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'Schanz Pin Extractor' Technique for Removal of a Broken Intramedullary Nail

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Abstract

Intramedullary nail removal is an uncommon but complicated procedure with significant surgical challenges, especially in the case of a broken nail. There are multiple cumbersome techniques for nail removal described that are frought with difficulty. We present a technique designed to take advantage of the difference in metallurgy of a stainless steel Schanz pin and a cannulated titanium intramedullary nail. We use a 5.0 mm self-tapping Schanz pin that is able to be drilled into the softer cannulated segment of titanium intramedullary nail designed to accomate a guide wire. Once drilled into the desired segment of nail, the distal interlock can be removed, and the Schanz pin can be connected to a T-shaped handle used as an extractor to pull out the nail.

Keywords: Extraction; Intramedullary; Nail Removal

Introduction

Intramedullary nailing continues to increase secondary to its biomechanical advantages and minimally invasive approach [1]. Although rare, complications such as infection, non-union, and broken intramedullary nails that necessitate removal pose significant surgical challenges [2-5]. To date, the published methods described in the literature for the removal of a broken femoral intramedullary nail are complex procedures and fraught with difficulties including long surgical time, implant-extraction device mismatch, patient morbidity, iatrogenic fracture, longer recovery times, and higher overall healthcare costs [6-11]. To our knowledge there is only one published case presentation that describes similar technique [12].

Current techniques for removing broken intramedullary nails include utilization of: diaphyseal osteotomy, stuffing the nail with guidwires, advancemenf of the nail, retrograde impaction of the broken segment, insertion of a extraction bar over a guide pin, bent tip guidewire, Harrington rod impactors, cerclage wires, reamers and k-wires [13-25]. The multitude and variety of these techniques suggest a general ineffectiveness and need for a technique that can simplify the extraction process, minimize surgical trauma, and enhance patient outcomes.

In response to these challenges, we propose a reproducible, efficient, minimally invasive, and cost effective strategy to extract broken or intact intramedullary nails utilizing a Schanz pin. This technique is designed to take advantage of the difference in metallurgy of a stainless steel Schanz pin and cannulated titanium intramedullary nails that are able to accommodate a guide pin [26]. The softer nature of the titanium nail allows the stainless steel Schanz pin to drill into the nail. The Schanz pin can then be fastened to a T-handle and be utilized as an extractor to remove the nail.

Technique

The most commonly utilized application for this technique in our experience is the removal of a broken antegrade intramedullary femoral nail. After removal of the antegrade nail we often address the nonunion with the placement of a lateral unicortical plate on the proximal femur [27]. For this reason we recommend this procedure be performed with the patient lateral decubitus on a bean bag on a radiolucent table and ensuring biplanar x-rays of the entire femur can be obtained prior to prepping and draping. If positioning the patient in the lateral decubitus position we recommend prepping the entire leg into the surgical field.

The procedure is initiated with the removal of the lag screw. This is performed under standard technique utilizing the prior lag screw incision, and inserting the threaded driver for the lag screw

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Figure 1: Proximal aspect of the broken intramedullary nail removed with conical extraction bolt.

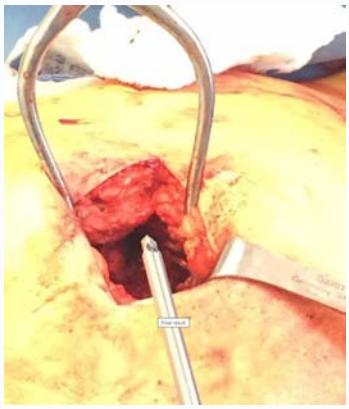

Figure 2: Introducing the Schanz pin into the intramedullary canal of the proximal femur and into the cannulated portion of the remaining intramedullary nail.

into the lateral aspect of the lag screw for removal. We then proceed with removal of the distal interlock screw. Once the distal interlock screw is removed we place either a pin or screwdriver through the interlock screw hole to prevent rotation of the nail.

Once the lag screw and distal interlock are removed we perform a standard lateral approach to the proximal femur including the most proximal incision from the initial insertion of the intramedullary nail. We make an incison in line with abductor tendon fibers as they insert onto the greater trochanter and place a self retaining retractor to visualize the proximal aspect of the nail. The proximal aspect of the broken nail can be removed utilizing a conical extraction bolt inserted into the proximal aspect of the nail with good interference fit (Figure 1). If the proximal broken nail fragment is free-floating or loosely adherent to the surrounding tissue may additionally be removed with a rongeur. If utilizing this technique to remove an intact intramedullary nail it is imperative that the set screw within the proximal nail is removed prior to the next step.

Through the split in the abductor tendons the 5.0 mm Schanz pin is placed on a T-handle and is introduced into the intramedullary canal of the femur and into the remaining cannulated portion of the femoral nail (Figure 2 and Figure 3). Placement of the Schanz pin into the cannulated distal portion of the remaining intramedullary nail can often be appreciated by tactile feel, however can be verified on intraoperative radiographs (Figure 4). It is imperative that an

Figure 3: Schanz pin is placed through the abductor tendon split into the intramedullary canal and cannulated portion of the remaining intramedullary nail.

