

Case Report

Sequential manual manipulation technique of closed reduction to retrieve a bent femoral intramedullary nail: a case report

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ABSTRACT

A bent intramedullary nail in femur can be extremely difficult to extract when a patient presents after a secondary episode of trauma following the original episode for which nailing was done. These bent nails require utmost precision while extracting them, to prevent injury to the surrounding soft tissues and neurovascular bundle of the limb. We encountered a particularly rare case of a bent Kuntscher nail who presented to us nearly 20 years (post his primary surgery in 2001) after sustaining a secondary trauma. There was a 29-degree bend in the antero-posterior view and a 106-degree procurvatum bend in the k nail on the lateral view. We followed a technique of sequential manual manipulation under radiographic guidance to correct the acute bend of the nail, taking care not to create any additional fractures. Following nail extraction, the fracture was fixed with an interlocking nail and went on to unite uneventfully. At 3-year follow up, patient was walking pain free and exhibited a good knee range of motion.

Keywords: Bent intramedullary nail, Exchange nailing, Kuntscher nail

INTRODUCTION

K-nails were introduced for the first time during the Second World War by Gerhard Kuntscher who revolutionized the management of shaft of femur fractures in the 20th century. He is known as the father of intramedullary nailing as he popularized his concept of 'Marrow Nailing' which laid the foundation of modern intramedullary nail designs.¹⁻³ The cloverleaf design of the nail provided stability, based on the principle of three-point fixation.²

These nails were indicated for isthmic shaft of femur fractures since the nail could provide reasonable stability when it fits the isthmus snugly.^{2,3} Although K-nails were instrumental in improving the management of shaft of femur fractures, they also had their pit falls.^{4,5} They lacked the interlocking design (used in most of the modern nails),

rendering them rotationally unstable leading to a possibility of malunion. Another potential disadvantage of using K-nails was their inability to resist torsional forces as compared to the conventional interlocking nails.³⁻⁵ Since these K-nails aren't as tough as their modern interlocking nail counterparts, they can break or bend within the medullary canal of the bone (when subjected to another trauma), making it technically difficult to extract these nails.^{6,7} However, a bent k-nail is more challenging to remove than a broken one due to the difficulty in navigating through the acute bend.⁷

Extraction of such a bent nail poses distinct challenges that frequently necessitate specialized methods and a comprehensive set of instrumentation for nail extraction.⁷⁻⁹ We encountered a particularly rare case of a bent Kuntscher nail leading to an acute fracture of femoral diaphysis (distal to the previously united fracture).

CASE REPORT

A 63-year-old male presented to our trauma emergency with the chief complaints of pain in the right lower limb and an inability to bear weight on the right side for 2 days. We elicited a history of fall from stairs (at his home) following which he developed a procurvatum and a varus deformity in his right thigh (Figure 1A & B).

On clinical examination, there was no distal neurovascular deficit in the involved extremity. After the initial resuscitation and pain relief, he was subjected to orthogonal radiographs of his right thigh with hip and knee, which revealed a peri-implant fracture of the right femur along with an acute bend in the Kuntscher nail.



Figure 1: Clinical depiction of the varus (A) and Procurvatum (B) deformity; pre-operative radiographs (C-E) demonstrating the bent K-nail (with a deformity) and a fracture distal to the old united fracture.

There was a 29-degree varus bend in the antero-posterior view and a 106-degree procurvatum bend in the k nail on the lateral view (Figure 1C- E). The K-nail was used to fix his right shaft of femur fracture in 2001, followed by unrestricted return to activities of daily living. We recommended a revision intramedullary nailing for this patient with the possible of adding an autologous bone graft. A written informed consent was taken from the patient, thoroughly explaining the possibility of complications such as post-operative neurovascular injury; an additional intra-operative fracture; and requirement of breaking the K-nail to remove it if we couldn't retrieve it otherwise.

Intra-operative details

The patient was placed supine on the operating table, under the effect of regional anesthesia. After confirmation of the

level of anesthesia, we gave an attempt of manual manipulation to correct the deformity. Since it was a varus and procurvatum deformity, we applied valgus and extension forces to the distal fragment in an attempt to counteract the forces.

To explain this further, one assistant applied downward force to the distal aspect of the proximal fragment (just proximal to the apex of the deformity) and the other assistant used his hand to lift the distal fragment and gave a valgus force to correct the coronal plane deformity.

Utmost care was taken to ensure not to cause any additional fracture of the distal femur or the neck of femur. We took serial intra-operative radiographs after every 5-10 degrees of visible correction of the deformity. Finally, we were able to achieve near complete correction of the deformity (Figure 2A) which was also confirmed by orthogonal intra-operative radiographs (Figure 2B, C). After a successful correction of the deformity, we positioned the patient on a traction table and removed the K-nail with an extractor (Figure 2D & E). The hook of the extractor was placed in the proximal eye of the nail.¹

Following K-nail removal, the fracture was subjected to closed reduction and sequential reaming of the intramedullary canal done over a beaded guide wire. Finally, we inserted a wide diameter nail (12 mm) after confirming fracture reduction on intra-operative radiographs. The limb rotation was checked prior to distal and proximal locking with interlocking bolts, followed by wound closure in layers. There was no distal neurovascular deficit on post-operative examination. Our patient was subjected to post-operative radiographs on the 2nd day after surgery (Figure 3).

