

Tibia Nailing Using Modular Stand: A Technical Note

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Abstract

Interlocking nailing is a well-established procedure for managing unstable tibial shaft fractures. Closed reduction and internal fixation of the tibial shaft fractures require ease of intraoperative positioning, maneuvering, and biplane imaging.

We describe the use of an innovative modular tibia-nailing stand, which greatly enhances the ergonomics of the tibia nailing procedure.

Categories: Orthopedics, Trauma

Keywords: intraoperative fluoroscopy, ergonomic design, tibia shaft fracture, modular tibial stand, tibia nailing

Introduction

Closed tibia nailing is a popular, established, and commonly performed operative procedure for the treatment of tibial shaft fractures [1]. For improved outcomes, optimum fracture alignment and rotational correction play an important role [2]. Intraoperative fracture alignment is usually obtained by applying traction along the long axis of the leg manually or by distractor assistance. Final reduction and nail position depend on the accuracy of guidewire placement, which requires biplane imaging [3]. To achieve this, the procedure is performed on a radiolucent operation table with traction being applied either manually or on traction assembly [4,5]. Even though these techniques are well established and commonly used, there are few associated difficulties in patient positioning, maneuvering, and intraoperative biplane imaging. The availability of a fracture table exclusive to the tibia is also an issue. It is not portable and requires significantly longer positioning time than manual traction, making it inconvenient and time-consuming [6]. Also, it does not allow sequential or simultaneous procedures in a polytrauma patient with multiple lower limb injuries without re-positioning or re-draping. Manual traction overcomes all these drawbacks of standard fracture table traction and significantly decreases the operative time [3]. Manual traction can be applied using a radiolucent foam triangle, adjustable knee and tibial positioner device, tibial and femur triangles, or hanging free leg technique [5]. However, the inventory required for the manual traction using the above-mentioned commercially available devices is cumbersome, and maintaining operative field sterility can also be an issue.

We have developed a simple autoclavable modular tibial stand to overcome these technical difficulties with manual traction application in the tibia nailing procedure.

Technical Report

Patients are operated on under suitable anesthesia (neuraxial block or general anesthesia as required) in the supine position, under tourniquet control. After sterile draping and prepping, ensured a free position of drapes such that the knee can be flexed up to 90 degrees. Next, the foot is draped separately. A modular tibial stand is assembled (Figure 1) and used throughout the procedure to keep the knee in various degrees of flexion based on the requirement (Figure 2).

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FIGURE 1: Components of modular tibia stand.

- (a) Modular tibial stand with the four detachable cylindrical attachments of various heights, tibial baseplate, and top resting plate;
- (b) Knee resting plates;
- (c) Maximum tibial stand length;
- (d) Complete modular tibial stand.

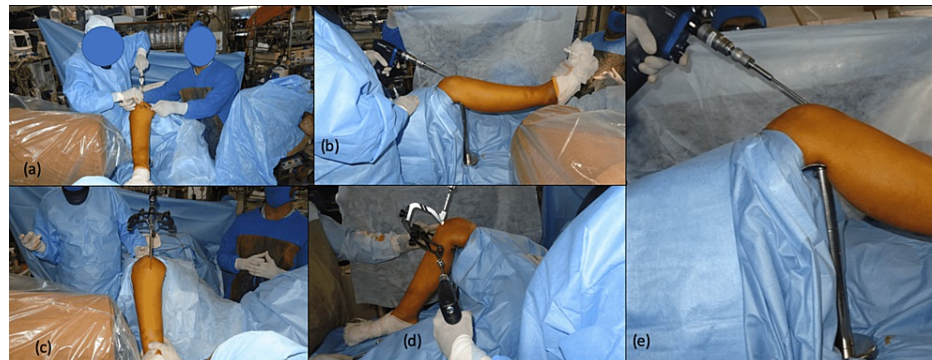


FIGURE 2: Various steps of tibia nailing with modular tibial stand.

- (a) Guidewire insertion under fluoroscopy control;
- (b) Reaming in extension (needed in proximal tibia fractures);
- (c) Nail insertion with the jig for proximal locking;
- (d) Proximal tibia locking
- (e) Reaming in flexion.

Routine steps for tibia nailing are done. Various degrees of knee flexion possible with a modular tibial stand is described pictographically (Figure 3).

