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"Close to the tip, with little bone to grip": stabilizing two periprosthetic proximal femur fractures above a distal femur megaprosthesis using a combination of DHS and 3.5 mm screws

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ABSTRACT

The incidence of periprosthetic fractures is increasing, presenting significant challenges due to patient longevity and the complexity of repeated surgeries. This report details the successful treatment of a previously unreported periprosthetic fracture pattern using a modified dynamic hip screw (DHS) technique. Two cases involved patients with extracapsular fractures in short proximal femur segments above megaprostheses. The fractures were reduced and stabilized with a DHS device, complemented by 3.5 mm screws from a different manufacturer to achieve effective bicortical fixation around the thick stems. Early weight-bearing was initiated post-operatively, with both patients achieving fracture healing without mechanical complications. This approach highlights the importance of careful preoperative planning and the selection of appropriate fixation methods, particularly in complex cases where traditional solutions may not be viable.

Introduction

The incidence of periprosthetic fractures is steadily increasing and is expected to reach epidemic levels soon [1]. Concurrently, their complexity is rising due to the repeated surgeries patients undergo, who now have longer lifespans and higher functional expectations [2–5]. This short report aims to present a satisfactory resolution of a previously unreported periprosthetic fracture pattern achieved through a modification of the dynamic hip screw (DHS) technique.

Materials and methods

Both patients provided informed consent for the use of their data and images, ensuring confidentiality. The writing of this technical report was adapted to the CARE guidelines.

The first case involves a 75-year-old male with respiratory and cardiovascular comorbidities and a history of knee revision due to

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pain. He underwent a two-stage revision for a periprosthetic infection caused by coagulase-negative *Staphylococcus* and two single-stage femoral revisions due to mechanical loosening, with the most recent procedure involving a custom-made component (Fig. 1a). These interventions span a 14-year period since the primary arthroplasty. He presented for follow-up three months after the latest procedure, complaining of persistent pain that has confined him to a wheelchair following a low-energy trauma the month before. Imaging revealed a hip fracture above the knee stem; AO/OTA (UCS) 31A1 (VC3) (Fig. 1b,c).

The second patient is a 66-year-old healthy female who suffered polytrauma and underwent open reduction and fixation of a distal femur fracture. Due to persistent pain and lack of radiological consolidation, cultures were taken, which tested positive for *Klebsiella oxytoca*. A two-stage megaprosthesis procedure was indicated, followed by two femoral component revisions due to aseptic loosening (Fig. 1d). Five years after the initial fracture fixation and six months after the last revision, she sustained a fall, because of which presented a 31A3 (VC3) fracture (Fig. 1e,f).

Surgical technique

The fractures were reduced on a traction table with the patients in the supine position. The approach was a lateral subvastus with a proximal mailbox tenotomy (Figs. 2a, 3a). In case two, forceps and cerclage wires were used to reduce the lateral cortex (Fig. 3b, c). In case one, an additional pin was inserted to prevent malrotation of the neck (Fig. 2d). In both cases, the DHS system (Synthes, Solothurn, Switzerland) was used with LCP 135° plates and standard barrels. The cephalic screws were short-threaded in the first case and long-threaded in the second. The DHS was applied in the usual manner, aiming for a centered position of the cephalic implant with a tip-apex distance of <20 mm (Figs. 2b, c, 3d, e). The plate was fixed to the femur with a non-LCP screw just distal to the barrel, and compression was applied to the fracture with the compression screw (Figs. 2e, 3f). In case two, the lateral cortex was stabilized with a conventional Trochanter Stabilizing Plate (TSP), which was contoured proximally to fit the trochanter (Fig. 3f). The distal stems were uncemented and occupied much of the femoral canal. Fixation around the stem was achieved by combining the DHS with 3.5 mm screws from the Evos-Small plate system (Smith & Nephew, London, UK). Prior to surgery, we verified compatibility between the plate

