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A Novel Surgical Technique for the Extraction of a Broken, Incarcerated Intramedullary Reamer

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Abstract

The breakage of intramedullary implants and instruments is a rare but challenging surgical complication. Traditional retrieval methods, such as invasive osteotomy or specialized kits, are associated with increased morbidity and may not be universally available. We present the technical description of a surgical method, based on a case of a 30-year-old male patient with a broken, cannulated, intramedullary reamer in a fractured femur. The technique involves creating a distal entry point in the intercondylar notch, passing the plain end of a ball-tipped guide wire retrograde sequentially through the reamer's cannulation, the fracture site, the proximal fracture segment, and the piriformis fossa using a T-handle to push the reamer out of the proximal surgical wound. The described technique resulted in the successful and complete removal of the broken reamer. The procedure was performed without the need for a cortical osteotomy, effectively leveraging the reamer's cannulation and avoiding a more invasive approach, preventing the loss of fracture hematoma. This novel retrograde technique is a safe and effective alternative for extracting broken, cannulated, intramedullary instrumentation. The core principles of this technique may be extrapolated to manage similar unexpected complications in other long bone fracture surgeries. This case highlights the value of adaptable, non-invasive solutions to complex intra-operative challenges.

Categories: Trauma, Orthopedics
Keywords: broken nail, broken reamer, fracture-related complications, intramedullary nailing, retrograde

Introduction

The breakage of intramedullary instrumentation during an ongoing surgery is an uncommon but serious complication in orthopedic surgery. The resulting fragments can become firmly incarcerated within the medullary canal, presenting a significant challenge for surgeons. Existing retrieval methods such as invasive osteotomy or reliance on specialized, often unavailable, extraction kits have considerable drawbacks [1-4]. The removal of such broken instruments and implants can be extremely challenging and time-consuming. The technique described here offers a novel and reproducible alternative to previously described methods of removing a cannulated, broken reamer. This article describes a novel, retrograde extraction technique developed to manage a broken flexible reamer in the femur.

Technical Report

This report describes a novel surgical technique based on the successful management of a 30-year-old male naval sailor who presented with a closed mid-diaphyseal femur fracture (AO/Classification 32-B2) while he was on leave. The patient underwent antegrade intramedullary nailing on the fracture table attachment of a standard orthopedic table. Due to the accidental non-sterilization of the ball-tipped guide wire by an operative assistant, it was decided to perform the procedure using a plain-tipped guide wire. The ball-tipped wire was immediately sent for autoclaving. The plain-tipped guide wire was passed across the fracture site, and careful, sequential reaming was performed in 0.5 mm increments over a plain-tipped guide wire. Unfortunately, the flexible reamer of 10 mm diameter fractured around 5 cm proximal to the distal tip of the reamer and became incarcerated in the distal femoral fragment (around 15 cm proximal to the knee joint). Figure *1* shows the fluoroscopic view and the annotated schematic representation of the description.

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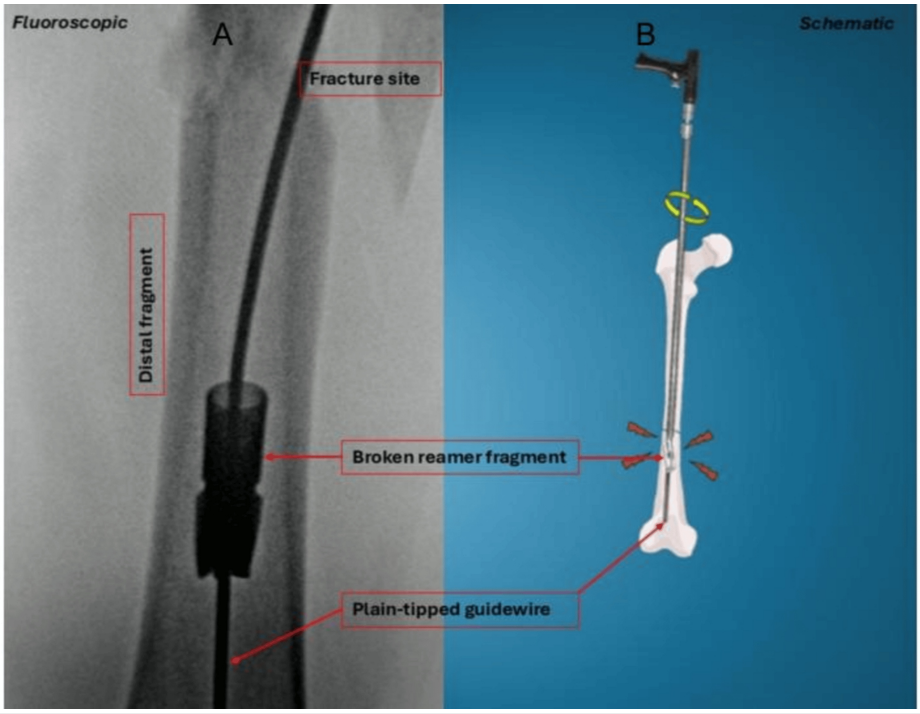


