Closed Management of a Bent Tibial Nail: Can Revision Be Avoided?

A Case Report

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Investigation performed at the Northeast Health Wangaratta, VIC, Australia

Abstract

Case: A 49-year-old gentleman sustained a closed, right tibia peri-implant fracture with a bent intramedullary nail. This resulted in a 17° valgus and 5° recurvatum deformity with fracture at the distal third of the tibial shaft. The patient underwent closed manipulation with an F-Tool and was reviewed by our unit over the following year.

Conclusion: This is the first case report of closed manipulation of a tibial fracture over a bent implant. This approach was successful in correcting deformity to within acceptable limits, achieved radiological union, and was associated with excellent patient-reported outcomes at all points of follow-up.

Tibial shaft fractures are the most common long bone fracture and are estimated to affect approximately 0.02% of the population annually. They most frequently occur in young men following a high-energy mechanism[1]. Restoration of function is usually achieved with reduction and intramedullary fixation[2]. Although rare, secondary injuries resulting in peri-implant fractures with bending of the tibial nail can occur[3]. We found only 10 cases in the literature, all of which were managed with removal and replacement of the intramedullary nail[3-12].

Revising a bent intramedullary nail can be difficult. If the nail cannot be removed from its index insertion site proximally, it may need to be bent or sectioned at the fracture site before removal. In rare cases, this may require tibial longitudinal corticotomy, which adds significant morbidity[13]. Open surgery at the fracture site impairs its blood supply, and revision increases the cost and risks of surgery, with a tibial nail valued over $ 700 USD at our institution. Revision could also introduce anterior knee pain if it was not already present.

When researching treatment options at the time of the patient presenting, we found no published evidence on the use of closed manipulation without exchange of the tibial nail for a peri-implant tibial fracture. Prior peri-implant fractures with bending of a tibiofemoral nail[14] and a distal radius volar plate[15] have been managed with closed manipulation alone and achieved good outcomes. Factors that guide the decision to proceed with closed manipulation in isolation include the patients' risk profile for open surgery, fracture pattern, and the anticipated reducibility of the fracture and implant in a closed fashion[14]. This article describes the first case in the published English literature of successful outcomes at 1 year after closed manipulation of a bent tibial intramedullary nail without implant exchange.

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

Case Report

A 49-year-old gentleman was presented to our center's emergency department in 2023 after sustaining a right tibia and fibula peri-implant fracture with associated bending of an intramedullary tibial nail in a skiing accident. He also sustained an ipsilateral minimally displaced posterolateral tibial plateau fracture. The patient had well-controlled type 1 diabetes mellitus (HbA1c = 6.6%), was a nonsmoker, and otherwise was an active individual who worked as a seafarer fisherman.

The patient had a closed injury, was neurovascularly intact, and demonstrated no clinical features of compartment syndrome. Radiological images demonstrated a minimally displaced lateral tibial plateau fracture, deformity of the intramedullary nail, and acute tibia and fibula fractures (Figs. 1 and 2).

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJSCC/C523).

Keywords tibial fractures/surgery; closed management; closed manipulation; closed reduction; trauma; bent implant; peri-implant fracture; fracture fixation; intramedullary/instrumentation; bone nails; humans; male