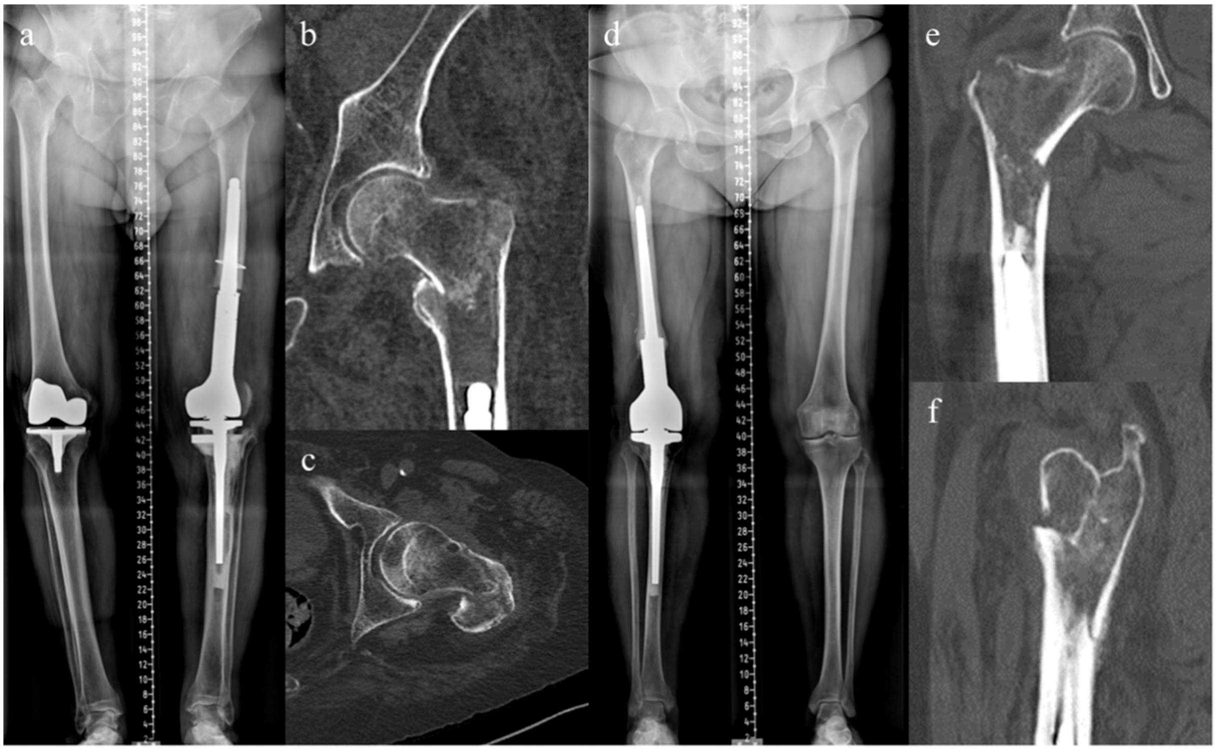

Fig. 1. Case presentations; pre-injury images and periprosthetic fractures.
Case 1.
X-ray telemetry showing left distal femur tumor arthroplasty with an uncemented femoral stem.
Coronal CT revealing an intertrochanteric femur fracture in varus near the proximal stem tip.
Axial images of the same CT.
Case 2.
X-ray telemetry showing right distal femur replacement with an uncemented femoral stem.
Coronal CT showing an intertrochanteric femur fracture near the femoral stem.
Sagittal CT revealing lateral cortex involvement at the implant tip.

