Use of the F-Tool for the Removal of a Bent Intramedullary Femoral Nail With a Sagittal Plane Deformity

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Use of the F-Tool for the Removal of a Bent Intramedullary Femoral Nail With a Sagittal Plane Deformity

MICHAEL J. HEFFERNAN, MD; WALTER LECLAIR, MD; XINNING LI, MD

abstract

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Locked intramedullary nailing is the current standard of treatment for femoral shaft fractures and has low complication rates. Bent femoral intramedullary nails resulting from secondary trauma are rare and technically challenging. This article describes a case of a 36-year-old man who presented with a bent femoral intramedullary nail following a motorcross accident. The patient had a previous femoral shaft fracture treated with an intramedullary nail. Previous reports outlined methods to remove bent femoral nails through the fracture site and proximally; however, this article describes a novel technique combining the use of a Midas Rex MR7 high-speed burr (Medtronic, Minneapolis, Minnesota) and the F-Tool (Synthes, West Chester, Pennsylvania) to facilitate nail extraction.

The patient was placed in the lateral decubitus position. After limited exposure at the fracture site, the intramedullary nail was weakened at the apex of the deformity with a Midas Rex MR7 high-speed burr. We then used the F-Tool to straighten the nail to facilitate removal through the original proximal insertion site. The F-Tool allows forces to be concentrated at the apex of the deformity and minimizes soft tissue damage. Additional advantages of our technique include limited exposure and the ability to remove the nail in 1 piece.

Figure: Photograph of the F-Tool (Synthes, West Chester, Pennsylvania) being used at the apex of the deformity to straighten the bent intramedullary nail after partial sectioning with the Midas Rex MR7 high-speed burr (Medtronic, Minneapolis, Minnesota).

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Drs Heffernan, Leclair, and Li have no relevant financial relationships to disclose.

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Several surgical options exist for the management of diaphyseal femoral shaft fractures; however, intramedullary nailing has consistently led to a high fracture union rate, with a low incidence of complications.[1,2] Intramedullary nailing is considered the gold standard for the treatment of closed diaphyseal femoral shaft fractures. Complications of intramedullary nailing include malunion, nonunion, malrotation, infection, and hip or knee pain depending on the site of nail insertion.[3,4] Refracture of the femoral shaft due to secondary trauma around a stable intramedullary nail with subsequent nail bending has been reported in the literature.[5-16] Some authors describe the technique of opening the femur at the fracture site, sectioning the nail, and removing the proximal and distal nails through the fracture site.[10,12,16] Other techniques include straightening the bent intramedullary nail in the coronal plane with the perineal post[11] or using a percutaneous technique,[6] a fish hook technique,[5] or a combination of these techniques.[8,11,13,14,17-19]

A review of the literature regarding bent femoral intramedullary nail extraction indicated that the majority of treatments were for coronal plane deformities, with the most common deformity being in the apex-lateral direction.[7] These reports typically involve weakening of the intramedullary nail, then using the perineal post to manually straighten and extract the nail. However, the perineal post may not provide enough counter force to straighten a bent intramedullary nail.

This article describes a novel technique using a combination of a Midas Rex MR7 high-speed burr (Medtronic, Minneapolis, Minnesota) and the F-Tool (Synthes, West Chester, Pennsylvania) to facilitate the extraction of a bent intramedullary femoral nail. This was performed in a patient who sustained a femoral fracture around a previously placed intramedullary femoral nail that resulted in significant sagittal plane apex-anterior deformity. This article will help orthopedic surgeons who are confronted with this complication after intramedullary nailing. The patient consented for this case to be reported.

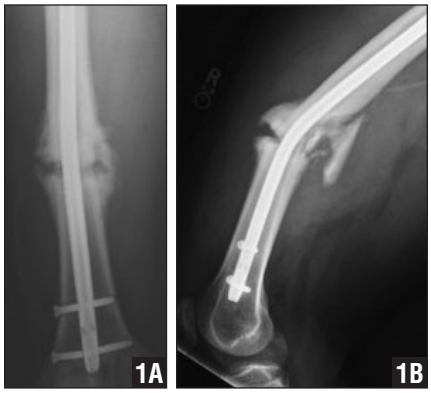

Figure 1: Preoperative anteroposterior (A) and lateral (B) radiographs revealing an apex-anterior deformity around a bent femoral intramedullary nail.

Case Report

A 36-year-old man presented after being in a motocross accident. On initial evaluation, the patient was hemodynamically stable, with a Glascow Coma Score of 15. He reported right leg pain but no motor function loss or numbness. No other associated pain existed in the bilateral upper extremities or the left lower extremity. The patient's medical history included a femoral fracture, which had been treated with an intramedullary nail (Synthes) at another hospital approximately 4 months previously. He had recently returned to full activities of daily living. On physical examination, the patient's skin was intact and had a significant deformity of the right thigh. He had full motor and sensation on the right lower extremity distal to the injury site. Anteroposterior and lateral radiographs were obtained (Figure 1). The femoral fracture was classified as AO/OTA 32-B2 type with apex-anterior angulations of 33° in the sagittal plane and 7° apex-lateral angulations in the coronal plane.