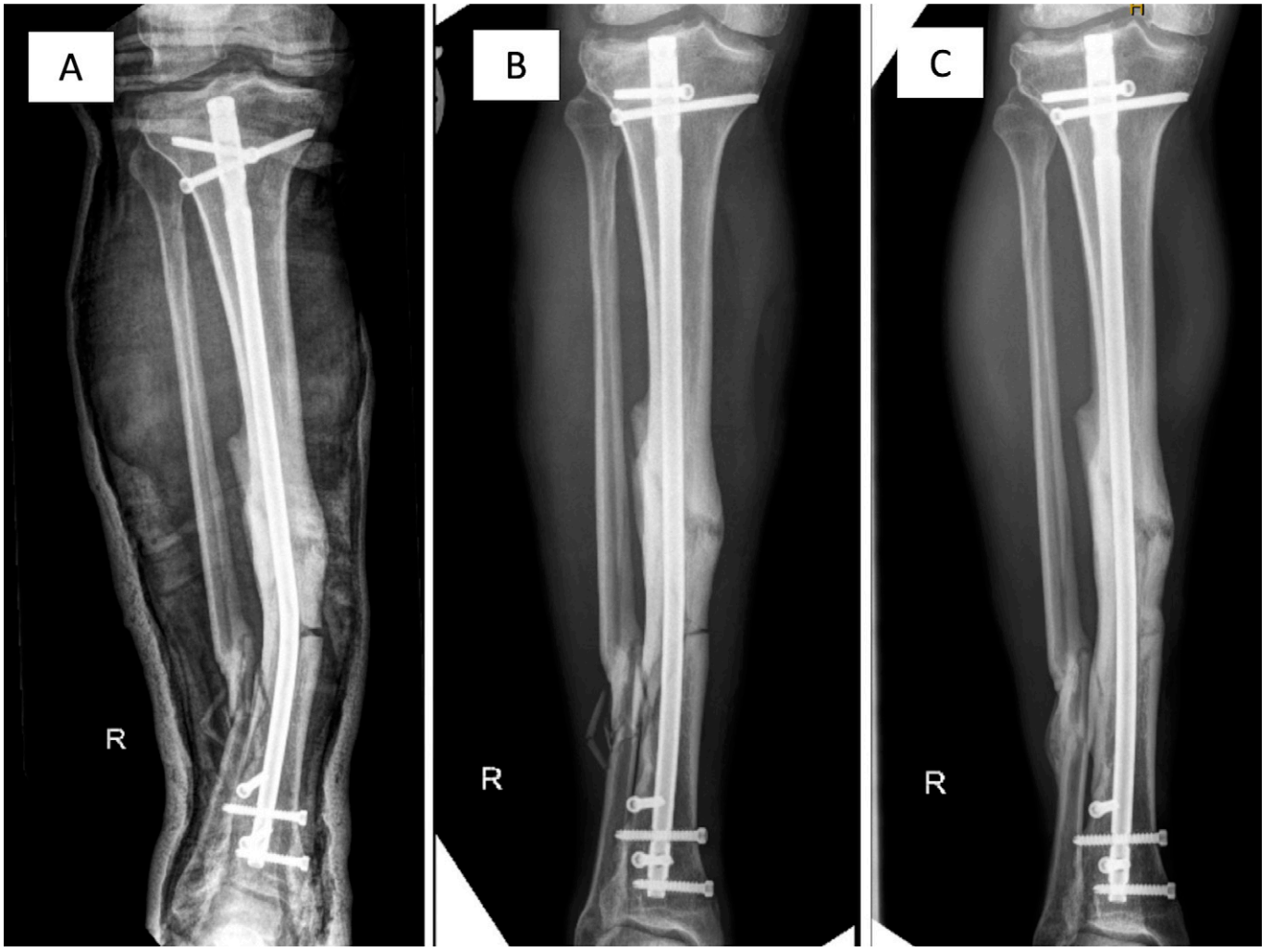

Fig. 1

Anteroposterior radiographs premanipulation (**Fig. 1-A**), day 1 postmanipulation (**Fig. 1-B**), and at 1 year postmanipulation (**Fig. 1-C**).

Previous Fracture Management

The patient had previously sustained a right tibial shaft fracture in another high speed (60 miles/hour) skiing accident in 2017 that had been managed with a 9 × 345 mm Stryker T2 (Stryker) Tibial Nail at our institution. Initial postoperative formal imaging demonstrated valgus malalignment, and the patient returned to theater for revision nailing with insertion of a poller screw 48 hours later. The patient returned to theater a third time, 48 hours after the second surgery for revision of the most distal cross bolt and insertion of a syndesmosis screw for diastasis and syndesmosis penetration noted on postoperative imaging. Radiological images of the injury and 1-year postoperative films following the 2017 injury are shown in Fig. 3. Despite the complicated initial course, the patient achieved an excellent functional outcome, returning to premorbid function and high-impact sporting activities (skiing and dirt biking) within 9 months. There was no interval imaging between the radiographs 1 year after nailing and refracture; however, computed tomography (CT) imaging at the time of refracture demonstrated new clean fracture surfaces suggesting union had occurred.

