SCFE Screw Removal with Coring Reamer

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Abstract: In situ percutaneous pinning of a Slipped Capital Femoral Epiphysis (SCFE) is a safe and effective surgical treatment to prevent deformity progression in children.[1] Contemporary implant options include cannulated fully and partially threaded screws available in stainless steel or titanium. Routine implant removal is controversial, yet some surgeons attempt removal to reduce risk of fracture associated with an increased stress riser, screw irritation, or in preparation for future hip procedures.[2,3,4] Difficulty with hardware removal is well documented in SCFE patients.[4–8] In this article, we describe our technical tips for removal of a stuck 7.3-millimeter cannulated cancellous SCFE screw in a patient who required surgical treatment for chronic symptomatic SCFE deformities. We describe screw removal failure that ultimately required over reaming with a 10mm coring reamer to retrieve the screw. A written and video technical guide is provided for evaluating the opportunities and obstacles of how similar cases can be addressed with success.

Key Points:

- SCFE screw removal is inherently difficult.
- Preoperative planning and the expectation for challenges should be discussed with the surgical team as well as the patient and family.
- Use of a coring reamer to remove the screw and surrounding bone en bloc is a viable option.
- Bone graft can augment the final defect.

Introduction

Slipped Capital Femoral Epiphysis (SCFE) is a disorder of adolescents with open femoral head physes resulting in posteromedial displacement of the femoral epiphysis relative to the femoral neck metaphysis. The deformity can lead to abnormal hip mechanics and places these children at risk of needing future secondary hip surgeries. This problem has a predilection for obese males and is classified based on acuity and stability.[9] Early in situ percutaneous pinning of a SCFE provides resistance to shear forces along the plane of the slip and prevents deformity progression in children.[1] Today, fully and partially threaded cannulated screws (titanium or stainless steel) are the predominant method of fixation.[5,10]

After closure of the physis, routine implant removal following termination of growth around puberty is controversial. Leaving hardware in place may result in fractures in young adults secondary to stress risers and difficulty with future arthroplasty.[2,11,12] On the other hand, implant removal requires a second planned operation, with an increased surgical exposure and risk of fractures at the time and after implant removal.[2,8,11] It is recommended that asymptomatic SCFE implants

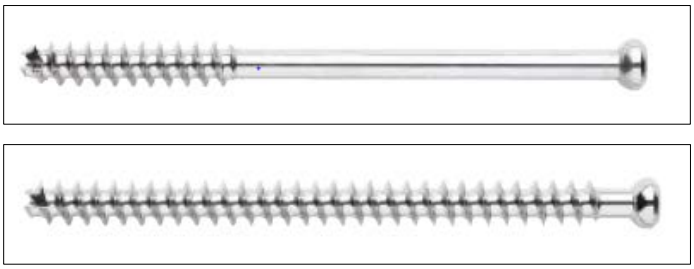

Figure 1. *Partially threaded (top) and fully threaded (bottom) cannulated screws*

should not be removed unless they are responsible for pain or prominence.[13]

Implants placed for SCFE are notoriously difficult to remove, with a complication rate of 34%, with some authors reporting rates as high as 61% and 83% with older implant models.[14–16] The factors behind difficult screw removal is often attributed to metal composition (titanium vs. stainless steel) and thread length (partially vs. fully threaded, see Figure 1).[17,18] Stainless steel screws have been the preferred choice for many years, as titanium screws have osseointegration and thus require more torque to remove.[2,5,18] Partially threaded screws may have some benefits as they can potentially compress the growth plate or at least allow the growth plate to compress with weight-bearing. Yet partially threaded screws require additional torque to remove due to bone growth behind the threads.[2,7]

Recent studies suggest stainless steel fully threaded screws as the preferred SCFE hardware due to ease of removal.[2,7,11,18] When straightforward screw reversal fails due to an inaccessible screw head, stripped screws, or inadequate torque with a socket or vice grips, successful techniques include over-reaming, "easy out" conical screw extraction and parallel planes screw reconstruction.[2,5,7,11,19]

In this manuscript, we provide a technical guide for our solution to the problem of a lodged partially threaded stainless steel screw as well as an overview of current techniques and guidelines for decision-making prior to implant retrieval.

