Preventive Fixation of the Greater Trochanter in the Intramedullary Nail for Unstable Pertrochanteric Fractures of the Femur: A Surgical Technique

Simone Verzellotti[1], Lorenzo Massimo Oldrini[1]*, Alberto Mameli[1], Ralph Muller[1], Marco Delcogliano[1,2], Axel Gamulin[3]

[1]Department of Surgery, Service of Orthopaedics and Traumatology, Lugano, Switzerland.

[2]Faculty of Biomedical Sciences, University Della Svizzera Italiana, Lugano, Switzerland.

[3]Division of Orthopaedic and Trauma Surgery, University Hospitals of Geneva, Geneva, Switzerland.

Research Article

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***For Correspondence:**

Lorenzo Massimo Oldrini, Department of Surgery, Service of Orthopaedics and Traumatology, Lugano, Switzerland

Email: lorenzoldrini@gmail.com

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ABSTRACT

Proximal Femoral Fractures (PFF) represent a global public health burden as more than 10 million cases per year are globally reported. Kyle 3 and 4 or AO/OTA 31A2 pertrochanteric fractures account for 10%-15% of all PFF. This specific fracture pattern is characterized by intrinsic mechanical instability as a result of the presence of a detached greater trochanter fragment and is usually treated using a Cephalomedulary Nail (CMN). However, the unstable greater trochanter fragment makes the insertion of the CMN guide wire challenging. Consequently, the authors developed a surgical technique allowing for both stable greater trochanter fragment stabilization and easier CMN guide wire insertion to avoid fracture dislocation and fragment collapse. The aim of this surgical technical note is to describe this procedure basically allowing fracture simplification from unstable to stable, so that this complex PFF pattern can be approached in a structured manner with predictable results in terms of fracture reduction quality and implant position accuracy, even by junior surgeons.

Keywords: Pertrochanteric fractures; Hip fracture; Gamma nail; Proximal Femoral Fractures (PFF)

INTRODUCTION

Proximal Femoral Fractures (PFF) represent a global public health burden as more than 10 million cases per year are globally reported [1]. This number is steadily growing as the average age of the population increases [2]. Classification of PFF is determined by the anatomical location of the fracture at the proximal extremity of the femur and in relation to the hip capsule. The most common type of PFF is the femoral neck (intracapsular) fracture, which accounts for 60% of all PFF [3]. Pertrochanteric fractures account for 30% of all fractures, and subtrochanteric fractures account for 10% [4]. Pertrochanteric fractures are most usually classified using the Kyle and Evans classification system, which is based on fracture stability, as well as the AO/OTA classification system [5,6].

The present surgical technical note focuses on a particular type of pertrochanteric fracture characterized by fracture fragment instability, classified as trochanteric multifragmentary fracture Kyle 3 and 4, or AO/OTA 31A2, which accounts for 37%-42% of all trochanteric fractures [7]. This fracture pattern is characterized by intrinsic mechanical instability as a result of the presence of a detached greater trochanter fragment and is usually treated using a Cephalomedulary Nail (CMN) [7]. However, the unstable greater trochanter fragment makes the insertion of the CMN guide wire challenging [8]. The authors developed a surgical technique allowing for both greater trochanter fragment stabilization and easier CMN guide wire insertion to avoid fracture dislocation and fragment collapse.

The aim of this surgical technical note is to describe this procedure basically allowing fracture simplification from unstable to stable, so that this complex PFF pattern can be approached in a structured manner with predictable results in terms of fracture reduction quality and implant position accuracy, even by junior surgeons.