Management of the Peri-implant Fracture and Bent Intramedullary Nail

The patient was admitted to our hospital for intended surgery. As the patient was comfortable and internally splinted, he underwent surgery 6 days later when appropriate equipment could be arranged for a potentially difficult revision. A surgical plan had been devised for removal of the nail if closed manipulation alone was unable to yield a satisfactory outcome, including the ordering of a diamond-cutting burr to section the nail at the fracture site if required. Our experienced theater technician (Author M.R.) suggested using our padded F-Tool for the closed manipulation. This provided a fulcrum and long lever arm for controlled manipulation. The F-Tool is an aluminum metal and padded vinyl device custom made by a theater technician over 15 years ago on-site at our institution. The F-Tool is also commercially available from

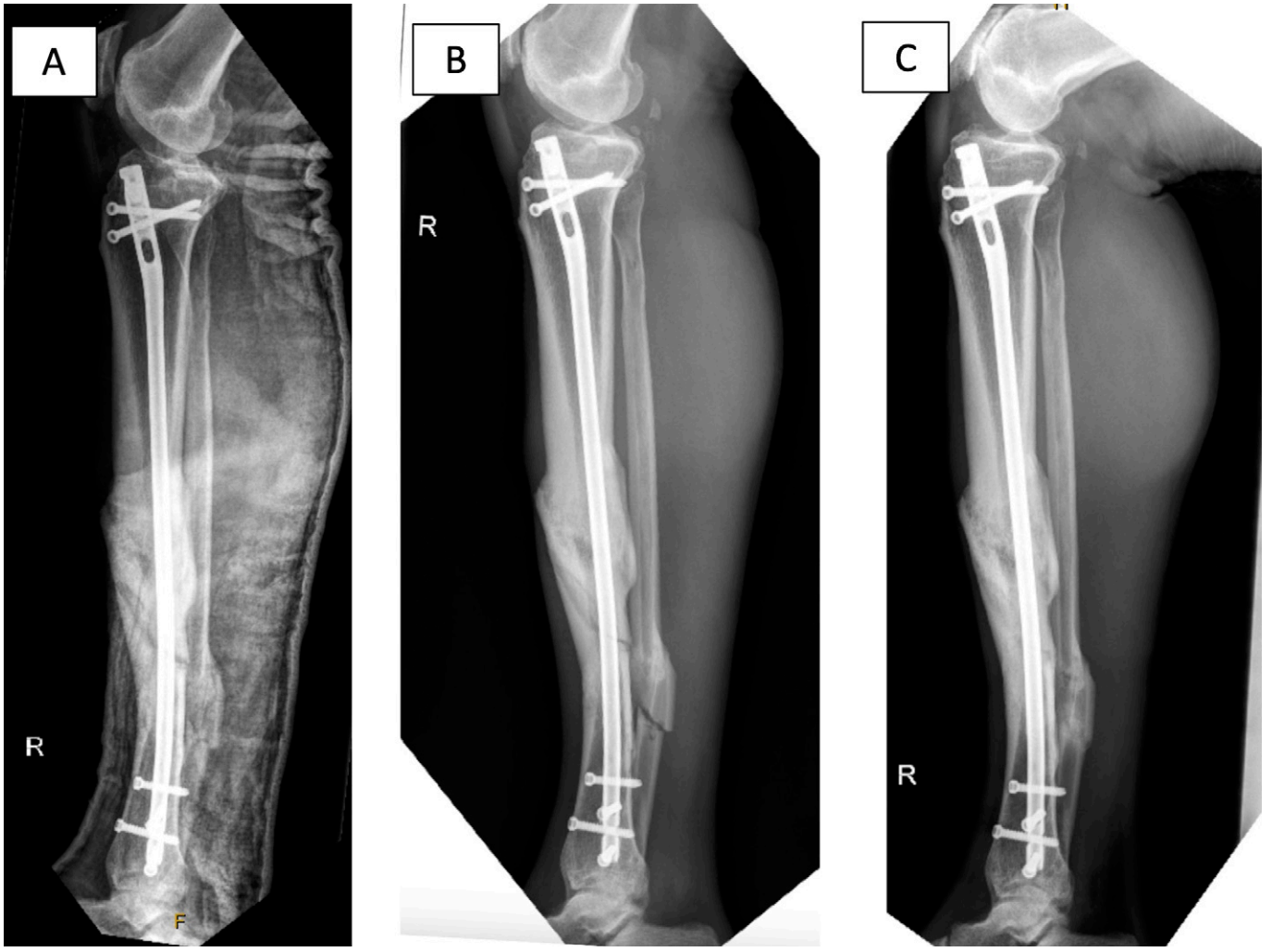

Fig. 2

Lateral radiographs premanipulation (**Fig. 2-A**), day 1 postmanipulation (**Fig. 2-B**), and at 1 year postmanipulation (**Fig. 2-C**).

other providers[16]. The specifics of the dimensions are detailed in Fig. 4.

