is case-dependent, but in general, if the plateau or proximal fracture does not enter the nail trajectory on computed tomography scan, the nail is placed first using standard semiextended technique (author preference: supra-patellar, but parapatellar also possible) (Fig. 1). This allows the distal portion of the tibia to move as a unit, allowing leverage for the femoral distractor if necessary. If the fracture enters the planned nail trajectory, the articular surface is stabilized first.

The plateau or proximal tibia component is approached in a standard manner (anterolateral, medial, or both). The anterior compartment musculature is elevated and a submeniscal

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Figure 1. X-rays and representative CT cuts of a segmental tibial shaft fracture with a lateral tibial plateau component. The plateau fracture did not enter the planned nail trajectory (arrows); therefore, the nail was placed prior to plateau fixation.

arthrotomy is performed in the anterolateral approach. The articular surface is elevated using a standard combination of wires, osteotomes, bone tamps, and/or bone graft (Fig. 2). The surgeon’s proximal tibia plate of choice is positioned and provisionally secured with K wires proximally, and a push-pull reduction instrument (“whirlybird”) distally if the nail has not yet been placed (Fig. 3). If a whirlybird device is not available, a unicortical screw can be used to achieve the same goal. A periarticular clamp can be used to decrease condylar width (Fig. 4). Care must be taken to plan screw trajectory away from the nail path, and aim to support the articular surface fragments. Additional rafting screws or mini-plates separate from the primary plate can also be used for this purpose if screw trajectory is suboptimal (Fig. 5). Screws can also be made short initially and replaced with bicortical or longer screws once the nail is in position.

The nail component is placed according to surgeon preference, but should be placed as proximally as possible, to maximize

proximal tibia surface fixation with the nail locking bolts. Nails with multiple proximal screw options are preferable for this purpose, as screws can be directed into different parts of the plateau, further supporting proximal fragments (Fig. 5). Certain nails provide the opportunity for lateral nail/plate linkage. However, this is not strictly necessary, provided the plate is secured appropriately in the shaft. Additionally, there may be a size mismatch between the plate and a tibial nail screw, resulting in the inability to link constructs without using the smaller diameter screw with an extra washer, in a similar fashion as described previously for femur fractures.^[21]

3. Cases

In our series, 5 patients were treated with nail-plate combinations and early weight-bearing for tibial shaft-plateau injuries (Table 1). The average age of the cohort was 53.6 ± 11.8 years and there were 3 female and 2 male patients. All sustained

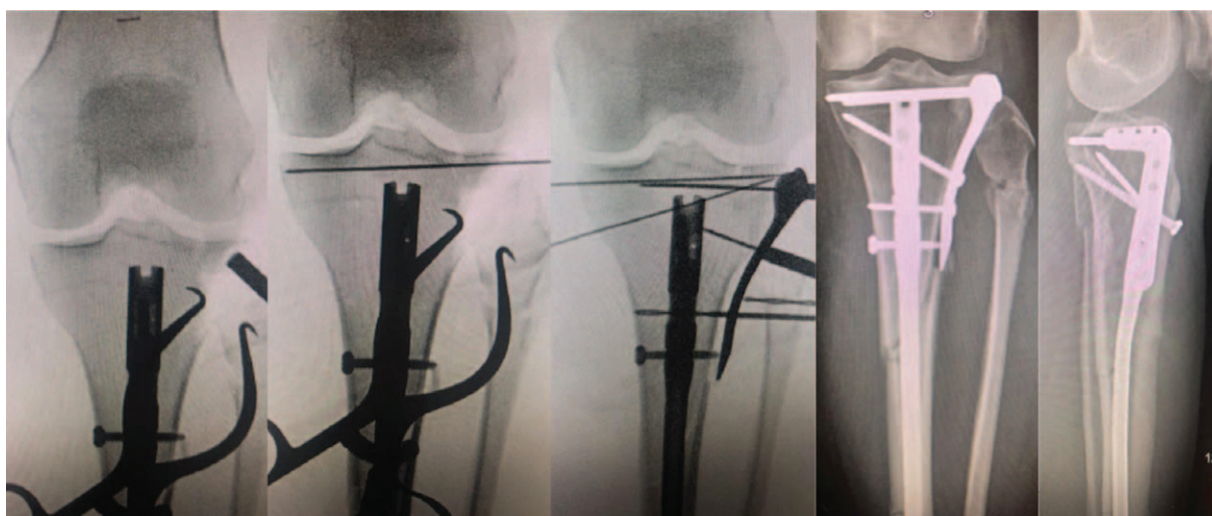


Figure 2. Fluoroscopic images and final construct healing of the patient in Figure 1. A standard anterolateral approach to the tibial plateau is performed, the impaction is elevated, and a plate is placed with screws above the nail. The nail has been stabilized with a screw proximally and distally; more proximal screws in the nail are also possible for additional metaphyseal support.