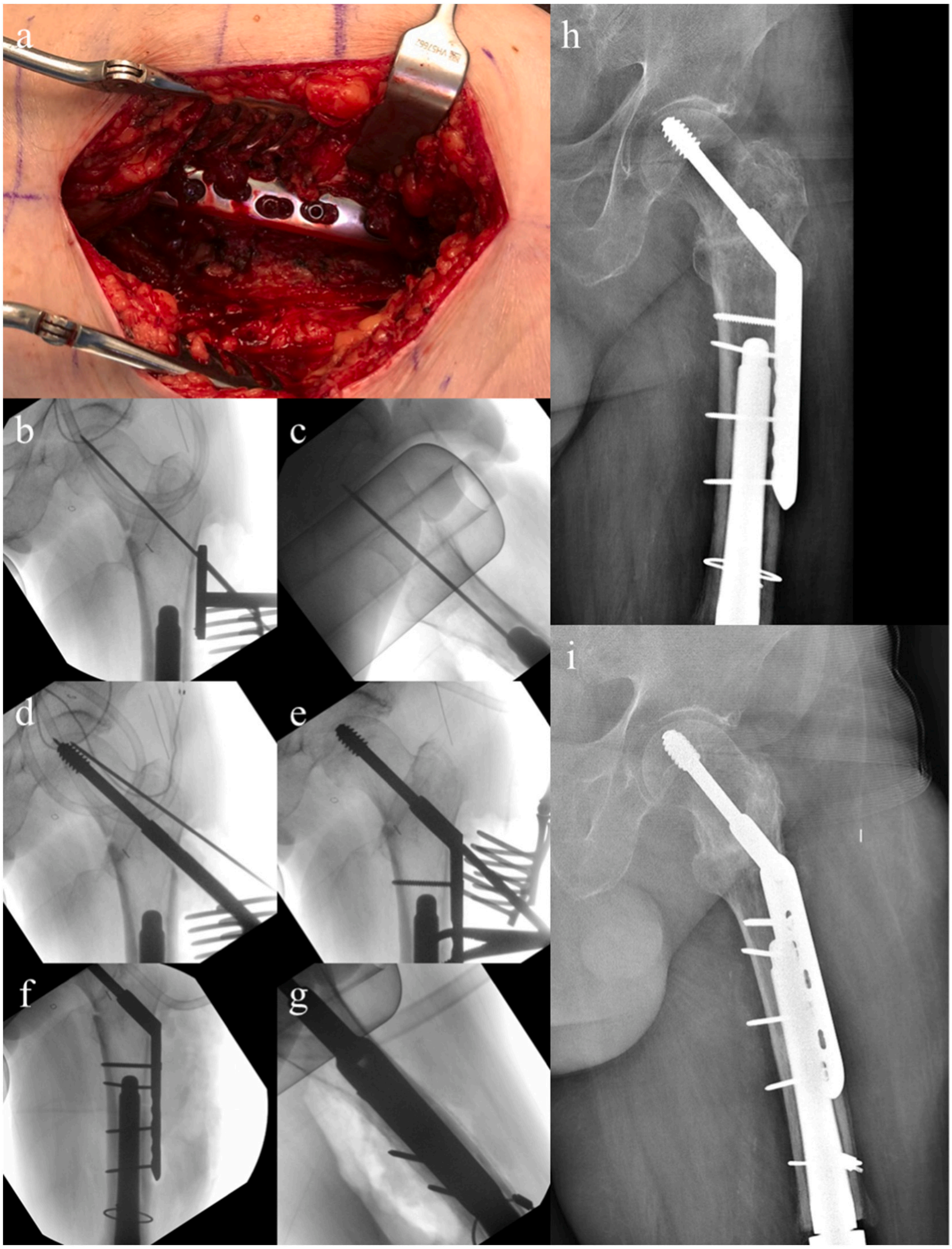

Fig. 2. Surgical technique in the first case.
Lateral subvastus approach and implant positioning.
Intraoperative AP X-ray showing the insertion of the cephalic implant pin in relation to the distal femoral stem.
Correct positioning of the pin is confirmed in the axial view.
Introduction of the cephalic implant, with an additional pin preventing rotation at the fracture site.
A 4.5 mm bicortical screw is inserted, and the fracture is compressed.
Adequate plate-stem overlap. Bicortical fixation around the stem is achieved using 3.5 mm screws.
The axial view demonstrates correct plate positioning, allowing screws to be placed both anterior and posterior to the stem.
AP X-ray at 6-month follow-up showing construct stability and complete bone healing.
Axial view at the same follow-up.

