Removal of a Bent Tibial Intramedullary Nail Through Osteotomy and Partial Sectioning

A Case Report

Haad Arif, BS, Steven Molina, BS, and Christopher LeBrun, MD

Investigation performed at Riverside Community Hospital, Riverside, CA

Abstract

Case: An 18-year-old male patient presented with a closed fracture of the left tibia and fibula and a bent intramedullary nail after a repeat motorcycle accident. The patient was 5 weeks postoperative from intramedullary nailing of a closed left tibia fracture. The site of angulation of the tibial nail was noted to be more proximal than the fracture site. Partial sectioning of the nail through an osteotomy permitted the removal of the nail and revision tibial nailing.

Conclusion: This is the first reported use of an osteotomy and partial sectioning during the extraction of a bent tibial intramedullary nail.

Intramedullary nailing is a widely used technique in the management of displaced tibial shaft fractures[1-4]. Rarely, intramedullary nail extraction is indicated because of nail deformation after a subsequent injury to prevent the bone from healing in the direction of the deformation[5]. In such cases, removal of the existing implant may present a technical challenge depending on the nature of the injury, the type of nail deformity, and nail characteristics.

Despite the annual incidence of tibial shaft fractures estimated to be 20.8 per 100,000 persons and the popularity of intramedullary nailing, there remains a paucity in the literature on the removal of bent or broken tibial intramedullary nails[6]. No guidelines on the removal of deformed tibial intramedullary nail exist, and the literature is largely limited to case reports describing variations of a few central methods: standard extraction, external vs. internal manipulation of the deformation, and partial or complete sectioning[5,7-10]. We add to the existing literature by describing the unique open extraction of a bent tibial intramedullary nail through osteotomy and partial sectioning, and revision intramedullary nailing of the tibia and fibula fractures.

The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

Case Report

An 18-year-old male patient presented to the emergency department after a motorcycle accident. On physical examination, there was an obvious valgus deformity of the left tibial shaft. The overlying skin was intact. He was neurovascularly intact. The patient had a recent history of a closed fracture of the left distal tibia and fibula treated with titanium alloy tibial intramedullary nail placement through a suprapatellar approach 5 weeks earlier—also secondary to a motorcycle crash.

Imaging studies demonstrated an acute angulated and comminuted displaced extra-articular fractures of the distal tibia and fibula diaphyses with a bent tibial intramedullary nail measuring 9 × 345 mm (Fig. 1). The intramedullary nail had approximately 20° of apex anteromedial angulation. No signs of implant fracture were noted. The patient was taken to the operating room for revision surgery. Initial attempts to straighten the intramedullary nail by closed means were unsuccessful. Therefore, a longitudinal incision was made overlying the medial aspect of the distal tibia at the level of the fracture site. The apex of the concavity of the intramedullary nail was more proximal than the distal tibia fracture (Fig. 2), requiring an osteotomy of the medial distal tibia to access the apex of the concavity of the intramedullary nail. A tibial cortical osteotomy was performed and hinged on its intact posterior soft-tissue attachments. A high-speed handheld sagittal saw with a metal-cutting saw blade was used to remove a wedge from the intramedullary nail on the convex side (Fig. 3), weakening the intramedullary nail to permit straightening of the nail during extraction (Fig. 4). During resection of the wedge from the intramedullary nail, the area was continuously irrigated with normal saline to assist in preventing thermal injury. The

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSCC/C145).

Keywords Age (young adult); Sex (male); Complication (bent IM nail, bent intramedullary nail, bent tibial IM nail, bent tibial intramedullary nail); Device (IM nail, intramedullary nail, tibial IM nail, tibial intramedullary nail); Disease/condition (fracture, refr)

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1 Angulated and comminuted displaced fractures of the distal tibia and fibula diaphyses with a bent distal tibial intramedullary nail. **Fig. 2** Apex of curvature found to be more proximal than the fracture site. **Fig. 3** Intramedullary nail after partial sectioning. **Fig. 4** Straightening of the titanium nail after wedge resection.

Fig. 5
Operative fluoroscopy demonstrating proper reduction of both fractures and placement of all implants.