FIGURE 1: Fluoroscopic view (A) of the broken reamer over the plain-tipped guide wire in the distal femoral fragment along with the annotated schematic illustration (B).

Schematic illustration created using Microsoft PowerPoint (Microsoft Corporation, Redmond, USA)

The surgical team advocated an improvised and ingenious technique for its extraction, which is described as follows. The original plain guide wire was withdrawn and placed with the cannulation of the incarcerated reamer fragment. The knee was flexed to 30 degrees after releasing the traction, but the limb was not removed from the traction attachment. A small, suprapatellar skin incision was made, and an awl was used to create a direct entry point into the intercondylar notch of the distal femoral fragment, almost one centimeter anterior to the PCL insertion under fluoroscopic guidance, aligned with the axis of the distal femur fracture fragment as shown in Figure *2*.

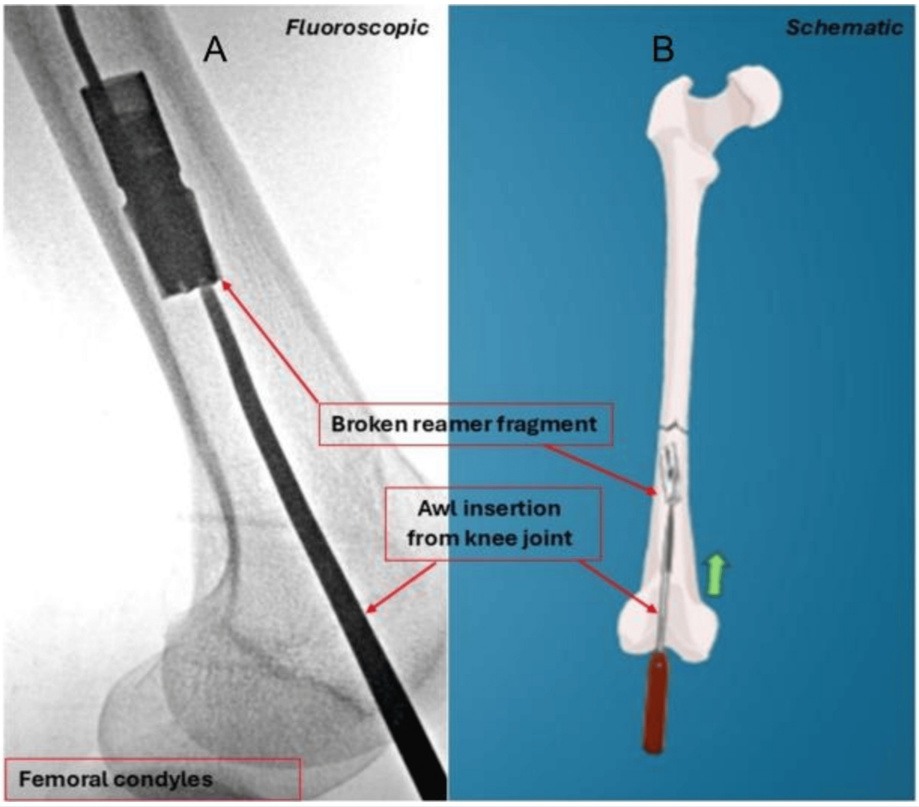


FIGURE 2: Fluoroscopic view (A) of awl insertion from the inter-condylar notch into the distal tip of the broken reamer along with the annotated schematic illustration (B).

Schematic illustration created using Microsoft PowerPoint (Microsoft Corporation, Redmond, USA)

A freshly autoclaved, sterile, ball-tipped guide wire was inserted retrograde, plain-tip first, through this new entry point. The wire was carefully advanced through the cannulation of the broken reamer under fluoroscopic guidance and then across the fracture site into the proximal fracture fragment, eventually exiting the original proximal surgical incision through the piriformis fossa. A T-handle was attached to the exposed proximal end of the guide wire. The broken reamer was then carefully hammered in a retrograde fashion along the path of the guide wire. The ball-tip of the guide wire provided a stable, low-friction surface for the impact, ensuring the reamer was pushed out smoothly as shown in Figures *3*, *4*.