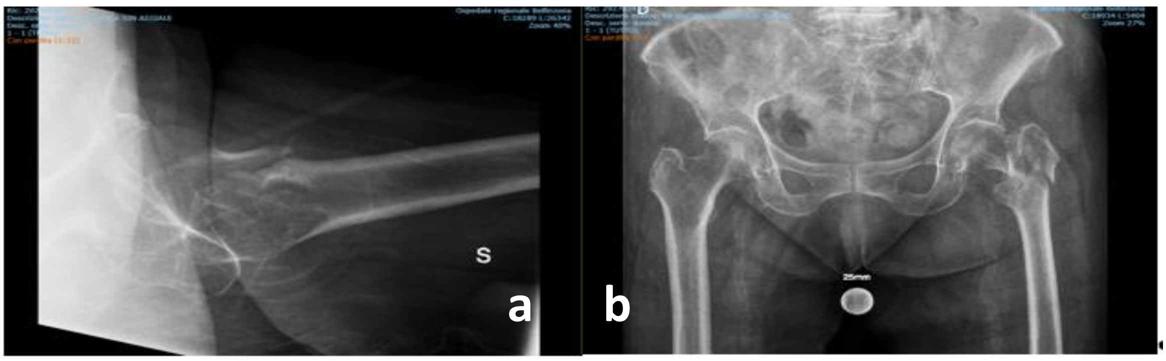
Surgical technique

The authors used this greater trochanter stabilization technique in 34 pertrochanteric fracture fixations with a CMN. Fracture union was achieved in all cases by a minimum one-year follow-up period without surgical complications.

The specific pertrochanteric fracture pattern (Kyle 3 or 4; AO/OTA 31A2) is preoperatively recognized on available initial assessment radiographs (Figure 1).

The patient is brought to the operative room and positioned supine on the operative table. Either general or loco-regional anesthesia is applied [9]. The affected limb is washed with soap water and dried with a towel. Closed fracture alignment is performed with hip abduction and flexion followed by internal rotation and extension [10]. The affected limb is then hooked onto the traction device of the operative table through the dedicated boot after having properly padded foot and ankle bony prominences. The contralateral limb is placed abducted on a dedicated support.

Figure 1. 86 years old female patient with a pertrochanteric fracture Kyle IV of the left femur as a result of an accidental fall from patient's own height. **Note:** (A) Anteroposterior; (B) Axial radiograph

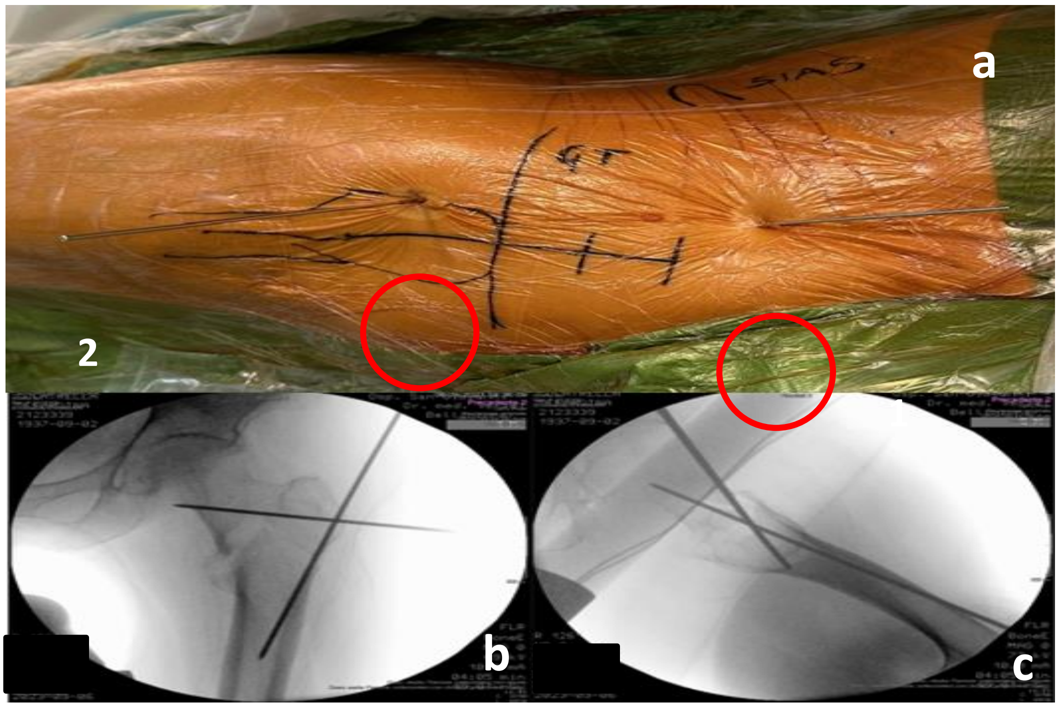


Next, traction and internal rotation of the lower limb are applied to achieve the desired reduction [11]. Reduction is checked under fluoroscopic control (C-arm) and operative landmarks are worked out for the proximal incision at the apex of the greater trochanter, both in anteroposterior and axial projections. Sterile operative field is set up after proper skin disinfection.