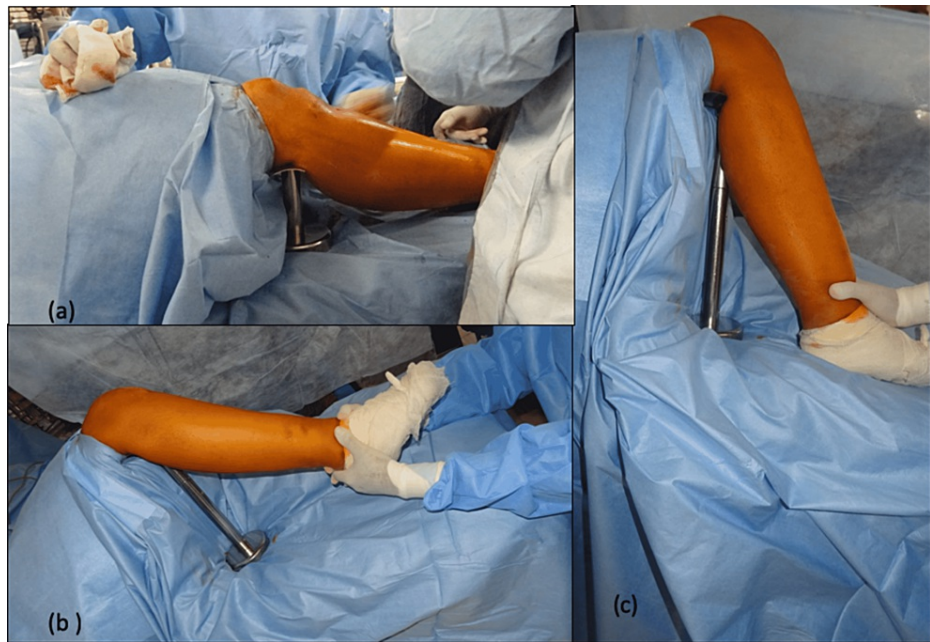


FIGURE 3: Various degrees of knee flexion possible with modular tibia stand.

(a) Thirty degrees of knee flexion with the smallest attachment of tibial stand is required during entry point incision and during closure to maintain adequate tissue tension;
 (b) Modular tibial stand for applying on-table traction to align fracture;
 (c) 100 to 110 degrees of knee flexion possible with the modular tibial stand, required during guidewire and nail insertion.

Intraoperative biplane imaging is done throughout the procedure, as required (Figure 4).



FIGURE 4: Ease of intraoperative biplane imaging with modular tibial stand.

(a) Intraoperative anteroposterior imaging;
 (b) Intraoperative lateral imaging.

*Xt: X-ray Tube *Ii: Image Intensifier

The important peculiarities of the tibial stand and its advantages have been described in Table 1. Even though it is metallic, it does not hinder intraoperative fluoroscopic views, as shown in Figure 5.

| Sr No. | Features | Advantages |
|--------|--|---|
| 1. | Made of stainless steel | Autoclavable |
| 2. | Heavy tibial base plate | Improves stability traction counter traction ability; Good rotation and varus/valgus control; The scrubbed surgical assistant stabilizes the cylindrical block with one hand, thereby preventing intraoperative toggling of the leg when giving traction. |
| 3. | Adjustable, slotted four cylindrical blocks of various lengths | Provides modularity in the height of the tibial stand as required during the procedure; During skin incision and closure: 30-degree flexion is desired, which can be obtained using the smallest size cylinder; During guidewire negotiation, traction-countertraction application for fracture manipulation, and nail insertion: 90 to 110 degrees knee flexion is desired and can be obtained by using all the four slotted cylinders; Nailing in extension is easily possible. |
| 4. | Wide and narrow top plate | The top plate is convex, smooth, and wrapped with a thick gauze to avoid damage to popliteal structures during traction application; Does not hinder the intraoperative fluoroscopy view of the proximal nail insertion site (Figure 5). |

TABLE 1: Peculiar features and advantages of the tibial stand.