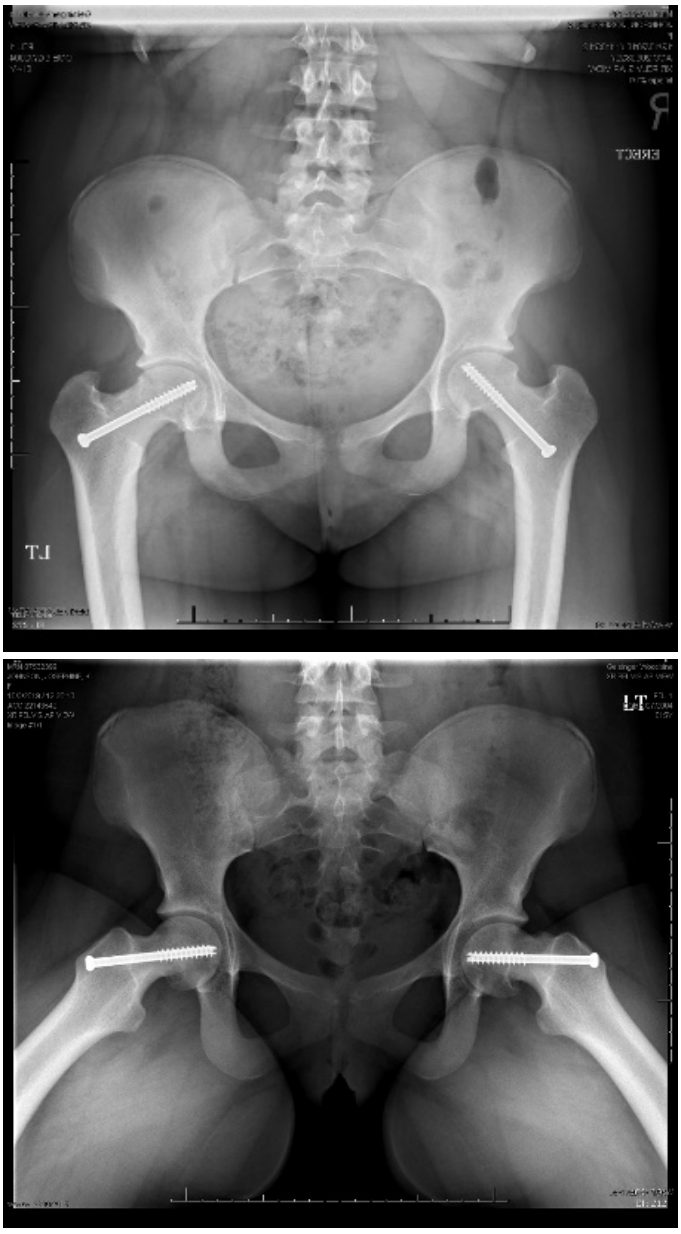

Figure 2. *Preoperative AP pelvis (top) and Frog leg lateral (bottom) radiographs demonstrating bilateral partially threaded SCFE screws.*

Description of the Method

Case Details: A 15-year-old female underwent pinning for a SCFE 38 months prior. She presented with chronic symptomatic hip impingement and was indicated for surgical hip dislocation, 7.3mm cannulated partially threaded screw removal, relative femoral neck lengthening via trochanteric osteotomy, and femoral

Figure 3. *Collared Guide Pin*

Figure 4. *Collared guide pin engaging cannulated screw*

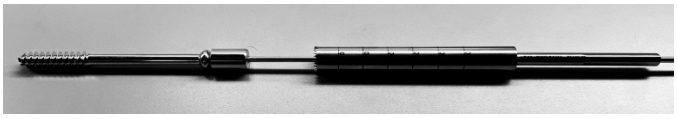

Figure 5. *Cannulated reamer seats over guidewire*

Figure 6. *Reamer at its final position at the level of the threads*

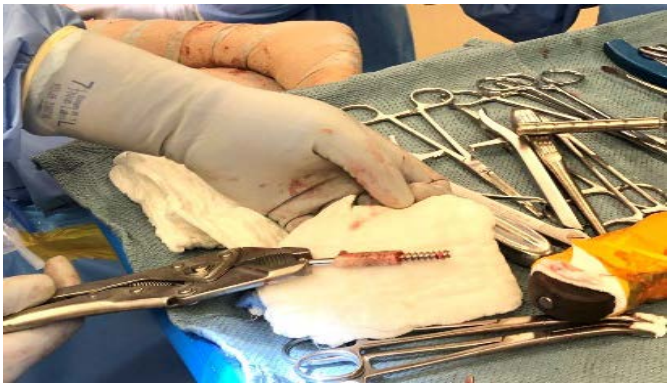

Figure 8. *Adhered collar of bone*

neck osteoplasty (Figure 2). After a large lateral exposure centered over the greater trochanter was performed, our attention was turned to removal of the previously implanted screw. Counterclockwise movement of the screw was halted by rapidly increasing resistance, necessitating creative alternative attempts at removal. Traditional retrieval methods, including an increased lever arm with vice grips failed. Ultimately, the screw drive failed in a stripping manner. Directly gripping the screw head with the vice grips was discussed though concern for torsional fatigue and mid

Figure 7. *10mm reamer*

shank failure became a primary concern. In addition, if we deformed the head or shank, passage of a wire or pin up the screw (Figures 3 and 4) might have been impossible, thus preventing us from using the following technique.