At this point, under anteroposterior and axial C-arm control, a first 2.0 mm Kirschner wire is inserted in the latero-medial direction at the level of the anterior third of the femur, from the greater trochanter to the metaphyseal region of the proximal femur. The inclination of the Kirschner wire is 90° in relation to the femoral shaft axis in the anteroposterior view and parallel to the femoral neck axis in the axial view (Figure 2). Care must be taken not to overpass the second femoral cortex because of the risk of femoral vessels injury. With this fisrt Kisrchner wire, the fracture is simplified from three to two fragments by fixing and securing the greater trochanter with the femoral neck.

A second 2.0 mm Kirschner wire is then placed from distal to the apex of the greater trochanter (approximately 1.5 cm) and aimed distally with 15° inclinations relative to the femoral shaft axis in the anteroposterior view and parallel to the femoral neck axis in the axial view, staying in the anterior third of the medullary cavity (Figure 2). With this second Kirschner wire, the entire fracture is provisionally fixed, leaving enough space within the medullary cavity of the femoral shaft and neck to correctly place a CMN. an accidental fall from patient's own height: (A) Anteroposterior; (B) axial radiograph.

Figure 2. Same patient as in Figure 1. Clinical picture. **Note:** (A) Anteroposterior C-arm view; (B) Axial C-arm view; (C) kirschner wire inserted in the latero-medial direction at the level of the anterior third of the femur, from the greater trochanter to the metaphyseal region of the proximal femur. The inclination of the Kirschner wire is 90° to the axis of the femoral shaft in the anteroposterior view and parallel to the axis of the femoral neck in the axial view; kirschner wire inserted 1.5 cm distal from the apex of the greater trochanter and pointed distally with an inclination of 15° to the axis of the femoral shaft in the anteroposterior view and parallel to the axis of the femoral neck in the axial view, remaining in the anterior third of the medullary cavity.

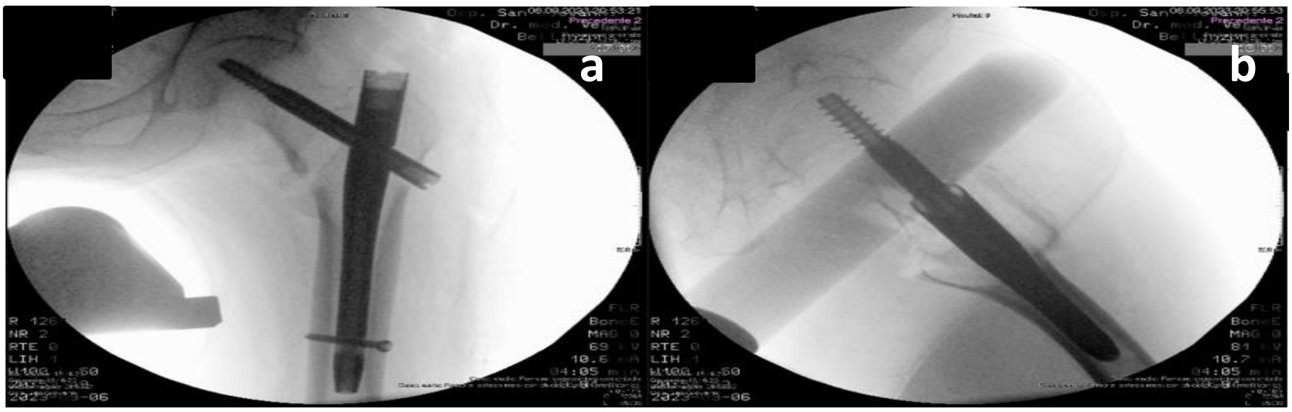


The authors use the gamma3 nail (180 mm) as their preferred implant for this kind of fracture pattern, but any other CMN could be chosen. The cannulated curved awl is used to drive the guide wire in place. The correct entry point is located at the junction of the anterior third and posterior two-thirds of the tip of the greater trochanter on the axial view and on the tip of the greater trochanter on the anteroposterior view (Figure 3).

Figure 3. Same patient as in Figure 1. C-arm entry point with cannulated curved awl. **Note:** (A) Anteroposterior view; (B) Axial view.