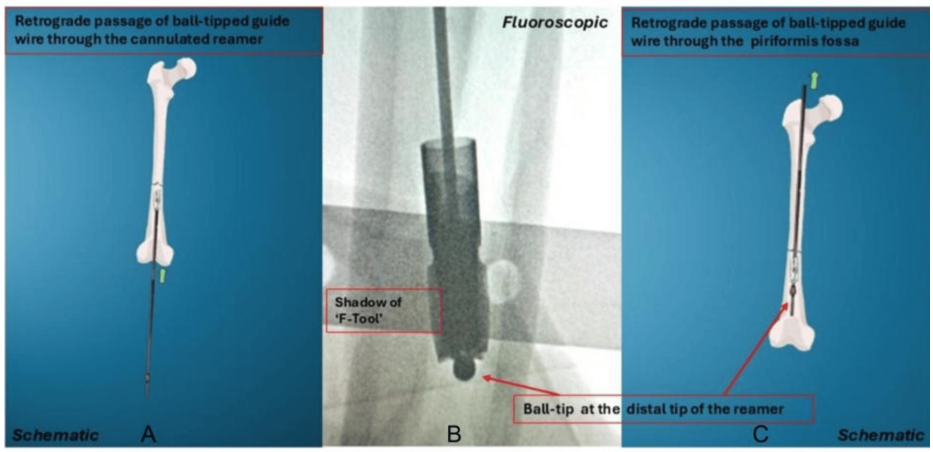


FIGURE 3: Schematic representation (A) of retrograde insertion of the ball-tip guide wire, fluoroscopic view (B) of the ball-tipped guide wire abutting the distal tip of the broken reamer at the fracture site, with the F-Tool visible in the background and its schematic representation (C) (from left to right).

Schematic illustrations created using Microsoft PowerPoint (Microsoft Corporation, Redmond, USA)

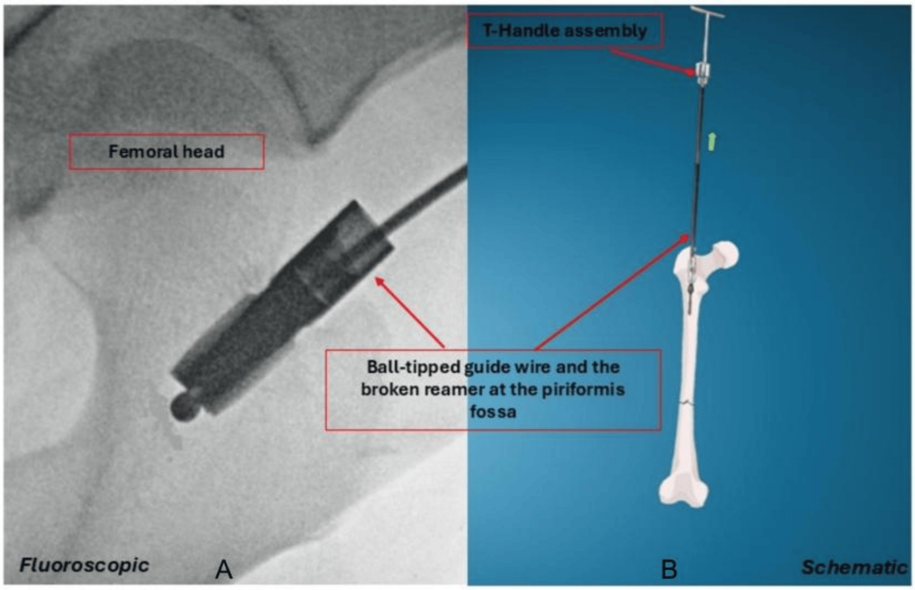


FIGURE 4: Fluoroscopic view (A) of the reamer and ball-tipped guide assembly in the proximal fragment near the piriformis fossa and the annotated schematic illustration (B).

Schematic illustration created using Microsoft PowerPoint (Microsoft Corporation, Redmond, USA)

The extracted broken reamer assembly, as shown in Figure *5*, demonstrates that the broken reamer fragment was removed completely, and further imaging done during the procedure ensured no retained metal fragments.