We utilized the Arthrex Cannulated Coring Reamer and Collared Pin (Naples, FL) to remove a 10mm diameter bone core around the screw up to the level of the threads (Figure 7). To detail the technique, the guidewire is inserted into the cannulated screw and over fitted with the reamer on power (Figures 4-6, 10, 11). This engages both the center of the bit as well as the center of the screw to provide accurate coaxial alignment. The collar prevents migration of the guidewire toward the joint since it abuts the head of the screw. Measured markings on the coring reamer allow confident reaming without the use of fluoroscopy (Figure 7). Driven at full speed, copious irrigation is used to cool the heating reamer.[20] The bone is given adequate time intervals to cool down with further irrigation.

After reaching the threads, the screw, along with a strongly adherent collar of bone around the shank, easily unscrews by hand with assistance of vice grips (Figures 8, 9, 12). The 70mm long by 10mm diameter defect can be filled with a dowel of cancellous bone autograft or allograft. In our case, we hand burred from a rectangular stock piece measuring 3x15x15mm. The dowel is slightly over fitted and tamped into the defect. The surgical technique for coring out SCFE screws is summarized in Table 1.

The method described is simple, intuitive, and is not specific to a brand of equipment. Other brands of coring reamers may be available at your institution. Choose one with an inner diameter that just barely goes over the

screw. Be aware a very tight fit can lead to metal debris. To avoid extensive bone loss, choose the reamer with the thinnest kerf. The time for which reamer-based extraction takes is considerably fast– on the order of less than 5 minutes. However, the total time to extraction from initiation of screw removal is unpredictable. That, of course, is determined by the steps taken prior to committing to over reaming and is surgeon dependent.

Table 1: Surgical Technique for Removal of Lodged SCFE Screws Using Coring Reamer

- Requirements for Reaming Technique:
  - Cannulated screw removal in the setting of stripped threads
  - Failed traditional retrieval methods
  - Intact shank
- Positioning:
  - Lateral decubitus position on a well-padded peg board or bean bag
  - Flexion of the contralateral leg improves visualization of hip with fluoroscopy
- Approach:
  - Case Dependent
    - Removal of the screw should be attempted early on in cases with large exposures
  - Percutaneous method is still possible
- Guidewire and Reamer Assembly (see Figures 1-6):
  - Short end inserted into the cannulated screw with the collar resting on screw head.
  - Reamer is inserted over guidewire
  - These steps ensure coaxial alignment of the system
  - Ensure short end of guidewire does not exceed length of screw
- Reamer Size Choice:
  - Larger than screw diameter to prevent production of metal debris
  - Small enough to minimize bone loss
- Reaming Depth (see Figure 6):
  - Ream until threads reached
  - Reference markings on coring reamer or use fluoroscopy
  - The final depth requires knowledge of implant length and distance to proximal threads
- Cooling:
  - Copiously irrigate during reaming
- Extraction:
  - Use a screwdriver, vice grips, or pliers for screw removal in a counterclockwise manner

Comparison to Other Methods

Other noted techniques for screw removal include "easy out" conical extraction and the parallel planes technique, which are not applicable in all cases.[5 21] The easy out technique is not applicable in the setting of a screw that is resistant to rotation. Rather, it is a technique used when heads are stripped, but the potential for rotation exists.

Parallel planes technique uses a diamond tip bur to create parallel surfaces on either side of a screw head to form a more efficient contact area for pliers. The technique effectively modifies the recessed head that only accommodates a driver to a "bolt" that accommodates pliers. Though this certainly has application in similar situations, the screw must have the potential to rotate. In our attempts leading to over reaming, we applied exceptional forces with an approximately 8-inch-long vice grip lever arm that were nearing the potential for shank fracture. Neither of the aforementioned techniques would suffice in this situation. In addition, if one severely deforms the screw head it will be hard to place a guide pin down the shank.

The over reaming technique has several disadvantages. Some surgeons note that over reaming sacrifices considerable healthy bone and extends operative time.[19] We agree the technique removes greater bone than what would otherwise be left if the screw were successfully removed by traditional methods, however, that option did not exist in our case. The risk of fracture associated with reaming in this context has not been adequately quantified. One author reported out of 43 screws in 27 patients, two adolescents sustained a subtrochanteric

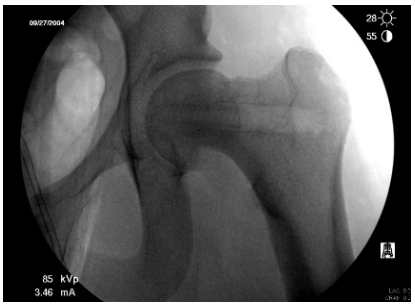

Figure 9. *Defect on fluoroscopy*

fracture 5 and 7 weeks after hardware removal.[11] Both of these patients required extensive chiseling of the lateral cortex at the time of retrieval. Fracture after uncomplicated screw removal is the closest comparison available. In a series of 38 SCFE screw removal procedures with 1.6-year follow-up there were no fractures after screw removal.[16] We imagine the risk for fracture after coring should theoretically be greater than uncomplicated screw removal. One should, therefore, make attempts to avoid over reaming, and once committing to it, select the smallest size reamer available to minimize structural bone loss.