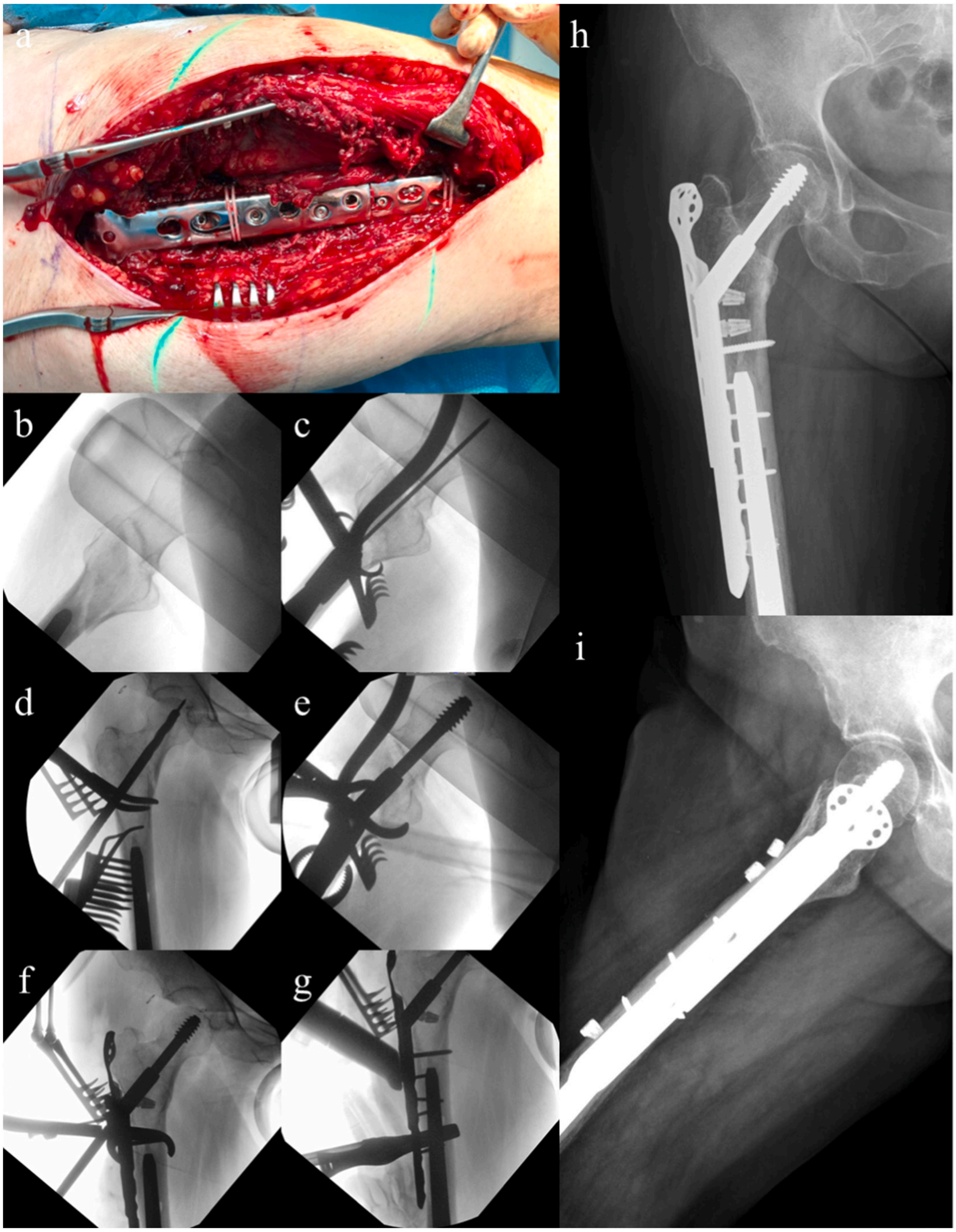

Fig. 3. Surgical technique in the second case.
Larger subvastus approach and implant positioning, including the trochanter-stabilizing plate and additional cerclage fixation.
Intraoperative X-ray AP view showing displacement of the lateral cortex.
Axial view showing lateral cortex reduction using clamps and cephalic guide insertion.
AP view showing adequate cephalic implant drilling and lateral cortex reduction.
Final seating of the cephalic implant in the axial view, with correct plate positioning allowing for anterior and posterior bicortical screw fixation around the stem.
The lateral cortex is additionally stabilized with a cerclage and a trochanteric stabilizing plate.
Distal fixation with 3.5 mm bicortical screws around the stem is achieved.
AP X-ray at 6-month follow-up showing complete bone healing.
Axial view at the same follow-up.