Medullary cavity opening and proximal reaming are manually performed with the 15.5 mm drill to avoid excessive displacement forces at the level of the greater trochanter and proximal metaphysis of the femur. The CMN is inserted in the correct position under C-arm control using the dedicated holder. The cervical screw position is prepared with a threaded guide wire which should lie in the postero-inferior or mid-central quadrants of the femoral neck. The rotational stability of the proximal meta-epiphyseal portion of the femur is increased using a second anti-rotational threaded guide wire placed from the lateral part of the greater trochanter to the femoral neck and head. At this point, the two 2.0 mm Kirschner wires initially placed to stabilize the fracture are removed and the cephalic screw is inserted into the neck after drilling. Next, the distal fragment is fixed with a screw in a static position according to standard technique. Final fracture reduction and implant position are checked using multiple plan C-arm imaging (Figure 4). Surgical wounds are then thoroughly washed and sutured according to standard technique, and a sterile dry dressing is applied.

Figure 4. Same patient as in Figure 1. Postoperative definitive C-arm images following intramedullary nailing. **Note:** (A) Anteroposterior view; (B) Axial view.



Following surgery, patients immediately begin mobilization physiotherapy on the first postoperative day with full weight bearing under the supervision of the physiotherapist. Physiotherapy on the first day is based on learning virtualization using crutches in a correct and secure way. On the second day, exercises in the stairs with crutches are carried out, and from then patients are free to move unsupervised. On the first postoperative day, a check of hemoglobin parameters is performed to assess possible postoperative anemia. Patients are discharged to a specialized rehabilitation facility by the time pain is under control, wound shows no signs of inflammation, and patients are autonomous in the stairs. Thereafter, patients perform routine clinical and radiological checkups at 6 weeks, 3, 6 and 12 months after surgery (Figures 5-7).

Figure 5. Same patient as in Figure 1. X-ray follow-up at 6 weeks after osteosynthesis. **Note:** (A) Anteroposterior view; (B) Axial view.

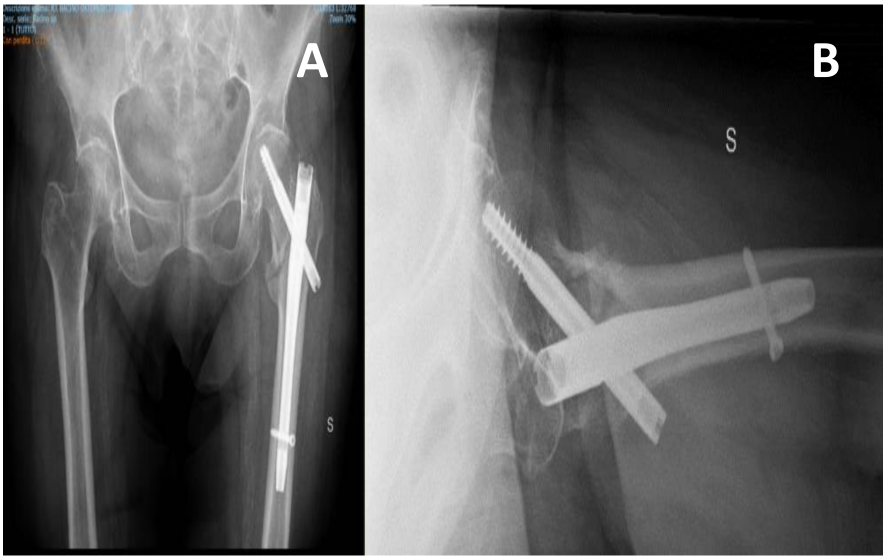


Figure 6. Same patient as in Figure 1. X-ray follow-up at 3 months after osteosynthesis. **Note:** (A) Anteroposterior view; (B) Lateral view.