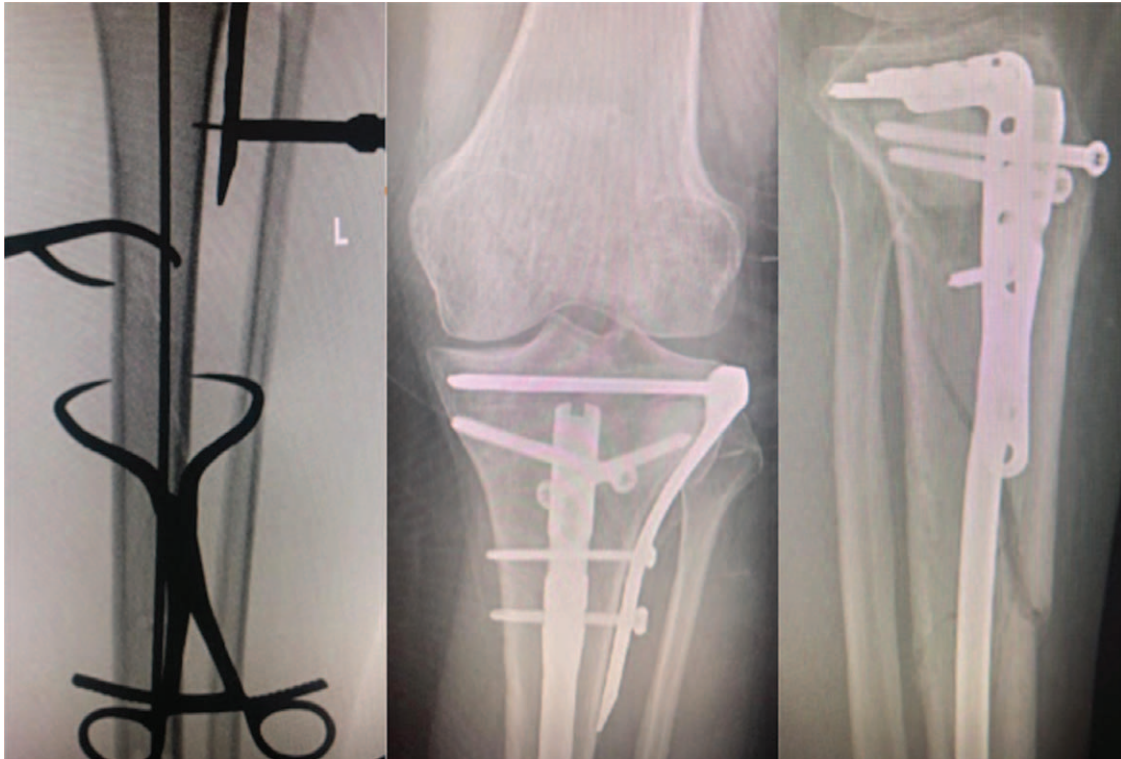


Figure 3. Use of a push-pull reduction device ("whirlybird") to provisionally stabilize the distal portion of a tibial plateau plate. This was followed by nail placement and linkage of the plate through the nail. The tibial plateau has been stabilized with screws proximal to the nail as well as calcium phosphate bone substitute.

high-energy mechanisms of injury. One injury was open. The cases were classified according to Schatzker; there were 3 Type II, 2 Type VI, and 1 Type V. Four of 5 patients were treated initially with external fixation for soft tissue swelling, with definitive conversion within 10 days. The average length of hospitalization was 17.6 ± 8.9 days.

Four of 5 patients were prescribed immediate weight-bearing postoperatively, and 1 was prescribed partial weight-bearing of 30 lbs. No patients experienced treatment complications during hospitalization or during their treatment course. Average time to healing was 7.2 ± 2.2 months; 1 patient is still undergoing treatment.