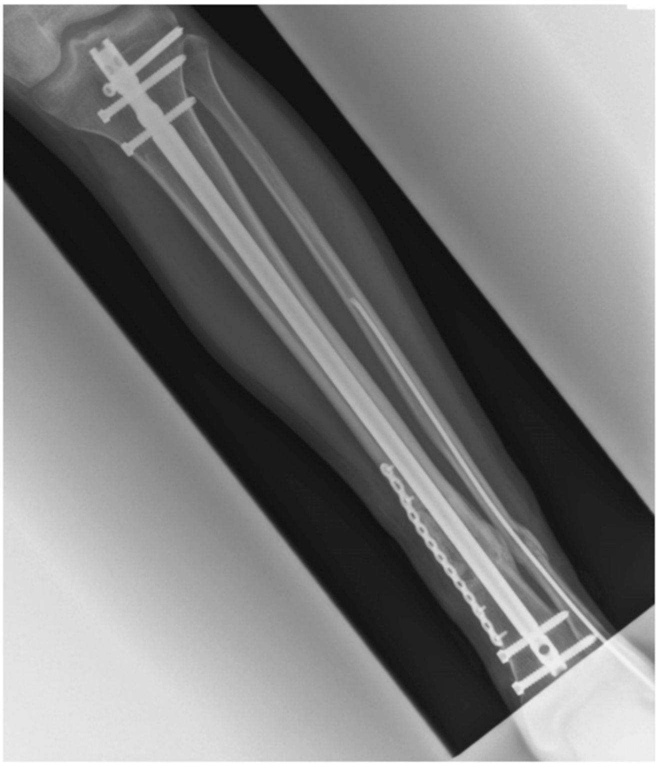

Fig. 6
Anterior-Posterior radiograph at 4 months postoperative.

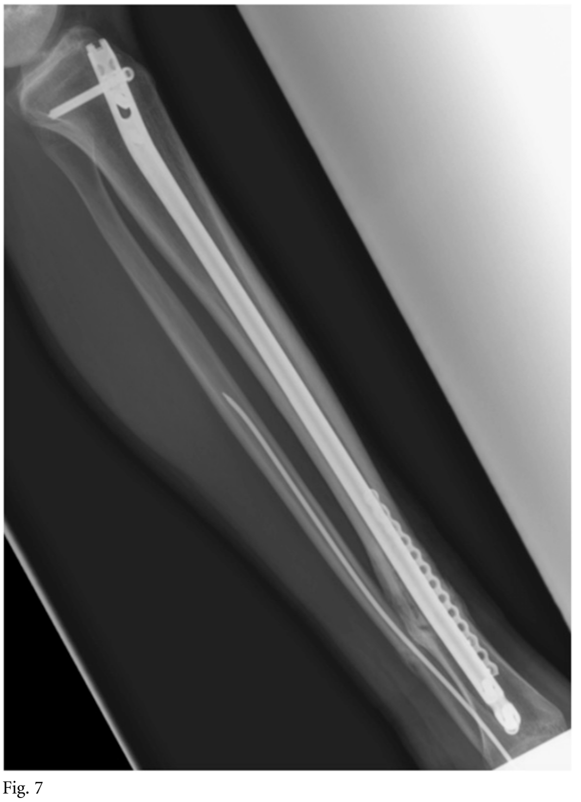

Fig. 7
Lateral radiograph at 4 months postoperative.

surrounding soft tissues were covered with laps with applied Surgilube to improve adherence of metal debris to the surrounding laparotomy sponges and decrease metal contamination to the surrounding soft tissues.

Once the bent intramedullary nail was removed, the medullary canal was reamed sequentially over a ball-tipped guidewire. A titanium, 10-mm tibial nail was inserted in a standard fashion. The 2 distal interlocking screws were then placed using a freehand technique, whereas the 2 proximal interlocking screws were placed using the targeting guide. A mini-fragment plate with unicortical screws was used to bridge and reduce the osteotomy site. To increase stability of the overall construct, intramedullary fixation of the distal fibular shaft fracture was performed. After gaining access to the distal fibular intramedullary canal using a 4-mm drill bit, fixation of the fracture was accomplished through retrograde insertion of a 2.5-mm flexible titanium nail past the fracture site and into the proximal intramedullary canal. The nail was cut outside the skin and then tamped into the appropriate position. Intraoperative fluoroscopic views demonstrated excellent reduction of both fractures and placement of all implants (Fig. 5). The patient's most recent follow-up visit was at 4 months postoperative. The patient denied pain and was ambulating without an assistive device. There was no tenderness to palpation at the distal tibial shaft or distal fibular shaft fractures. Imaging studies (Figs. 6 and 7) demonstrated progressive, but

TABLE I Description of Cases With Open Extraction of Bent Tibial Intramedullary Nails

Year	Author	Age, Sex	Type of Nail	Direction and Direction of Deformity	Method of Extraction
2011	Aggerwal et al.[7]	30 M	Stainless steel	28° apex anterior bend	Partial sectioning
2016	Kose et al.[10]	39 M	Stainless steel	32° coronal bend	Partial sectioning
2019	Pathak et al.[9]	45 M	Stainless steel	42° apex posterior and 5° apex medial bend	Complete sectioning
2019	Gaubert et al.[11]	25 M	Not disclosed	45° apex anteriolateral bend	Corticotomy and retrograde extraction
2023	Present case	18 M	Titanium	20° apex anteromedial bend	Osteotomy and partial sectioning

incomplete fracture consolidation. Patient was subsequently lost to follow-up.