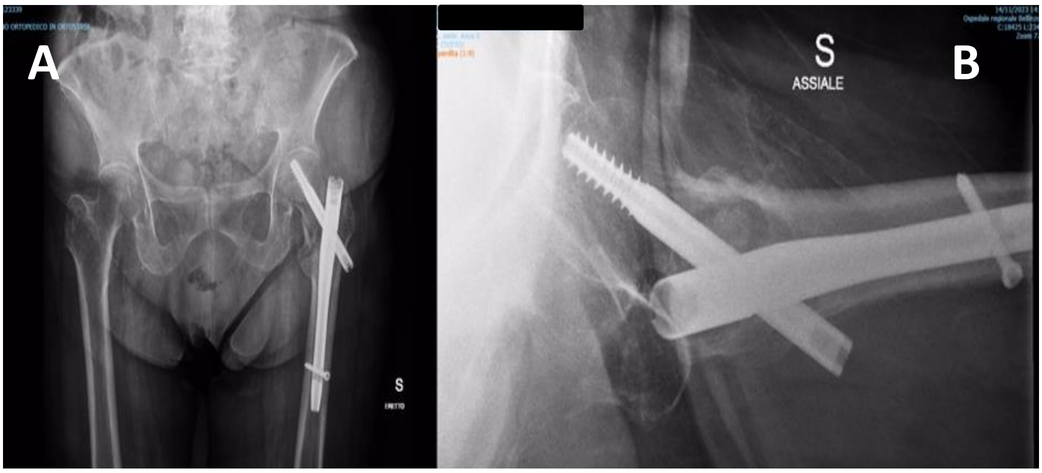
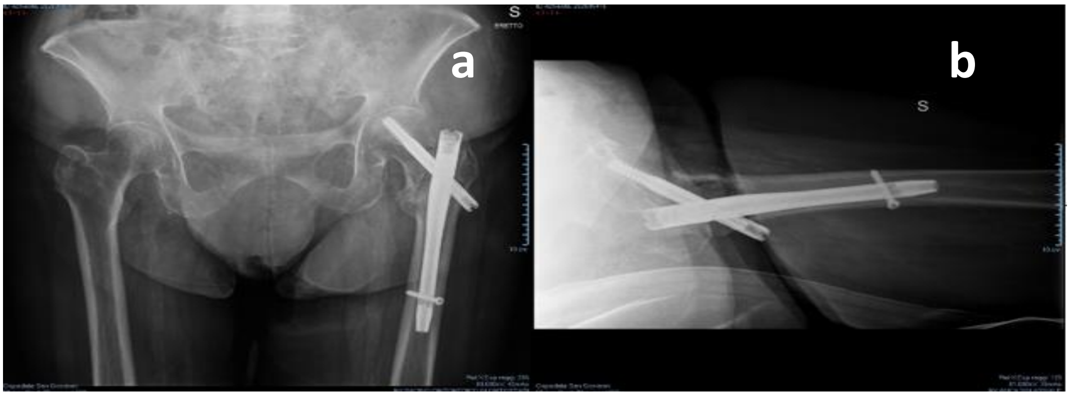


Figure 7. Same patient as in Figure 1. X-ray follow-up at 6 months after osteosynthesis. **Note:** (A) Anteroposterior view; (B) Axial view



RESULT AND DISCUSSION

The goal of this surgical technique is to ensure the maintenance of proper fragment reduction prior to the introduction of the intramedullary nail in unstable multifragmentary pertrochanteric fractures type Kyle 3 and 4 (AO 31A2) and to avoid peroperative displacement of the fracture fragments. This technique simplifies the fracture pattern from unstable to stable so that this complex PFF pattern can be approached in a structured manner with predictable results in terms of fracture reduction quality and implant position accuracy, even by junior surgeons.

The optimal treatment of unstable pertrochanteric fractures remains controversial despite the mechanical advantages of CMN use and has a high complication rate [12,13]. This type of fracture has an increased risk of varus collapse of the proximal fracture fragment and subsequent migration of the cephalic screw through the cancellous bone of the femoral head resulting in cut-out [14]. In addition, potential insertion of the cephalic screw through the fracture line of the greater trochanter may cause displacement of the latter [14]. A recent study by Berk et al., found that AO 31A2 fractures had a delayed union rate of 29.9% and a non-union rate of 6.9%) [13].

When proper fracture reduction cannot be maintained with closed manipulation during the steps of CMN insertion, open reduction might be an option, but this is associated with increased soft tissue damage and disruption of the local vascularization, which can lead to impaired healing and increased complication rate. A technical upgrade of the closed reduction technique, without further skin opening and fracture exposition, would therefore be of great interest.