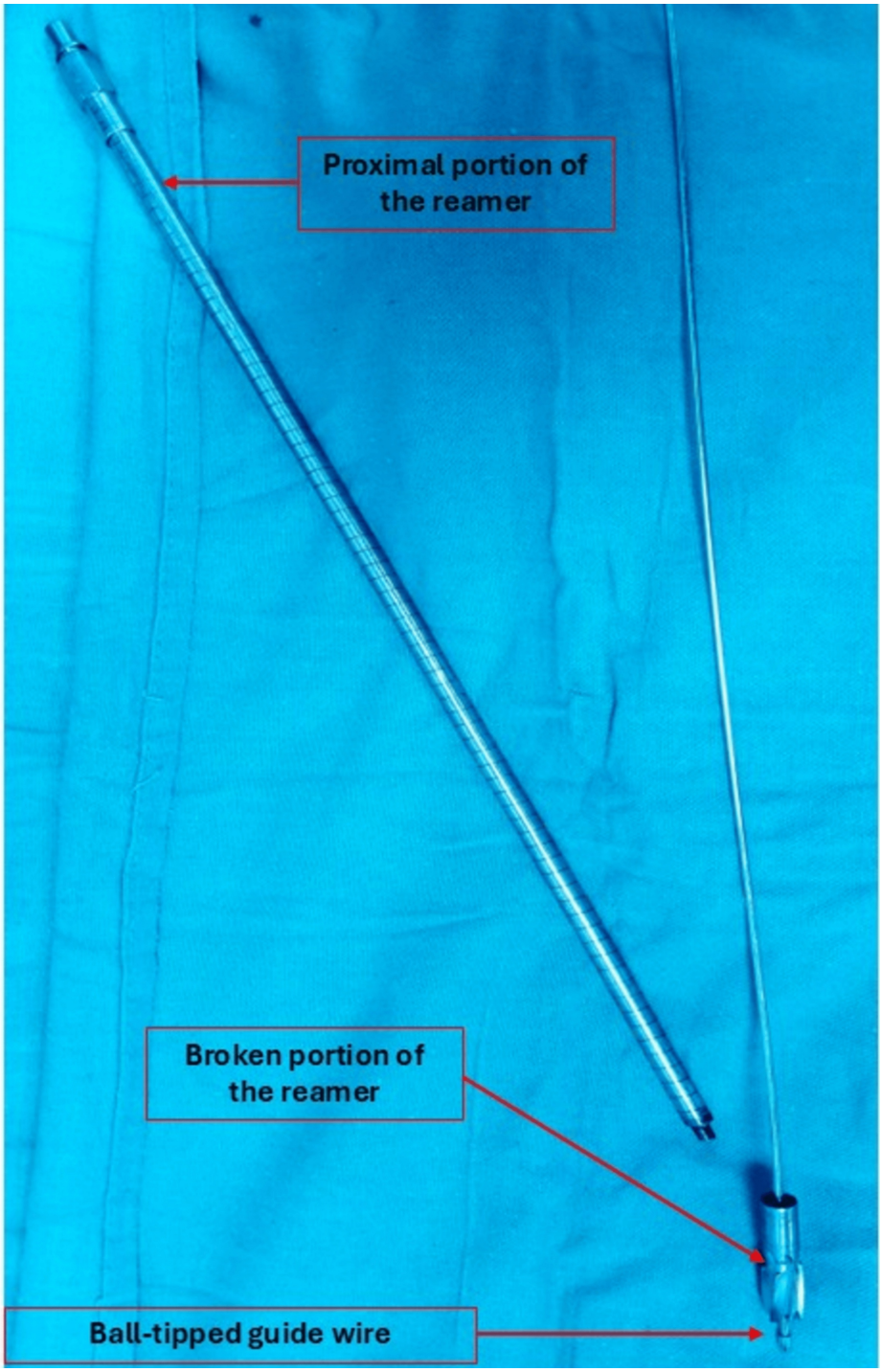


FIGURE 5: The extracted complete reamer with the ball-tipped guide wire.

Following the successful removal of the reamer, the ball-tipped guide wire was re-inserted across the fracture site in an antegrade fashion. Further reaming and nail insertion were carried out uneventfully. The entire nailing procedure took 180 minutes. The patient was allowed immediate, partial weight bearing using axillary crutches and was encouraged to perform range of movement of the knee as per tolerance. The fracture healed completely as shown in the radiograph (Figure *6*), and the patient is asymptomatic one year after the surgery. The X-ray also demonstrates no retained metal fragments of the reamer. Due to the migratory nature of his profession (Naval sailor), further clinical and radiological follow-up could not be carried out. The institutional ethical committee clearance and the patient's consent were obtained. No statistical analysis was carried out since this is a description of a single case.

