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# Removal of a 'cold-welded' femoral head lag screw in a nail combination

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## SUMMARY

We present a case of a femoral head lag screw 'cold welded' to an intramedullary nail (IMN) in a female in her 20s during exchange femoral nailing of a subtrochanteric femoral osteotomy non-union. We subsequently developed a reverse spiral-fluted bolt extraction socket, designed to engage the outer wall of a bolt or screw. The lag screw was removed from the Smith and Nephew Meta-Tan IMN, 1 week later, and exchange nailing was successfully completed. This case report describes a technically challenging situation of a cold-welded femoral head lag screw during a complex revision. This report introduces a novel removal device and technique for such cases.

## BACKGROUND

The management of femoral non-union following intramedullary nail (IMN) fixation remains a challenge for orthopaedic surgeons, often necessitating complex revision procedures.[1] Extraction of the index hardware can prove problematic during exchange nailing. Difficult extraction of bent or broken IMNs and interlocking screws has been described. However, there is a scarcity of reports on difficult removal of femoral head lag screws in combination with an IMN, with only one prior report of a 'cold-welded' lag screw described.[2–5] Similar to the current case, this was encountered in a Trigen Meta-Tan nail (Smith & Nephew, Memphis, USA). However, the removal technique required significant excision of cortical bone from the greater trochanter, necessitating additional plate and screw osteosynthesis in this region.[5]

This report presents a novel surgical technique and device for the removal of a cold-welded femoral head lag screw in an IMN. This case report was produced in accordance with the Surgical CAse REport guidelines, with the patient giving informed consent.[6 7]

## CASE PRESENTATION

A female in her 20s presented for management of a left femur non-union with disabling pain and inability to progress beyond household ambulation. Radiographs revealed established oligotrophic non-union at the site of a prior subtrochanteric femoral derotation osteotomy performed at another institution (figure 1a). She was booked for exchange nailing, implanting a T2 Stryker recon nail (Michigan, USA) with iliac crest bone graft augmentation.

### Treatment

With the patient supine on a fracture table, the non-union site and proximal screws were exposed through the previous incision. The Trigen Meta-Tan IMN features a unique interlocking two-screw system, with a lag screw cranially and a compression

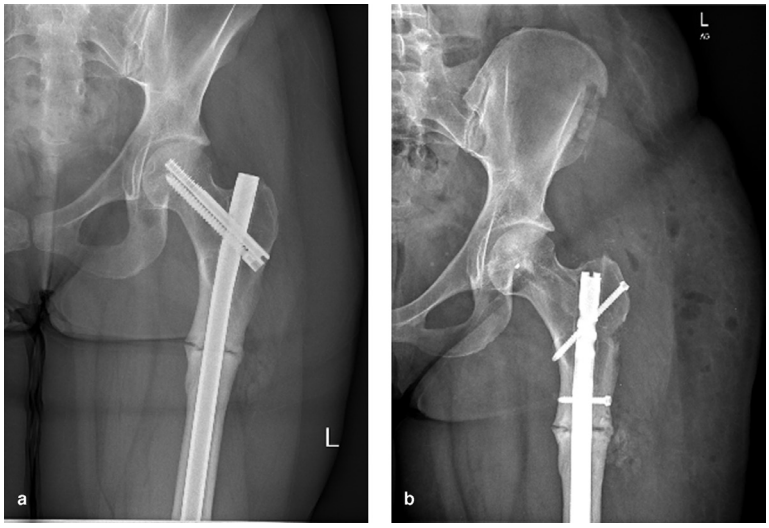


**Figure 1** (a) Preoperative X-ray demonstrating the oligotrophic non-union of the subtrochanteric femoral derotation osteotomy demonstrated with an intact Smith & Nephew Trigen Meta-Tan intramedullary nail in situ and (b) postoperative X-ray of the proximal femur with a Stryker T2 Recon nail in situ. Minimal lateral cortical destruction implicated in the removal of the lag screw is demonstrated.

**Figure 2** Intra-operative image intensifier from first stage surgery. The lower compression screw has been successfully removed while the femoral head lag screw is cold-welded. The engagement head of the lag screw can be seen to be broken, with the head of the reverse cutting conical extraction device broken off within the screw. A wire is passed through the nail, confirming no set screw is present.

screw caudally, passed through the same IMN hole (figure 1a). The distal compression screw was removed without difficulty.

A guide wire was inserted into the lag screw and the appropriate extraction screwdriver was engaged. However, counterclockwise force did not result in screw rotation. Preoperative CT and product usage confirmed no set screw was in situ. Further rotation attempts led to the failure of the screw engagement point. A small lateral cortical window was created. A trephine was inserted to create surrounding space and a vise-grip was trialled. A reverse-threaded conical extraction screwdriver was thoroughly engaged within the screw. Despite various leverage devices, the screw simply would not disengage. Under the direct vision and on fluoroscopy, the two components appeared cold-welded.[8] Minor insertion and extraction of the nail with the 'backslapping' technique, as well as intramedullary use of a punch, were trialled to disengage the screw from the nail to no avail. Eventually, the conical extraction screwdriver broke off within the lag screw (figure 2). At this stage, in view of the length of the operation and the potential for further bone and soft tissue trauma, the decision was made to plan a second operation. Open disclosure was performed.