Troubleshooting any challenge in the OR takes time, including complicated screw removal. Complications related to implant removal are well noted for increased surgical times, with implant removal alone lasting over an average of 70 minutes, and some cases lasting well over 100 minutes.[11,14,19] In a series of 43 SCFE screws removed, the average operative time for removal [51 min. (26–107 min.)], which was double that for insertion.[11] Tan reported 160 minutes dedicated to SCFE screw removal in a situation similar to ours.[6] In our case, nearly 60 minutes was dedicated to recognition of the problem, traditional attempts at retrieval, and successful utilization of the reamer. Roughly 5 minutes were accounted for the use of the reamer. In our opinion, the main determinant of time is dependent on the surgeon's anticipation of failure and availability of the necessary instruments intra-operatively.

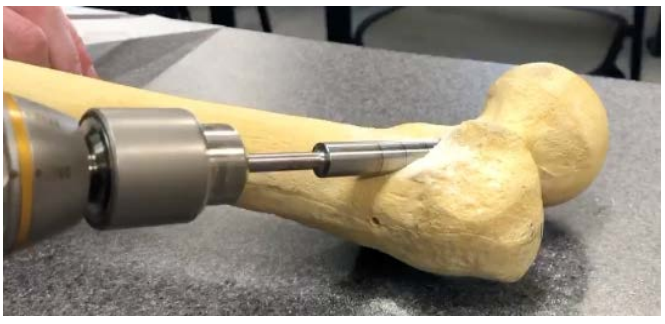

Figure 11. *Over reaming*

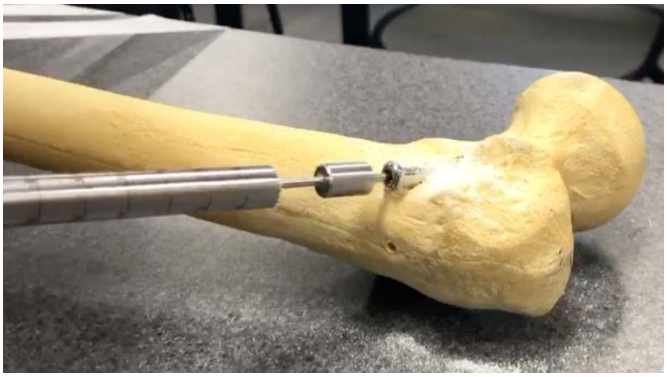

Figure 10*. Wire guided assembly ensures coaxial alignment*

Over reaming to remove failed hardware has proven successful in a few cases.[19] Over reaming partially threaded screws is a successful and accurate technique for removing partially threaded SCFE screws. Using our described technique with appropriate preoperative anticipation, we expect one can reduce removal times compared to other noted methods.[11,19] Our instrument set up allows for the reamer to remain coaxial in the screw, minimizing screw debris in the wound, and avoiding the need for fluoroscopy. While this technique employs significant loss of bone stock, fracture in this context has yet to be described.

Summary

Removal of orthopaedic implants in pediatric patients is often difficult, with a 10% complication rate for implant removal surgery.[14] Implants placed for SCFE are notoriously difficult to remove, with a complication rate of 34%, with some authors reporting rates as high as 61% and 83% with older implant models.[14–16] The over reaming technique appears to be a safe method of retrieval when traditional methods fail. Further studies are warranted to investigate the risk of fracture after reaming as well as screw design characteristics that contribute to challenging removal.

Figure 12. *Extraction with vice grips*

Additional Links

Accompanying Video: https://youtu.be/O0BlEa30exc

AO Trauma hardware removal guide educational information: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwitq8S80vDnAhXITd8KHfXBDBIQFjAAegQIAhAB&url=https%3A%2F%2Faotrauma.aofoundation.org%2F-%2Fmedia%2Fproject%2Faocmf%2Faotrauma%2Fdocuments%2Feducation_pdf%2Forp_handout_english_implant-removal.pdf%3Fla%3Den%26hash%3DE4B40F4E0080A773FE860D1C6CF2EF0636E555E9&usg=AOvVaw0M50ek4PV52qgUzd4jRkY8

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