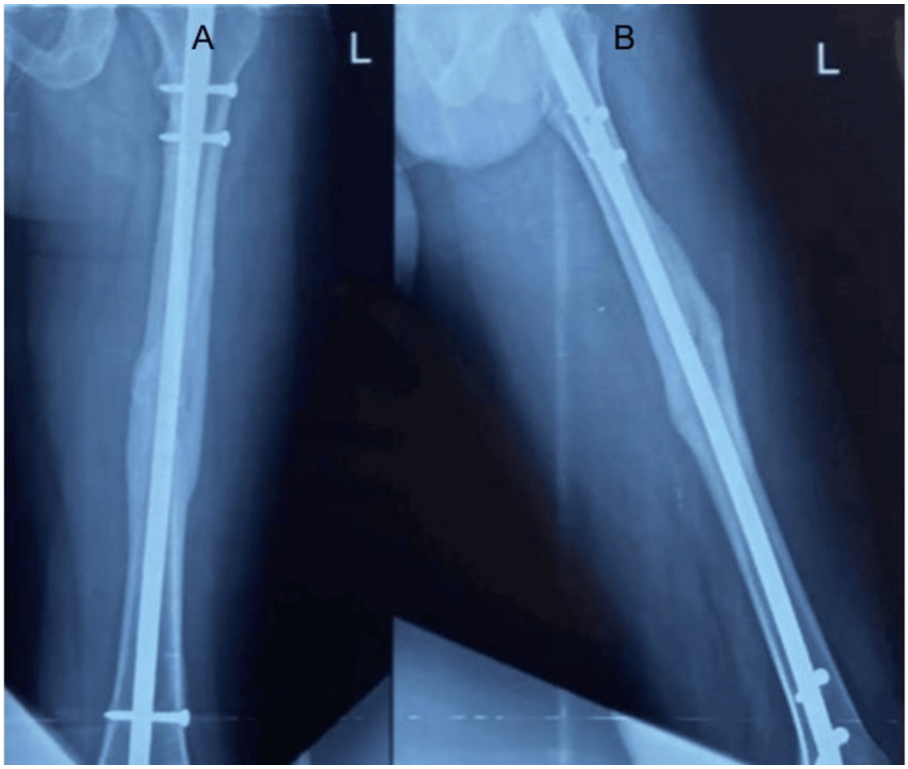


FIGURE 6: AP (A) and lateral (B) view plain radiographs representing complete fracture union without any retained metal fragments.

Discussion

The retrieval of a broken intramedullary instrument or implant is a significant intraoperative challenge in orthopedic surgery. The technique described in this report-using a retrograde ball-tipped guide wire and a T-handle to push a broken, cannulated instrument proximally from a new distal entry point-presents a practical intraoperative solution when standard antegrade retrieval fails. A review of the literature reveals several techniques used for similar complications, each with its own advantages and limitations. Many traditional antegrade methods, performed from the original proximal entry point, often involve specialized instruments designed to grasp, hook, or engage the broken instrument fragment. The AO group has described "The Hook and Grasper" technique, which includes over-reaming the medullary canal and using a long extraction hook to remove the broken fragment [5]. Other surgeons have reported using laparoscopic graspers, modified reaming guides, multiple guide wires, or a jumbo cutter to grip the reamer for extraction [6-9]. Bisbinas et al. described the use of a Küntscher nail inserted from the piriformis fossa to push a broken reamer out distally from the knee joint during total knee replacement [10]. Darowish and Gorczyca created a cortical window in the proximal tibial metaphysis to remove the reamer and associated particles [1]. Low et al. drilled corticotomy holes adjacent to the reamer head to decompress the medullary canal [2], and Jlidi et al. similarly used a corticotomy to remove trapped bone fragments and extract the broken reamer [3]. Londhe et al. performed a linear osteotomy in the distal tibial fragment and pushed the reamer out in a retrograde manner [4]. Kwak et al. opened the fracture site and used a guide wire in a retrograde manner to pull out the reamer [11], while Chloros et al. utilized a ball-tipped guide wire, curettes, graspers, and a nail extraction hook [12].