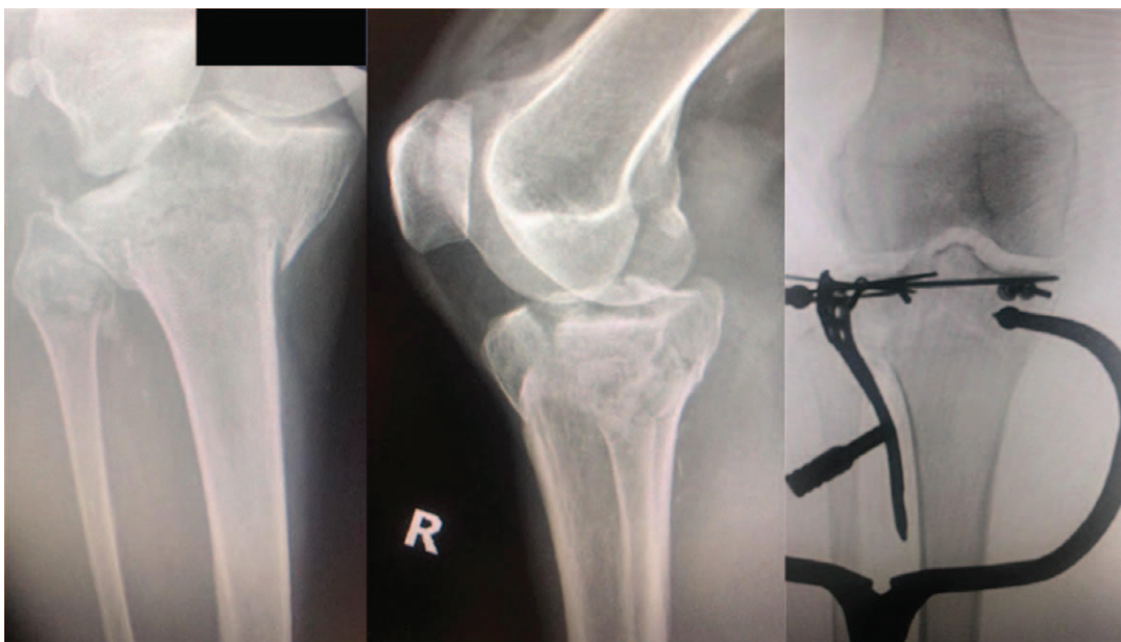


Figure 4. Proximal tibia fracture in a patient with osteoporosis with medial and lateral plateau extension. A periarticular clamp is being used to restore condylar width.