and screw head diameters (Fig. 4). The smaller diameter of the 3.5 mm screws allowed for greater polyaxiality, enabling bicortical fixation anteriorly and posteriorly around both stems, aiming for at least eight cortices of distal fixation (Figs. 2f, g, 3g). In the second case, the TSP was secured with screws and cerclages, and the DHS distal end was additionally fixed with a cerclage.

Results

Both patients began early weight-bearing and had an uncomplicated course. At 6 months, the fractures had healed (Figs. 2h, i, 3h, i), and they were pain-free at the fracture site, able to walk with a single cane.

Discussion

In recent years, the increasing complexity of periprosthetic fractures has posed significant challenges to both surgical capabilities and implant performance. Despite this, there has been a shift towards favoring fixation over revision, driven by technological advancements and a deeper understanding of biomechanical principles [1,5,6]. Fixation of fractures around megaprostheses remains particularly demanding. Alongside common issues like osteoporosis and occupied medullary canals, the large size and rigidity of these implants create stress risers that are difficult to manage given the limited bone stock. Reintervention rates are very high, so the goal should be to minimize complications [4]. While revisions offer more predictable mechanical behavior, they involve greater surgical invasiveness, higher complication rates, and increased costs [1,5]. In cases where the proximal segment is as short as ours, the only viable prosthetic solutions is total femur replacement, which is associated with high mortality and complication rates, or docking devices, which are still in the early stages of development [4,6,7]. Therefore, fixation was considered advisable, though it presented a series of difficulties.

Ensuring proper plate fixation around the femoral stem is critical to prevent mechanical complications [5,8,9]. Bicortical screws are preferred for their low pull-out risk and ability to control forces at the fracture site. If canal occupancy prevents its use, combining fixation methods with different mechanical properties is recommended [9]. Placing screws on both sides of the stem facilitates even load distribution, enhancing bone healing and minimizing the risk of interprosthetic fractures. To achieve this, precise centering of the plate on the diaphysis is essential [10]. Sufficient plate-stem overlap, with at least 6 cm and 8 cortices fixation, is recommended [8]. New plate designs offer features such as offset holes, polyaxiality, angular stability, and various screw diameters for enhanced fixation [2,3,5,6]. However, femoral neck fixation with locking plates has high failure rates, making the DHS the preferred option for extramedullary fixation [11]. The DHS combined with 3.5 mm screws enhances polyaxiality and screw placement in narrow spaces,