Additionally, Metikala and Mohammed previously described the use of a retrograde ball-tipped guide wire primarily for removal of a broken nail in an elective revision setting [13]. Unlike planned revision procedures or specialized techniques requiring pre-prepared equipment, the method described here represents a spontaneous, quick "on-table" decision executed immediately upon encountering an acute, unanticipated intraoperative reamer fracture and jamming during index fixation. This technique offers several potential advantages. It provides a less invasive option compared to extensive cortical windows or osteotomies, which can increase surgical time, blood loss, and the risk of stress fractures or nonunion. The technique requires no specialized extraction instruments, utilizing standard, readily available orthopedic hardware (a retrograde guide wire and T-handle). It avoids opening the primary fracture site, thereby preserving the osteogenic fracture hematoma. It avoids the need to over-ream the medullary canal along a new trajectory to accommodate hooks or graspers. The creation of a distal entry point in the intercondylar notch using an awl is a well-established entry technique routinely utilized in retrograde femoral nailing and knee arthroplasty. However, surgeons must remain aware that this technique introduces its own unique anatomical and procedural risks that require careful management. An intra-articular, transcondylar entry carries inherent

risks to the articular cartilage, the intercondylar notch, and the knee joint itself, including the potential for post-operative hemarthrosis or joint infection. Furthermore, retrograde driving of an incarcerated, jammed reamer across the fracture site carries potential risks of displacing fracture fragments, causing iatrogenic cortical fractures, or leaving metallic and bone debris within the medullary canal or joint space. To mitigate these risks, the retrograde push must be performed gently under continuous fluoroscopic guidance, followed by thorough irrigation of the joint space and meticulous fluoroscopic and visual inspection to ensure no retained debris or new cortical compromised areas remain. While this approach served as an effective intraoperative rescue in our case, further clinical evaluation is necessary to fully determine its comparative safety and efficacy against other retrieval techniques. An analysis of this complication offers a crucial educational takeaway regarding instrument selection and intraoperative safety. The primary reason for this failure was the initial lapse in sterilization protocol, substituting a ball-tipped guide wire with a plain-tipped alternative. Ball-tipped guide wires are designed to align within the center of the medullary canal to prevent eccentric reaming and prevent the reamer head from wandering or jamming against cortical irregularities. Utilizing a plain-tipped wire removes this centralizing safeguard, increasing the risk of the reamer catching, binding, and undergoing catastrophic fatigue failure under torsional loads. Surgeons must remain vigilant against compromising on fundamental equipment standards under pressure. However, when unforeseen equipment discrepancies or human errors inevitably occur in the operating room, the situation also highlights the critical necessity of surgical adaptability and resourcefulness. Rather than panicking or resorting to highly morbid, extensive approaches, recognizing the root cause and rapidly pivoting to an innovative, on-table rescue strategy such as the retrograde retrieval technique described here allows the surgeon to successfully manage complex intraoperative hardware failures while preserving patient safety and local bone biology. Nevertheless, the fundamental principle-using a retrograde ball-tipped guide wire and a T-handle to retrieve a broken cannulated instrument/implant proximally- may be potentially hypothesized for other long bones, with due respect to the local neurovascular structures and bone geometry, especially when antegrade methods fail, specialized equipment is unavailable, or preserving the local fracture biology is paramount. It underscores the importance of strict adherence to surgical sterility to avoid such catastrophic situations, quick surgical adaptability, decision-making, and resourcefulness when managing unexpected intraoperative hardware failure.

Conclusions

We have presented a successful case of a broken intramedullary reamer extraction using a novel retrograde technique. This method is a safe, effective, and minimally invasive alternative to traditional retrieval procedures. This method avoids the significant morbidity associated with traditional osteotomy-based approaches and does not require specialized, often unavailable, instruments. The technique's principles are generalizable, offering a valuable alternative for surgeons encountering similar complications with other cannulated, intramedullary instrumentation in various long bones. The technique has been described in a single case, and further evaluation of the same is required for validation of the same. This case highlights the importance of anticipating potential complications and having a plan for their management with readily available tools.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Vivek M. Philip, Narender Singh, Manish Prasad, Prasenjeet Singh

Acquisition, analysis, or interpretation of data: Vivek M. Philip, Narender Singh, Manish Prasad, Prasenjeet Singh, Rajiv Kaul

Drafting of the manuscript: Vivek M. Philip, Narender Singh, Manish Prasad, Prasenjeet Singh, Rajiv Kaul

Critical review of the manuscript for important intellectual content: Vivek M. Philip, Narender Singh, Manish Prasad, Prasenjeet Singh, Rajiv Kaul

Supervision: Vivek M. Philip, Narender Singh, Manish Prasad, Prasenjeet Singh, Rajiv Kaul

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. IEC: Army College of Medical Sciences, Delhi Cantonment issued approval 203/2025. **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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