The coronal, then the sagittal deformities were addressed in turn (Figs. 5-A and 5-B). Intraoperative radiograph was used to confirm reduction. Owing to concerns for the posterior neurovascular bundle and the smaller degree of deformity, the sagittal plane forces applied were less than those used in the coronal reduction. The tibial plateau fracture was managed nonoperatively due to the minimal fracture displacement and evidence of early degenerative joint disease.

A formal radiograph was obtained the following day. The patient was placed into an extension knee splint for 2 weeks and advised to remain non–weight-bearing for 6 weeks for the management of the ipsilateral tibial plateau fracture. He was provided aspirin for venous thromboembolism prophylaxis. Progressive loading through the right lower limb was allowed from 6 to 12 weeks postoperatively. At the 3-month review, the patient was fully weight-bearing on the right lower limb.

Outcomes

The radiographs premanipulation, day 1 postmanipulation, and 1 year postmanipulation are shown in Figs. 1 and 2. There was no rebound loss of the correction over time (Table I). There was no deformity seen on external inspection (Fig. 6).

The patient was clinically reviewed in our outpatient clinic 1-week postprocedure. He had minimal pain and was adhering to non–weight-bearing restrictions. Soft tissues were healthy, with some mild ecchymoses from contact with the F-Tool (Fig. 7). The patient was reviewed again at 6 weeks, 3 months, 6 months, and 1 year after surgery, and radiographs were performed to assess for union and deformity.

At 3 months, 6 months, and 1 year, quality-of-life outcomes were assessed with the EQ-5D-5L score[17,18]. Each domain is provided a score from 1 to 5, with 5 being the poorest quality of life and 1 being the best quality of life. The EQ Visual Analog Scale (VAS) provides a score from 1 to 100 for the individuals current health state, with 0 being the worst health imaginable, and 100 being the best health imaginable. Radiographs were assessed for union using the RUST

Fig. 3

Radiographs demonstrating the initial injury (**Fig. 3-A**) and postoperative radiographs (**Fig. 3-B**) at 1 year after initial tibial nailing.

score[19-21] (with fracture union defined as a score of 10–12), and the Johner and Wruhs Score[22] was used to assess the overall outcome (Poor/Fair/Good/Excellent) against complications, clinical and radiological deformity, mobility and pain, and gait and activity. These scores are widely used to assess outcomes after tibial shaft fractures[19]. These are presented in Table II.

Discussion

After failing to identify published evidence of previous closed treatment of a bent tibial nail with refracture, we felt it important to present our experience, so this may be considered by others in the future. We recognize that retention of an implant that has been straightened could result in fatigue failure of the construct. If nonunion or implant failure was to occur, requiring subsequent exchange of the nail, the physical dimensions of the canal may also be altered to the degree that simple exchange without corticotomy may prove difficult. Furthermore, in the absence of previously published cases of retaining a bent tibial nail, the risk of implant fatigue failure following this management option is unknown, which can make it difficult if counseling patients on the risk and benefits of retention vs. nail exchange. We acknowledge that the findings from this case cannot necessarily be extrapolated to other cases with different implants, degrees of deformity, or fracture patterns. Biomechanical information evaluating the degree of force required to deform intramedullary nails of varying width and material composition would be useful in determining which intramedullary nails could safely undergo closed manipulation. Of note, this patient was of a slim build, and their tibia was of an average adult length, measuring 40 cm.[23] Closed manipulation may not be feasible with the above method in those with shorter limbs, larger soft tissue envelopes, or fractures in more distal or proximal locations.