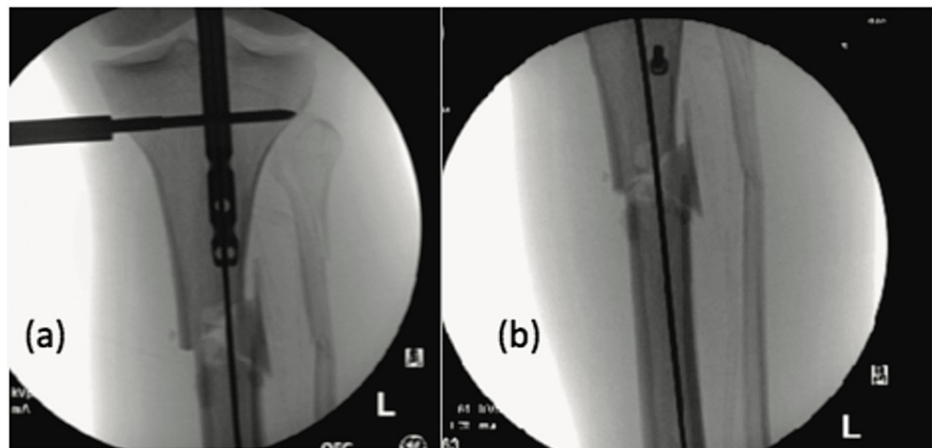


FIGURE 5: Intraoperative fluoroscopic images with modular tibial stand.

(a) anterior-posterior (AP) view; (b) lateral view.

Discussion

Closed tibia nailing is a popular and commonly performed operative procedure for treating tibial fractures [1]. For better postoperative outcomes, optimum fracture alignment, ease of intraoperative biplane imaging, and rotational control play an important role [2]. Intraoperative fracture alignment is obtained by applying traction in the long axis of the leg during guidewire and interlock nail negotiation [3]. There are various intraoperative positioning and traction application techniques during the tibia nailing [4,5]. These techniques have been summarized with the pro and cons of each technique (Table 2).

| | Traction through a smooth calcaneal pin | Pinless calcaneal traction by foot strapping | Adjustable knee and tibial positioner | Readymade tibial triangles | Hanging free leg technique | Fine wire frame assisted IM nailing | Modular tibial stand |
|--|---|--|---------------------------------------|--|--|--|---------------------------|
| Method of traction | Traction table | Traction table | Manual | Manual | Gravity assisted and manual | Distraction over circular frame | Manual |
| Traction table required | Yes | Yes | No | No | No | No | No |
| Patient positioning time | Increased | Increased | Less | Less | | | |
| Autoclavable | Yes | No | Yes | Yes | Not Applicable | Yes | Yes |
| Multiple simultaneous or sequential procedures in a polytrauma patient without redraping | Not possible | Not possible | Possible | Possible | Possible | Possible | Easy |
| Access to contralateral lower limb for comparison of length and rotation | Difficult | Difficult | Easy and rapid | Easy and rapid | Difficult | Easy | Easy and rapid |
| Associated complications/Limitations | Subtalar joint encroachment; Over distraction; Calcaneal pin site discharge | Skin excoriation in case the skin is friable or paper-thin; Difficult to apply if there is associated lower extremity injury like Bimalleolar fracture | Difficulty in sterilization | Cost; Need to maintain complete range of inventory | Exaggerated lower extremity edema; Risk of compartment syndrome and common peroneal nerve palsy in the contralateral leg in lithotomy position | Additional procedure of half-frame attachment; Risk of neurovascular injury during insertion of fine wires in the proximal and distal segments; Difficulty in intraoperative biplane imaging | Nil noticed in our series |

TABLE 2: Various methods of intraoperative positioning and traction application during intramedullary nailing of the tibia.

It has been shown that manual traction can significantly reduce the operating time compared to fracture table traction without compromising fracture alignment and outcome [3]. However, the commercially available inventory required for applying intraoperative traction can be cumbersome and on-table space-occupying [6].

We have found that modular tibial stand overcomes the difficulties associated with manual traction with excellent on-table biplane imaging and good axial and rotational control of the fracture possible by the assistant applying longitudinal traction. The assistant applying manual traction can easily control the intraoperative fracture site's rotational and axial alignment. The heavy tibial base plate provides improved stability, traction/countertraction ability, and good varus/valgus control. The height of the stand can be easily altered as per requirement because of the modularity of the various size cylindrical blocks of various lengths. Being made of stainless steel, it can be autoclaved easily.

Over the last 10 years, we have operated on over 600 cases of all tibial interlocking nailing using a modular tibial stand at our center. With the use of a tibial stand, we have found that the ergonomic of tibia nailing procedure has significantly improved in terms of reduced operative time, ease of intraoperative fluoroscopy, and traction application.

Conclusions

Obtaining satisfactory fluoroscopic images during the tibia nailing procedure and effective fracture site manipulation throughout the treatment necessitates proper intraoperative limb positioning. The use of a modular tibial stand, in our experience, takes care of both these concerns and assures that the results are repeatable. This could be a useful and safe alternative to the currently available limb positioning modalities during tibia-closed intramedullary nailing.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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