The patient was placed in the lateral decubitus position. A lateral approach to the femur was undertaken at the level of the fracture site. When the fracture site was exposed, tissue from the callus and a swab sample were sent for culture to rule out infection. An osteotome was used to open the previous fracture site to further expose the bent nail at the apex of the deformity (Figure 2). A Midas Rex MR7 high-speed burr was used to partially section the bent femoral nail at the apex. We started on the convex (anterior) side of the apex and worked posteriorly, leaving a thin remnant of metal at the posterior aspect of the nail. Continuous irrigation and suction was performed during this step of the procedure. The F-Tool was used to manually straighten the bent intramedullary nail (Figure 3), which was confirmed with intraoperative fluoroscopy (Figure 4). The distal and proximal locking screws were also removed using a percutaneous technique. The Winquest III Universal Intramedullary Nail Extraction System (Synthes) was attached to the proximal aspect of the nail, and extraction was performed with no difficulty (Figure 5). The proximal entry hole from the previous surgery was located and reused for the anterograde insertion of a T2 Femoral Nail (Stryker, Mahwah, New Jersey) measuring 13×380 mm.

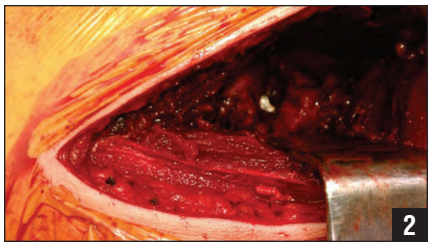

Figure 2: Intraoperative picture showing the intramedullary nail after sectioning with the Midex Rex MR7 high-speed burr (Medtronic, Minneapolis, Minnesota) at the deformity.

Figure 3: Photograph of the F-Tool (Synthes, West Chester, Pennsylvania) being used at the apex of the deformity to straighten the bent intramedullary nail after partial sectioning with the Midas Rex MR7 high-speed burr (Medtronic, Minneapolis, Minnesota).

The patient tolerated the procedure well and was made weight bearing as tolerated

postoperatively. He had no complications during his postoperative hospitalization course and was discharged.

At 4-month follow-up, he was pain free and fully weight bearing on his right lower extremity. Anteroposterior and lateral radiographs demonstrated callous formation at the fracture site, and the patient was permitted to perform all activities of daily living as tolerated.

Discussion

Intramedullary nailing is the standard method of treatment for closed diaphyseal long-bone femoral shaft fractures. Results in the literature have shown up to 98% union rates, with few complications.[1,2] Known complications of antegrade femoral nailing include neuropraxia associated with traction, angular or rotational malalignment, heterotopic ossification, hip pain, refracture, malunion, nonunions, and implant complications.[3] Broken implants, especially involving locking bolts, are relatively common, and removal techniques have been described.[9,14,20] Due to the relative rarity of bent intramedullary nails secondary to trauma, only case reports are found in the literature addressing the treatment options. In the current article, we highlight a novel technique of the combined use of a Midas Rex MR7 high-speed burr and the F-Tool to facilitate the removal of a bent intramedullary femoral nail.

The essential components for the successful extraction of a bent femoral intramedullary nail include weakening of the nail at the apex of the deformity and manually straightening the nail to facilitate removal. A Midas Rex MR7 high-speed burr with diamond cutting head was used to section the nail at the apex of the deformity until a small wall of metal remained (Figure 3). Other authors have also supported the use of a Midas Rex MR7 high-speed burr to weaken the nail; however, care must be taken to irrigate and suction while drilling to reduce heat and facilitate metal debris removal.[7,10] Other techniques have also been described, including making drill holes in the nail,[21] using a trochar and 3.5-mm drill bit to perforate the nail at the apex of deformity,[6] and using a pin cutter.[12] Although using a drill bit can be an attractive alternative option, it can be difficult to place and stabilize the drill bit or trochar on the apex of deformity. Other than weakening the nail, several authors reported complete sectioning of the nail and extraction of the proximal and distal segments.[10,12] Nicholson et al[10] used a Midas Rex MR7 high-speed burr to section the intramedullary nail, and removal of the distal segment was performed via the femoral incision while the proximal segment was removed from the original trochanteric insertion site. Singh et al[12] used a pin cutter to section the intramedullary nail, then the proximal and distal segments were removed from the original femoral incision site. To remove the sectioned nail through the femoral incision, more dissection and manipulation of the soft tissue is required, especially with the removal of the distal segment.