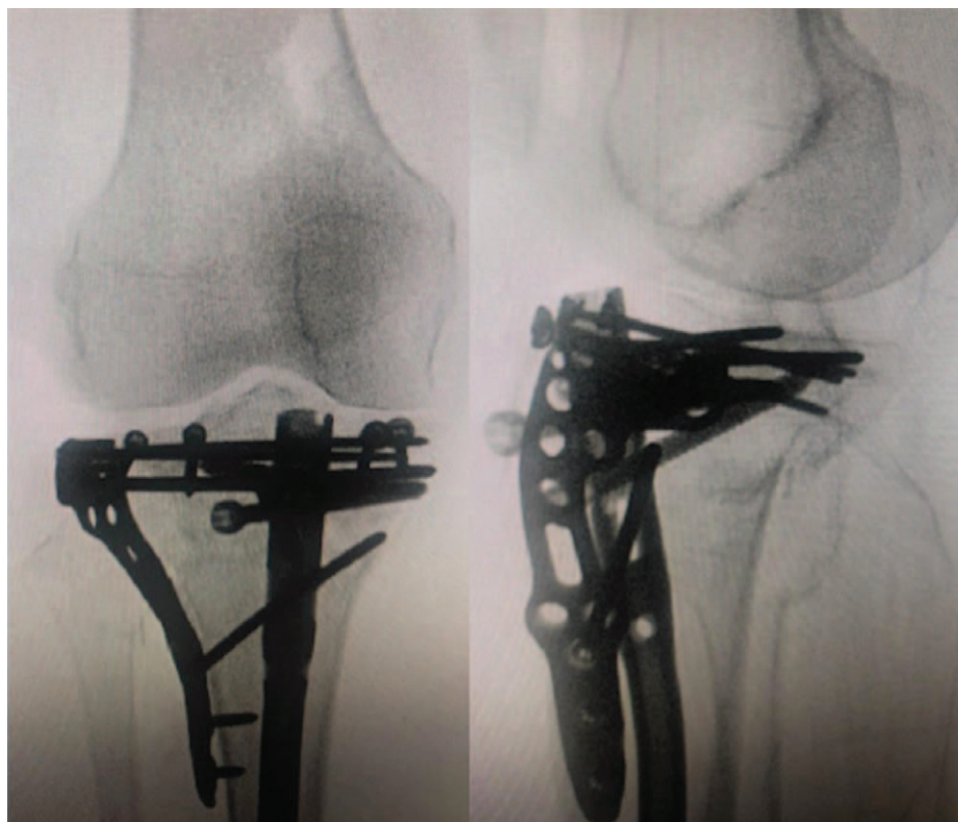


Figure 5. Final construct for the patient in Figure 4. Rafting screws (anterior to posterior) outside the plate are used on the lateral side to support posterolateral fragments. Lag screws from anterior to posterior are used to stabilize a simple medial split. Finally, the nail screws themselves are used for additional articular support, and the nail is placed as proximally as possible for this purpose.

4. Discussion

Nail-plate constructs have gained favor in the treatment of other technically difficult fracture patterns, such as the distal femur. These nail-plate combinations allow for early weight-bearing, especially in the elderly, for whom these injuries can be particularly debilitating. Biomechanically, these constructs demonstrate greater resistance to axial and torsional

forces than either nail or plate fixation alone.^[22,23] Use of a load-distributing device such as an intramedullary nail holds the reduction of the fracture, while a plate may control further motion at the articular surface, providing greater stability. In the same way, proximal tibia and tibial shaft fractures may benefit from the combination of these principles.

Table 1

Injury characteristics, operative details, and treatment course in patients treated with nail-plate constructs and early weight-bearing

Patient	Age	Sex	Mechanism	Additional injuries	Gustilo Anderson classification	Schatzker classification	Initial external fixation	Treatment complications	Length of stay (d)	Weightbearing status	Time to healing (m)
1	38	M	Motor vehicle collision	Contralateral open tibia and fibula fracture, Contralateral distal femur fracture	—	II	Y	N	32	WBAT	8.6
2	48	F	Pedestrian struck	—	II	II	N	N	18	PWB	N/A
3	52	M	Fall from 10 ft	—	—	VI	Y	N	8	WBAT	6.5
4	62	F	Fall from 3 ft	Contralateral patella fracture, scalp laceration	—	VI	Y	N	16	WBAT	4.3
5	68	F	Pedestrian struck	Ipsilateral anterior column with posterior hemitransverse acetabular fracture	—	V	N	N	14	WBAT	9.3

Four of 5 patients were allowed immediate full weight-bearing and 1 was allowed early partial weight-bearing (30 lbs). Patient 2 is still mid-treatment and has not achieved final union. PWB=partial weight-bearing; WBAT=weight-bearing as tolerated.

Use of the nail-plate construct for proximal tibia fractures employs a similar concept as that in the distal femur: support of the articular surface and the shaft using stable fixation for both the articular and axial components. Nail-plate proximal tibia fixation has been previously reported, but not in the context of early weight-bearing. Yoon et al^[17] presented an overall union rate of 93% in patients with proximal third tibia fractures that underwent nail-plate fixation and immediate weight-bearing, albeit only in those with extra-articular fractures. They posited that using a combined fixation method may circumvent the higher rates of malalignment seen in tibial nail fixation compared with plating, and reported no malalignment in their cases. In a recent study, Cinats et al^[19] reported plate-assisted reduction of proximal tibia fractures as a viable option, particularly in complex and open fractures. However, the analyses of the differences between patients with retained plating and those who had the assistive plate removed (n = 13 and 11, respectively) were underpowered, and no commentary was made regarding the postoperative weight-bearing status.^[19]

Several studies have examined the immediate weight-bearing concept in proximal tibia injuries with similar results. Kalmet et al^[24] described no differences in complications with an earlier return to full weight-bearing in patients prescribed permissive weight-bearing after operative fixation of tibial plateau fractures. Haak et al^[25] similarly reported no differences between immediate weight-bearing and 6 to 8 weeks of nonweightbearing in proximal articular tibia fractures including radiographic metrics, complications, and subjective reports. Immediate weight-bearing, as it gains further favor, can allow patients to have earlier range of motion and return to activities of daily living.

Expanding on these studies and the results of our case series, early weight-bearing after nail-plate fixation may be a safe and viable alternative for patients who sustain complex proximal tibia and shaft-plateau combination injuries.

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