Discussion

To the best of our knowledge, this case is the first reported use of partial sectioning through an osteotomy to extract a bent tibial intramedullary nail. Our case was complicated by the fact that, unlike previous reports, the area of nail deformation was not aligned with the fracture site. We found 4 studies describing the open extraction of a bent tibial intramedullary nail (Table I).

An in-depth understanding of the fracture biology and nature of the deformity is crucial in the surgical planning of intramedullary nail extraction. Open or comminuted tibial shaft fractures offer greater mobility and ease of intramedullary nail removal while decreasing the risk of iatrogenic fractures during extraction[8]. Standard extraction may be attempted in cases where the angulation is less than 20° or if the curve is in the apex posterior direction[7,8,10]. Otherwise, manual straightening may need to be attempted before extraction. This becomes especially true in the case of titanium intramedullary nails, which are more flexible than their stainless steel counterparts[9]. Straightening against a perineal post is another option; however, this is not suitable for very proximal or distal fractures because of the risk of soft-tissue injury and iatrogenic fractures[12]. In our case, despite the increased flexibility of the titanium nail, the apex anteromedial curvature and approximately 20° of angulation prevented standard extraction. If manual straightening fails, open extraction should be performed.

Open extraction of a bent tibial intramedullary nail has been performed through complete sectioning, partial sectioning, or by creating a cortical window to free the distal portion of the intramedullary nail followed by retrograde hammering[7,9-11]. By cutting at the apex of deformity, a surgeon can either completely section the intramedullary nail and proceed with the extraction of the 2 separate pieces or weaken the integrity of the intramedullary nail through partial sectioning to allow for straightening. Pathak et al. describe the complete sectioning of a bent stainless steel tibial intramedullary nail and removal using a standard extraction device and jumbo cutters[9]. Partial sectioning of an intramedullary nail has also been reported in 2 cases by Aggerwal et al. and Kose et al. Partial sectioning may be completed through removal of a wedge from the apex of the concavity of the intramedullary nail (closing wedge) as performed within this case vs. notching the nail at the convex side of the bend (opening wedge). By creating a window that is roughly half the diameter of the nail as described by Kose et al., we were able to sufficiently weaken the intramedullary nail enough such that it straightened during extraction[10]. Gaubert et al. describe a third technique for open extraction. In their case, the nail angulation was at the inferior third of the tibial shaft. As such, the authors created a corticotomy flap in the distal tibia to free the distal segment of the intramedullary nail. Once freed, the authors were able to successfully remove the intramedullary nail in a retrograde fashion.[11]

All reported studies described cases where the fracture site and the area of nail deformation were superimposed atop 1 another, allowing for straightforward access to the intramedullary nail[7,9-11]. Unfortunately, in our case, the apex of deformity was found to be more proximal than the fracture site, preventing direct access to the deformed area of the intramedullary nail. Therefore, we created a cortical osteotomy exposing the intramedullary nail convexity, enough to remove a wedge from the intramedullary nail and allow for straightening of the nail during extraction.

When performing an open extraction, consideration must be given to prevent both thermal injury to surrounding tissue as well as contamination of the fracture site by metal debris. Previously documented methods include continuous and thorough irrigation to wash out metal debris and cool the cutting area or placing surgical gauze swabs surrounding the area to catch any metal debris[9,10]. We took similar preventative steps, while adding surgilube to facilitate greater collection of metal debris.

In summary, the extraction of a bent tibial intramedullary nail with significant angulation is imperative in the treatment of tibial shaft refractures. Consideration must be given to the nature of the deformity, the type and location of the injury, the characteristics of the intramedullary nail, as well as the tools available to the operating team. In rare instances such as ours, where the fracture site and location of deformation are misaligned, an osteotomy is a viable option to allow for adequate exposure of the apex of the curve. ■

Haad Arif, BS[1]
Steven Molina, BS[1]
Christopher LeBrun, MD[1,2]

[1]School of Medicine, University of California Riverside, Riverside, California

[2]Department of Orthopaedics, Riverside Community Hospital, Riverside, California

E-mail address for C. LeBrun: christopher.lebrun@arrowheadortho.com

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