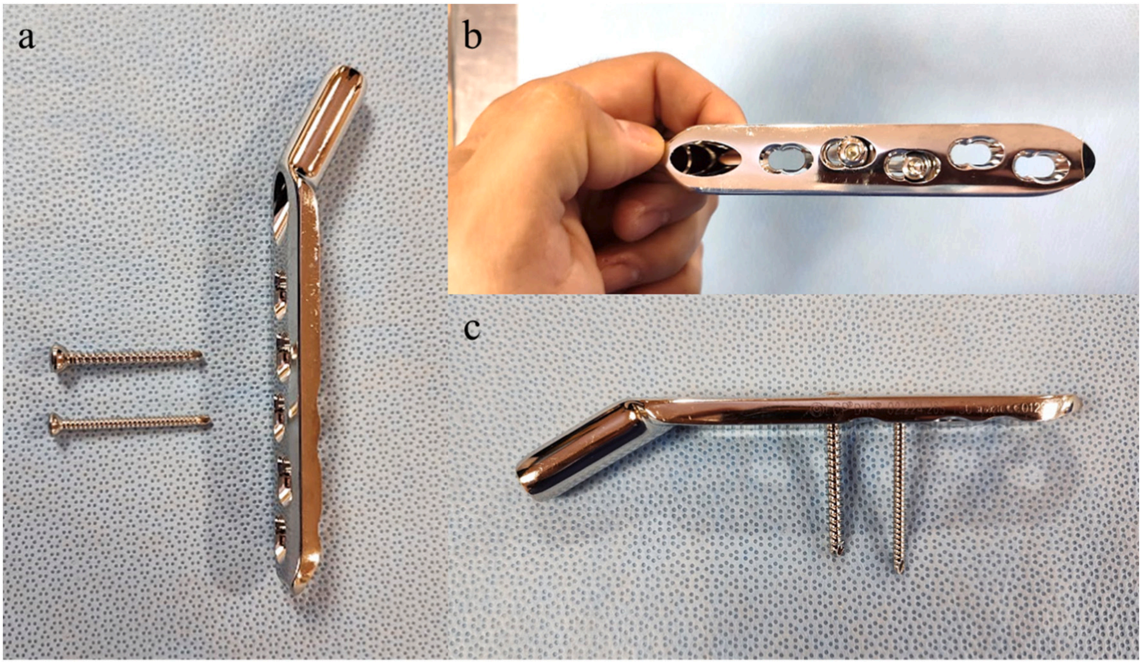

Fig. 4. Preoperative assessment of implant compatibility.
Lateral comparative view of the cortical screw diameters from the DHS system (top) with a head diameter of 8 mm and a thread diameter of 4.5 mm, and the Evos-Small system (bottom) with a head diameter of 5.6 mm and a thread diameter of 3.5 mm. The DHS plate has a thickness of 5.8 mm. Both screws are inserted into non-LCP holes, which have a superficial diameter of 8 mm and a deep diameter of 4.5 mm. The Evos-Small screw sits more deeply, but its head diameter exceeds the deep hole diameter by 0.9 mm, ensuring adequate fixation with enhanced polyaxiality.
Lateral comparative view of both screws protruding from the opposite side of the system.

enabling effective bicortical fixation around thick stems. The mixing of implants should be based on careful preoperative planning and biocompatibility principles, with the aim of minimizing the use of metals with different compositions whenever possible, although the actual clinical effect of this strategy remains controversial [12].

In most centers, cephalomedullary nailing (CMN) has now replaced DHS as the gold standard for treating extracapsular proximal femur fractures. Its mechanical performance is more predictable, reducing the likelihood of early failures [13]. In cases of medullary canal occupation, CMN remains viable when adequate canal space is available for implant placement. Plate augmentation can address stress risers in the interprosthetic gap [2,3]. DHS has proven effective in managing proximal femur fractures with extensive intramedullary occupation, such as peri-implant fractures following retrograde nailing or multilevel injuries [14,15]. In this particular setting, CT is essential for assessing lateral wall thickness and detecting fractures that may compromise DHS performance. If fractures are present, we should aim for anatomical reduction and additional stabilization with trochanter stabilization plates [13].

We conclude that extracapsular fractures in a short proximal femur segment above a megaprosthesis can be effectively treated with a DHS device. The use of 3.5 mm screws from another manufacturer provided secure bicortical fixation around the thick revision stem, facilitating safe and pain-free early weight-bearing and successful fracture healing without mechanical complications.

Consent to participate and publish

We obtained informed consent for the use of data and images from both patients, ensuring confidentiality.

CRediT authorship contribution statement

José-Vicente Andrés-Peiró: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Carlos Alberto Piedra-Calle:** Conceptualization, Methodology, Writing – review & editing. **Jordi Tomàs-Hernández:** Writing – review & editing. **Pablo S. Corona:** Writing – review & editing. **Carles Amat:** Writing – review & editing. **Jordi Teixidor-Serra:** Writing – review & editing.

Ethical approval

This study has been performed under the guidance of the WMA Declaration of Helsinki on Ethical Principles for Medical Research Involving Humans Subjects.

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Declaration of competing interest

The authors declare financial conflicts of interest with Smith & Nephew.
Zimmer-Biomet, Stryker, Link Orthopaedics, Arthrex, and MBA Surgical Empowerment.

Data availability

The data supporting the findings of this study are available from the corresponding author, José Vicente Andrés Peiró, upon reasonable request.

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