The surgical technique described here offers a minimally invasive approach without fracture fragments exposition, making tissue damage minimal. Possible complications related to Kirschner wire insertion should also be minimal, although they have not been investigated yet. Temporary fixation allows transformation of an unstable situation into a stable fracture pattern (Kyle type 1 or 2; OTA/AO 31A1), thus facilitating entry point preparation at the tip of the greater trochanter, entry point selection and preparation is critical for CMN fixation procedure to maintain proper reduction and obtain correct final fracture alignment in both coronal and sagittal planes [15,16]. The highlight of the technique described here is to identify the correct bone markers for the subsequent insertion of Kirschner wires. Correct introduction of the Kirschner wires in the anterior third of the medullary cavity of the femoral neck and shaft, as described above in the technique, allows a traditional insertion of the intramedullary nail without creating interference. From the authors' point of view, this technique transforming an unstable into a stable fracture pattern and not exposing the fracture fragments could theoretically ensure complication rates in terms of non-union, delayed union and cut-out close to those of simple

Kyle type 1 and 2 (OTA/AO 31A1) fractures. This technique could also theoretically help younger surgeons mastering this complex fracture pattern.

Additionally, the specific process of inserting both 2.0 mm Kirschner wires under multiplanar C-arm control was evaluated to last about 10 minutes. This additional step might increase overall operative time, but the authors believe that it could also save overall operative time by decreasing time used for further steps of CMN insertion. This still needs to be investigated.

CONCLUSION

The goal of this surgical technique is to maintain proper fragment reduction during CMN procedures for unstable multi fragmentary pertrochanteric fractures type Kyle 3 and 4 to avoid subsequent fracture dislocation and fragment collapse during guidewire insertion. This technique simplifies the fracture pattern from unstable to stable and could also theoretically help younger surgeons mastering this complex fracture pattern.

REFERENCES

1. Wu AM, et al. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990–2019: A systematic analysis from the global burden of disease study 2019. The Lancet Healthy Longevity. 2021;2:e580-e592.
2. Piirtola M, et al. Predictors of fractures among the aged: A population-based study with 12-year follow-up in a finnish municipality. Aging Clin Exp Res. 2008;20:242-52.
3. Lev AR, et al. Rates of transcervical and pertrochanteric hip fractures in the province of Quebec, Canada, 1981-1992. Am J Epidemiol, 1995;142:428-436.
4. Huusko T, et al. Update on current care guidelines: Hip fracture. Duodecim. 2011;127:1508-1509.
5. Bovbjerg PE, et al. Failure of short *versus* long cephalomedullary nail after intertrochanteric fractures. J Orthop. 2020;18:209-212.
6. Meinberg EG, et al. Fracture and dislocation classification compendium-2018. J Orthop Trauma. 2018;32:S1-s170.
7. Vicario C, et al. Necrosis of the femoral head after fixation of trochanteric fractures with Gamma Locking Nail. A cause of late mechanical failure. Injury. 2003;34:129-134.
8. Forte ML, et al. Provider factors associated with intramedullary nail use for intertrochanteric hip fractures. J Bone Joint Surg Am, 2010;92:1105-1114.
9. Ramanoudjame M, et al. CT evaluation of torsional malalignment after intertrochanteric fracture fixation. Orthop Traumatol Surg Res. 2010;96:844-848.
10. Adams CI, et al. Prospective randomized controlled trial of an intramedullary nail *versus* dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma. 2001;15:394-400.
11. Selim A, et al. Cephalo-medullary nailing *versus* dynamic hip screw with trochanteric stabilisation plate for the treatment of unstable per-trochanteric hip fractures: A meta-analysis. J Orthop Surg Res. 2021;16:47.
12. Nüchtern JV, et al. Malpositioning of the lag screws by 1 or 2 screw nailing systems for pertrochanteric femoral fractures: A biomechanical comparison of gamma 3 and intertan. J Orthop Trauma. 2014;28:76-82. [Crossref]
13. Berk T, et al. Trochanteric fracture pattern is associated with increased risk for nonunion independent of open or closed reduction technique. BMC Geriatr. 2022;22:990.

14. Lee C, et al. Strategies for pertrochanteric fracture reduction and intramedullary nail placement: Technical tips and tricks. J Am Acad Orthop Surg. 2022;30:867-878.
15. Teuben MPJ, et al. Cellular activation status in femoral shaft fracture hematoma following different reaming techniques: A large animal model. J Orthop Res. 2022;40:2822-2830.
16. Farhang K, et al. An anatomical study of the entry point in the greater trochanter for intramedullary nailing. Bone Joint J. 2014;96:1274-81.