Consultation with other senior surgeons and hardware suppliers was undertaken in planning a second-stage operation. Several devices were prepared and trialled on an identical nail in vitro, including a bolt extractor socket with reverse spiral flutes designed to engage on the outer wall of a screw or bolt (figure 3a and b, figure 3c). This device was sterilised for use in the theatre.

The patient returned to the theatre, the incision reopened and the lateral cortex bone window and screw were identified. The bolt extractor socket was connected via a square drive to a perpendicular rod. The bolt extractor was fastened down in a counterclockwise manner onto the outer wall of the lag screw, using the rod as a lever. The reverse cutting flutes of the bolt extractor engaged the substance of the lag screw, and continued counterclockwise rotation permitted successful extraction of the screw. The withdrawn screw was inspected, and no signs of damage were noted other than the broken engagement point and scratches from extraction devices (figure 3c). A 380 mm×13 mm Stryker T2 Recon nail was inserted after reaming (figure 1b). The non-union site was drilled, freshened and filled with iliac crest bone graft.

## OUTCOME AND FOLLOW-UP

Postoperatively, weight bearing was commenced from day 1, with the aid of crutches for the first 6 weeks. The patient achieved radiographic and clinical union at the 3-month follow-up. At 1-year follow-up, the patient reported being able to walk up to 5 km without pain.

## DISCUSSION

This report presents a case of a cold-welded femoral head lag screw in an IMN, a situation which has only been described once previously. Lag screw extraction was performed following the development and application of a novel bolt extractor socket used through a small lateral cortical window.

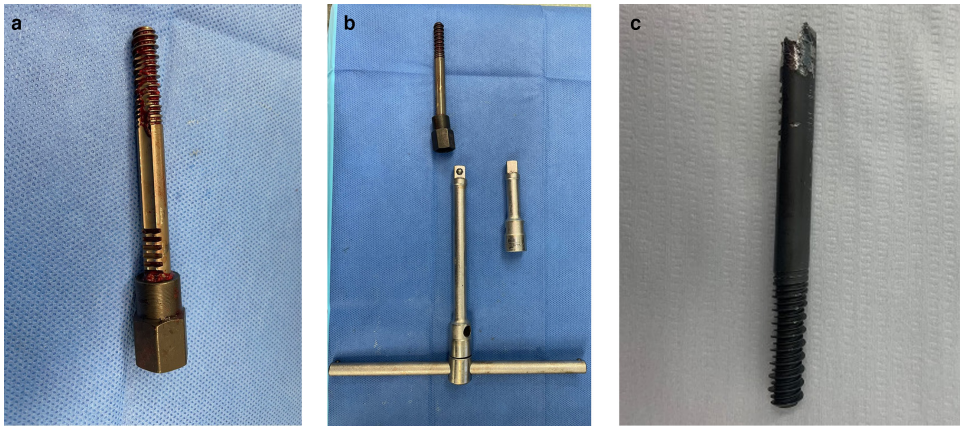


**Figure 3** (a) Reverse spiral fluted bolt extractor socket, engaging the successfully removed lag screw. (b) Operative set-up of the extraction device dismantled showing the screw engaged to the bolt extractor socket, which was connected via a square drive to a perpendicular rod for leverage. (c) Extracted screw showing engagement on the outer wall at the screw head of the bolt extractor socket. Evidence of the broken engagement point is also demonstrated.

The bolt extraction socket used reverse-threaded deep-cutting spiral flutes, with attachment options for square- or hex-headed devices. It is inserted over the top of an existing bolt or screw and engages in an outside-in grip, as opposed to the inside-out grip of typical reverse-threaded conical screwdrivers. The socket required only minor cortical excision to fit over the screw, through a bone window which had already been created trialling previous extraction devices. It demonstrated excellent grip and allowed significant force to be generated with the attachment of a lever rod. This overcame the bond between the lag screw and the nail. Similar extraction sockets are extensively used in the construction and automotive fields. This would be an inexpensive and invaluable addition in all major orthopaedic trauma units, given the widespread utilisation of IMNs.

A similar case of a cold-welded femoral head lag screw was also encountered during the removal of a Trigen Meta-Tan nail (Smith & Nephew, Memphis, USA).[5] The surgeons passed a carbide drill bit down the canal to break the screw and extract it in two pieces. Due to the extensive nature of this and previous removal attempts, there was significant trochanteric bone loss and fracturing, necessitating additional stabilisation with a plate. Postoperative radiographs demonstrated significant metal debris, and, unfortunately, the patient did not achieve union at follow-up.

## Patient's Perspective

The time between the two surgeries was incredibly difficult, filled with excruciating pain and a lot of anxiety. After the first operation, I was left feeling nervous and uncertain about what lay ahead. Waiting for the second surgery was nerve-racking. After the second operation, I felt optimistic as the surgeons were happy, I started rehabilitation on crutches, which I used for about 6 weeks before I could start weight-bearing unassisted. At first, I had a pretty bad lop-sided gait, which lasted for a few months, but that has resolved now. Now, 1 year later, I can run up to 500 metres without pain and walk five kilometres without any issues.

## Learning points

- 'Cold-welding' of hardware, while rare, can create significant challenges in revision surgeries.
- In cases where standard approaches do not work, consulting with colleagues, other specialties and suppliers can be invaluable. This collaboration led to an innovative approach that preserved bone integrity and achieved successful hardware removal.
- Traditional extraction techniques can risk extensive bone loss, potentially impacting the patient's recovery and outcomes. New devices like the bolt extractor socket can help avoid these risks, preserving bone and soft tissue.

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