Figure 4: Intraoperative visualization depicting Schanz pin placed into the cannulated portion of the remaining intramedullary nail.

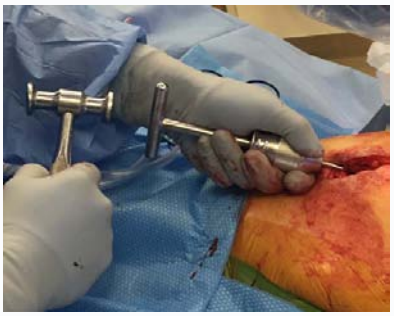

Figure 5: To assist seating and engagement of the Schanz pin into the remaining intramedullary nail gentle mallet blows can be provided to the T-handle fastened to the pin. It is imperative at this point that a pin or screwdriver is placed through the distal interlock site of the nail. Alternatively, if there is no available interlock option in the broken segement of nail being removed to prevent migration, a k-wire may be placed percutaneously at the contralateral end of the broken nail that the Schanz pin is being introduced into.

assistant hold either the pin or screwdriver within the distal interlock hole of the intramedullary nail to prevent rotation and advancement of the nail at the step. The Schanz pin can continue to be advanced into the intramedullary nail, as the self-drilling and self-tapping occurs there is often an audible engagement of the stainless steel Schanz pin into the nail. To assist proper seating and engagement of the Schanz pin into the remaining intramedullary nail gentle mallet blows can be provided on the T-handle (Figure 5). Once adequate purchase is obtained with the Schanz pin within the intramedullary nail, it is imperative that the chosen object within the distal interlock site of the intramedullary nail is removed prior to any attempts at removing the distal aspect of the broken intramedullary nail. Once the distal

Figure 6: Depiction of the Schanz pin engaged into the remaining intramedullary nail being removed through the initial entry site of the antegrade femoral nail.

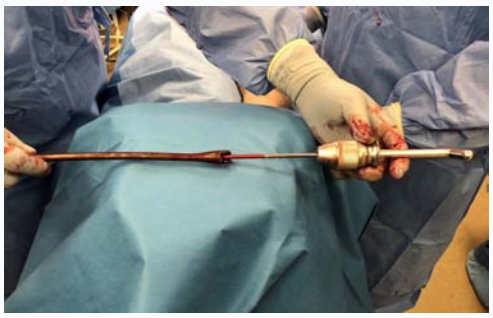

Figure 7: The attachment of the T-handle, Schanz pin, and distal intramedullary nail completes the formation of the Schanz pin extractor device.

interlock site is free of any object resisting rotation and extraction, the T-handle can then be malletted retrograde to extract the distal aspect of the broken intramedullary nail through the original entry site (Figure 6). The attachment of the T-handle, Schanz pin, and distal intramedullary nail completes the formation of the Schanz pin extractor device (Figure 7). This completes the intramedullary nail removal.

Case

58-year-old male with a past medical history significant for type 2 diabetes, end-stage kidney disease on peritoneal dialysis, and Parkinson's disease presented to our emergency department after a fall from standing. The patient sustained a left subtrochanteric femur fracture and underwent closed reduction and long intramedullary nailing of the left subtrochanteric femur fracture within 24 hours (Figure 8). Patient's postoperative course was complicated by a prolonged admission secondary to encephalopathy as well as complications with dialysis. Upon discharge the patient was lost to follow up.

The patient sustained a fall 8 months postoperative and presented to the emergency department. Radiographs were obtained demonstrating abundant callus about the patient's fracture site, unchanged alignment of the hardware, and he appeared to have achieved radiographic union of his fracture at this time (Figure 9). Additionally the patient reported that he was ambulating without assistive device at this time.

Six weeks after the radiographs demonstrated in figure 9 the patient presented to the emergency department with worsening

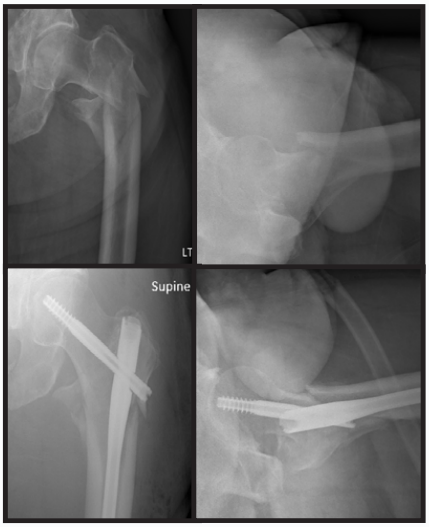

Figure 8: Demonstrates the patient after he sustained a subtrochanteric femur fracture that was treated with closed reduction and long intramedullary nailing.

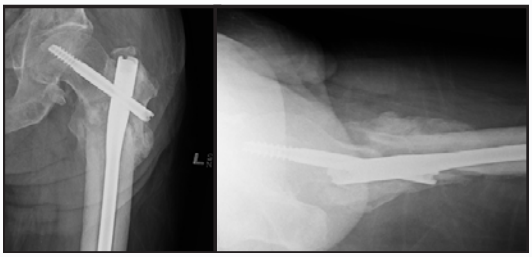

Figure 9: The patient radiographs 8 months postop.