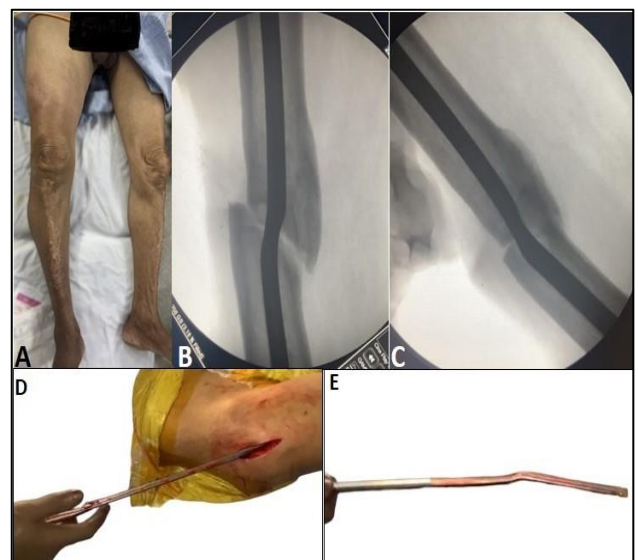


Figure 2: Visible correction of the right thigh deformity (A) after manual manipulation; intra-operative radiograph (B & C) confirming near complete straightening of the K-nail bend. Images depicting K-nail extraction (D & E).



Figure 3 (A-D): Immediate AP and lateral post-operative radiographs.



Figure 4 (A and B): Orthogonal radiographs of the right thigh depicting fracture union.



Figure 5: (A) Painless unassisted gait and (B) 0-150-degree knee range of motion at 3-year follow-up.

Outcome & follow-up

Our patient was discharged on the 4th post-operative day following wound inspection & gait training on a walking aid. He was kept on 1 monthly follow-up basis after suture removal. We encouraged independent walking (without the aid), two weeks after the surgery. We achieved sound fracture union with a florid callus formation at 5 months post-surgery (Figure 4). At our latest follow-up (3 years post-surgery), his knee range of motion was 0-150 degree and was walking pain free with an unassisted gait (Figure 5).

DISCUSSION

In today's Orthopedics, K-nails are seldom used, but modern-day surgeons can face a challenge while extracting these old nails.^{7,10,11} Nail removal procedures may be required in patients presenting with pain or degenerative joint disease necessitating Arthroplasty or any other surgical intervention which requires an intramedullary access.¹² It is crucial to understand the biomechanical properties of a K-nail in order to plan an effective extraction of an incarcerated or bent nail, without causing much harm to the host bone.⁵

The presence of a longitudinal slot throughout the length of the K-nail imparts elastic compressibility to the nail but also makes it more malleable to deforming forces since this longitudinal slot converts the nail into an open cylinder making it potentially weaker than modern interlocking nail designs.^{1-5,13}

It was hypothesized by Kuntscher that the closed longitudinal slot (during nail insertion) would open up once the nail reaches the isthmus, hence imparting biomechanical stability by virtue of its elastic compressibility.¹⁻³ Another drawback of this longitudinal slot is the fact that host bone can grow inside the nail through it, making nail extraction extremely challenging with an added risk of creating an iatrogenic fracture during nail removal.

Till date, a diverse range of extraction methods have been described for bent intramedullary nails, such as in-situ straightening; straightening over a 4.5 mm dynamic compression plate; using metal drill bits to break the nail at the apex from the convex side; hacksaw blade to cut the nail into two parts.¹⁴⁻¹⁷ Patterson et al were the first ones to report in-situ straightening of a Russell-taylor nail on a perineal post of the operating table.¹⁷ Neimpoog et al, 'extracted a bent intramedullary nail in femur by exaggerating the varus deformity to create a 'V' shaped angulation of the nail, followed by placement of a hook from the broken lateral cortex (at the apex of the deformity) to remove the nail.¹⁸

Nicolaides et al reported a case of 85 degrees bend in the thigh-nail complex of a patient which was associated with impending acute limb ischemia but was urgently managed

with a formal lateral surgical approach to the thigh to break the nail into two parts following which limb vascularity improved immediately.¹⁹

Dunleavy et al conducted a systematic review to evaluate different extraction techniques for bent intramedullary nails and their associated injuries.⁸ They concluded that most cases of bent nails required a limited surgical approach to access the cortex overlying the convex apex of the bend to split the nail (at the apex) essentially leading to a 'closing wedge' osteotomy of the distorted nail while retaining sufficient metal to allow plastic deformation of the remaining concave section, followed by extraction with the conventional methods.

The precise basis of our manual manipulation technique is the plastic deformation of the K nail, which allows gradual straightening upon application of an external force.^{2,3} This technique allows the surgeon to decrease patient morbidity since an open reduction is avoided. Another advantage is the avoidance of using metal drill bits and saw blades which are used to break the nail when in-situ straightening of the nail is unsuccessful. The use of drill bits creates a lot of metal debris which can contaminate the surrounding muscles and the periosteum.^{7,8,11}

CONCLUSION

To the best of our knowledge, this is the only case in which a clinical deformity of more than 90 degrees has been corrected by in-situ straightening or manual manipulation to extract a bent intramedullary nail. This was a good case to learn about the importance of a closed reduction (in-situ manipulation) technique to straighten a bent intramedullary nail.

The authors would like to advocate that a trial of closed manipulation should be given to every such case before proceeding for a formal open reduction and internal fixation (ORIF) which is a more invasive procedure and increases morbidity for the patient. We would like to conclude that each case of a bent nail should be treated as a unique one and there is no 'one size fits all' approach for such a challenging case in orthopedics. Each patient requires a careful pre-operative planning, along with availability of all the armamentarium required to extract the nail if the planned procedures fail.

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