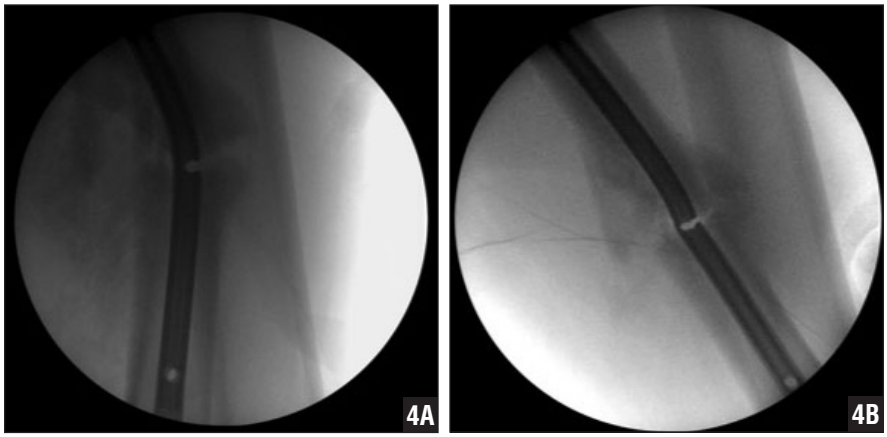

Figure 4: Intraoperative imaging showing the partial sectioning of the femoral nail with the Midas Rex high-speed burr (Medtronic, Minneapolis, Minnesota) and subsequent straightened nail following use of the F-Tool (Synthes, West Chester, Pennsylvania).

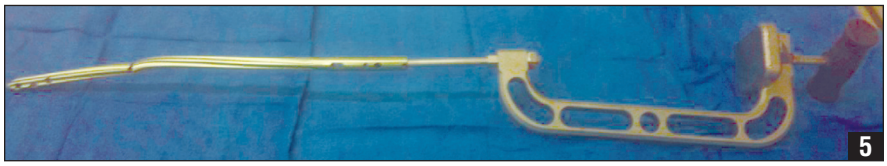

Figure 5: Photograph of the Winquest III Universal Intramedullary Extraction System (Synthes, West Chester, Pennsylvania) used to remove the femoral nail after straightening.

The second component of extracting a bent intramedullary nail is straightening the nail through a manual technique or with the use of assistive devices. We used the F-Tool to facilitate straightening the nail. The F-Tool allows focused forces to be concentrated at the apex of the deformity to generate significant force while minimizing damage to the local soft tissues. Other techniques have also been described, including the perineal post[7,11] and compression plate with bone-holding forceps[22] to facilitate reduction. These techniques are an alternative to removing bent nails; however, the perineal post may not provide enough counter force, whereas compression plating results in significant soft tissue dissection. Because the deformity in our patient was in the sagittal plane, we put the patient in the lateral position to allow better access for placement of the F-Tool at the apex of the deformity. Banerjee and Posner[7] also supported putting the patient in the lateral position when the deformity is in the sagittal plane. They partially sectioned the nail, and reduction was performed with the perineal post. The Table presents the other reported cases on removal of a bent intramedullary nail.

Table

Previously Described Techniques for Bent Intramedullary Nail Removal

Author	Implant	Deformity	Reduction Method	Outcome
Patterson & Ramser[11]	Russell-Taylor Femoral IM nail	30° varus angulation (coronal)	Closed reduction using perineal post as fulcrum	Reamed exchange nailing, fracture union
Banerjee & Posner[7]	Femoral IM nail	30° apex anterior (sagittal)	Anterior approach, high-speed burr to partially section off nail, perineal post	No complication
Sonanis et al[13]	Femoral IM nail	30° varus angulation (coronal)	Lateral approach, high-speed burr to partially section off nail, perineal post	No complication
Ohtsuka et al[21]	Femoral IM nail	28° varus angulation (coronal)	Lateral approach, drill to partially section nail, manual reduction	Reamed exchange nailing, fracture union
Apivatthakakul & Chiewchantanakit[6]	Kuntscher Femoral IM Nail	35° varus angulation (coronal)	Percutaneous, locking bolt trocar to introduce drill for partial sectioning of nail, manual reduction	Exchange IM Nail, no follow-up data
Nicholson et al[10]	Grosse and Kempf femoral IM nail	42° varus angulation (coronal)	High speed burr to fully section nail, distal portion removed through fx site	Exchange IM Nail, no follow-up data
Singh et al[12]	Kuntscher femoral IM nail	35° apex anterior (sagittal)	Jumbo pin cutters used to section nail, which was removed in 2 pieces through the fx site	Compression plating and bone graft, no follow-up data

Abbreviations: fx, fracture; IM, intramedullary.

CONCLUSION

Our technique of partial nail sectioning with a high-speed burr followed by the use of the F-Tool to straighten the nail is a simple, effective method to remove a bent femoral intramedullary nail. Advantages include limited dissection around the fracture site, removal of the nail in 1 piece, and localizing the force required at the apex of deformity to minimize soft tissue damage.

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