Despite the potential risks, closed manipulation for periimplant fractures over a tibial nail with retention of the nail is a feasible management option in certain situations and has the potential to yield excellent outcomes without the morbidity and cost of revision. The use of the F-Tool could also prove a useful adjunct before revision to straighten the nail before removal. In this case, the patient reported excellent functional outcomes as early as 3 months postoperatively and demonstrated radiological union by 1 year. It is a cost-effective option,

Fig. 4

Photograph of the F-Tool used for manipulation (**Fig. 4-B**) and its size relative to the theater technician M.R. (**Fig. 4-A**). Dimensions of the F-Tool: a = 90 cm; b = 28 cm; c = 7 cm; d = 26 cm (adjustable).

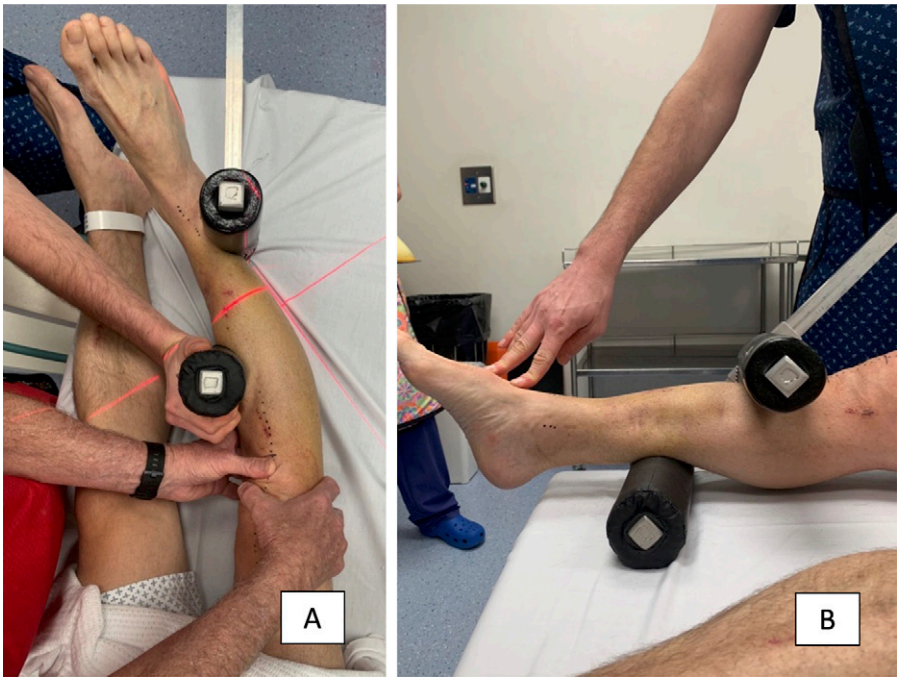

Fig. 5

Intraoperative photographs showing the coronal (**Fig. 5-A**) and sagittal (**Fig. 5-B**) manipulation maneuvers.

TABLE I Deformity of the Intramedullary Tibial Nail (°)

Time Point	Coronal	Sagittal
Postindex nail	0	0
Post refracture	17 (valgus)	5 (recurvatum)
Day 1 postmanipulation	4 (valgus)	3 (recurvatum)
1 year postmanipulation	4 (valgus)	3 (recurvatum)

Fig. 6

Clinical photographs demonstrating the anterior (**Fig. 6-A**), lateral (**Fig. 6-B**), and posterior (**Fig. 6-C**) leg at 6 months postmanipulation.

Fig. 7

Clinical photographs 1 week postoperatively.

TABLE II Quality of Life, Function, Complications, and Radiographical Outcomes

Time Point	Johner and Wruhs Score	RUST Score	EQ-5D-5L Score	
3 months		7	Mobility	1
Complications	Excellent		Self-care	1
Deformity	Excellent		Activity	1
Mobility	Excellent		Pain	1
Pain, gait, and activity	Excellent		Anxiety	1
			VAS	90
6 months		8	Mobility	1
Complications	Excellent		Self-care	1
Deformity	Excellent		Activity	1
Mobility	Excellent		Pain	1
Pain, gait, and activity	Excellent		Anxiety	1
			VAS	96
1 year		10	Mobility	1
Complications	Excellent		Self-care	1
Deformity	Excellent		Activity	1
Mobility	Excellent		Pain	1
Pain, gait, and activity	Excellent		Anxiety	1
			VAS	99

VAS = Visual Analog Scale.

particularly for regions with limited health care resources, and should be considered in similar cases before proceeding to revision. ■

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