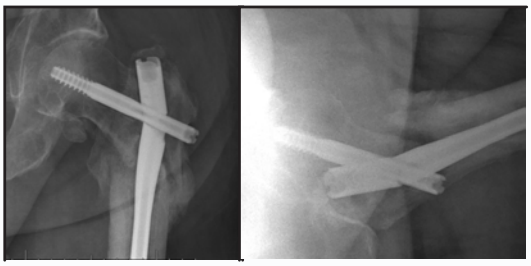

Figure 10: Radiographs demonstrating hardware failure and nonunion at the fracture site.

atraumatic left hip pain. Radiographs were obtained demonstrating fracture of the intramedullary hardware at the lag screw-nail interface (Figure 10). The patient went onto receive a hip aspiration confirming no evidence of the infection. After medical optimization the patient received hardware removal of the left femur utilizing the technique described above. Additionally the patient received a debridement of the nonunion site, bone marrow aspiration from iliac crest for stem cell harvest, impaction of cancellous allograft bone chips at the nonunion site in the prior lag screw site. To restore the neck shaft alignment and prevent varus collapse we placed a lateral 3.5 mm plate. We then proceeded with intramedullary nailing. Of note, the nail that was removed was 10 mm in diameter and we elected to place a 11 mm diameter nail. Final radiographs are depicted in figure 11. The patient was made weight-bearing as tolerated postoperatively,

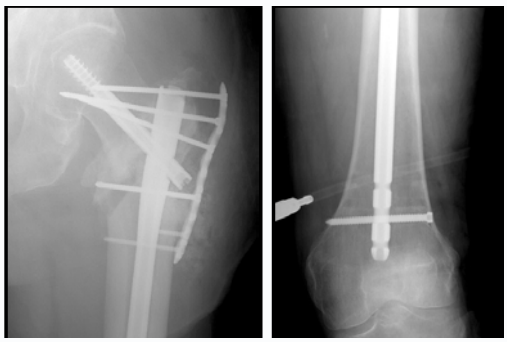

Figure 11: Post-operative Imaging.

underwent an uncomplicated postoperative course. The patient was discharged postoperative day 9 to a subacute nursing facility.

Discussion

With improvements in the management of medical cormorbidities, there is an expected increase in usage of intramedullary nails in a medically complex aging population [1]. Current reported nonunion rates and surgical site infection rates for femoral shaft fractures are 4.7-7.5% and 11.8%, respectively [2-4]. Additionally, Hui et al found that ligants had the highest incidence of intramedullary nail removal [5]. Considering this, there is a need for the development and implementation of a reproducible, efficient, minimally invasive, and cost effective strategy to extract broken or intact femoral intramedullary nails. Our study sought to address the limitations inherent in traditional removal methods, which are often complicated by technical challenges and increased patient morbidity [6-7]. The results of our investigation suggest that this technique offers several notable advantages over conventional practices and we would like to further promote this technique.

Yuan et al identified and a biomechanical investigation that all intramedullary implants undergo plastic deformation during implantation and extraction, giving legitimate evidence as to the source of the difficulty for nail removal [8]. Current methods for nail removal typically involve either the use of specialized extraction tools or open surgical techniques; some include femoral osteotomy, stuffing the nail with guidwires, advancemenf of the nail, insertion of a extraction bar over a guide pin, bent tip guidewire, Harrington rod impactors, cerclage wires, reamers and k-wires [13-25]. While effective, these methods can be associated with prolonged surgical times, higher risks of iatrogenic injury, and longer recovery periods [6-7].

The technique decribed in this article and by Mauras et al. integrates simple, common instruments that utilize a minimally invasive technique, simimilar to that of intramedullary nail implantation. Additionaly, this technique also may be utilized in cases where there is no available distal interlock by placing a k-wire to prevent further migation of the nail while placing the Schanz pin [28].

Utilization of a 5.0 mm stainless steel Schanz pin to self-drill and self-tap into the softer titanium cannulated portion of the intramedullary nail allows excellent fixation to the retained hardware. The Schanz pin and then be fastened to any number of extraction devices, we recommend a T-handle as it was readily accessible. The attachment of the T-handle, Schanz pin, and distal intramedullary nail completes the formation of the Schanz pin extractor device. This allowed for easy extraction of the retained intramedullary nail. Although this technique describes utilization of the Schanz pin to remove antegrade intramedullary nails, this technique is used by attending physicians at our hospital to remove other intramedullary nails including retrograde femur nails and tibial nails. The reproducibility, efficiency, and minimally invasive aspect of the described is widely he was advised by physicians within our system for intramedullary nail removal, including the pediatric population.

Conclusions

In conclusion, our technique for the removal of broken femoral intramedullary nails represents a meaningful advancement in orthopedic surgery. By addressing the limitations of traditional methods and improving both procedural efficiency and patient outcomes, Schanz pin extractor device holds the potential to significantly enhance the management of complex femur fracture nonunion and hardware failure.

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