European Journal of Orthopaedic Surgery & Traumatology (2019) 29:1141–1145
https://doi.org/10.1007/s00590-019-02413-7

TECHNICAL NOTE • HIP - FRACTURES

Use of a stainless steel locking calcaneal plate for quadrilateral plate buttress in the treatment of acetabular fractures

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Received: 17 October 2018 / Accepted: 4 March 2019 / Published online: 8 March 2019
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Abstract
Operative fixation of acetabular fractures involving the quadrilateral surface presents a challenging clinical scenario. Classically, quadrilateral plate buttress was achieved via the use of a "seven" plate. More recently, the use of an anatomic, pre-contoured design has been gaining popularity due to its pre-contoured shape and larger footprint, allowing for a wider quadrilateral plate buttress. The current study presents using a stainless steel locking calcaneal plate to obtain similar surface area coverage as the modern pre-contoured quadrilateral plate, but at a lower cost.
Level of evidence IV.

Keywords Acetabulum · Acetabular fractures · Quadrilateral plate · Pelvis fractures · Complex fractures · Seven plate · Quadrilateral buttress · Articular fractures

Introduction

Acetabular fractures with quadrilateral plate involvement are increasing in incidence, especially in the elderly population [1]. Quadrilateral plate involvement (with or without protrusio) is typically seen in the associated fracture types (i.e., both columns, anterior column with posterior hemitransverse, posterior column, and transverse or T-shaped fractures), and as recently subclassified by ElNahal et al., the quadrilateral surface alone can present in varying degrees of complexity and comminution [2–5].

While several fixation techniques have been described (i.e., cerclage wires, buttress screws, distal radius plates), the use of a "seven" pelvic reconstruction plate has been the mainstay of quadrilateral plate buttress [6]. While the "seven" plate technique has been reliable, the main drawback is the insufficient coverage zone, especially in comminuted fractures of the quadrilateral plate. More recently, a pre-contoured design has hoped to solve this drawback, by offering a larger plate buttress area, and thus, the use of this plate is gaining popularity, especially in North America [6]. However, in developing countries, the use of this newer plate is not cost-effective, thereby hindering use. Here, we combine the technique of a traditional "seven" plate and offer the increased surface area coverage provided by the newer plate. We describe using a stainless steel calcaneal locking plate as an inexpensive, reliable alternative in providing effective quadrilateral buttressing.

Surgical technique

After applying the time-out protocol of safety surgery, with the patient in supine position under general anesthesia and venous antibiotics, the modified Stoppa with or without a lateral window is performed. For additional access, osteotomy of the anterior superior iliac spine (ASIS) may also be performed. Fracture reduction is obtained in standard fashion, using pelvic clamps and a ball spike pusher. Similar to applying a traditional "seven" plate, the stainless steel locking plate is contoured and bent between 70° and 80°, aiming

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to have a portion resting on the supra-acetabular portion of the anterior column. Two screws fix the calcaneus plate on the anterior column, and if necessary, at least one screw is applied on the posterior column to increase mechanical stability of the construction. Recon plates fix the anterior column of the acetabulum, lying over the bent calcaneus plate. Figure 1 shows a sawbone model with the calcaneus plate buttressing the quadrilateral plate.

Case 1

A 47-year-old male suffered a motorcycle accident and presented an acetabular fracture (AO-OTA 62A3). Radiographs and CT scan depicted anterior column and wall fractures with quadrilateral plate displacement. Surgical strategy included modified Stoppa approach, anterior column fixation with a reconstruction pelvic plate, and a calcaneal plate underneath to buttress the quadrilateral plate surface, working as a spring plate (Fig. 2a–h). No intra- or postoperative complications were observed. Postoperative rehabilitation protocol included range of motion exercises, toe touches, and crutch-assisted weight bearing until complete fracture healing (3 months postfracture fixation).

Case 2

A 24-year-old patient suffered a motorcycle accident and presented a both-column fracture pattern of the acetabulum (AO-OTA 62C2). Surgical planning included the first window of the ilioinguinal and modified Stoppa approaches to fix the anterior and posterior columns, and a calcaneus spring plate was applied to buttress the displaced quadrilateral plate. Figure 3a–h depicts the fracture fixation. The patient presented no intra- or postoperative complications and followed the same above-mentioned rehabilitation protocol.

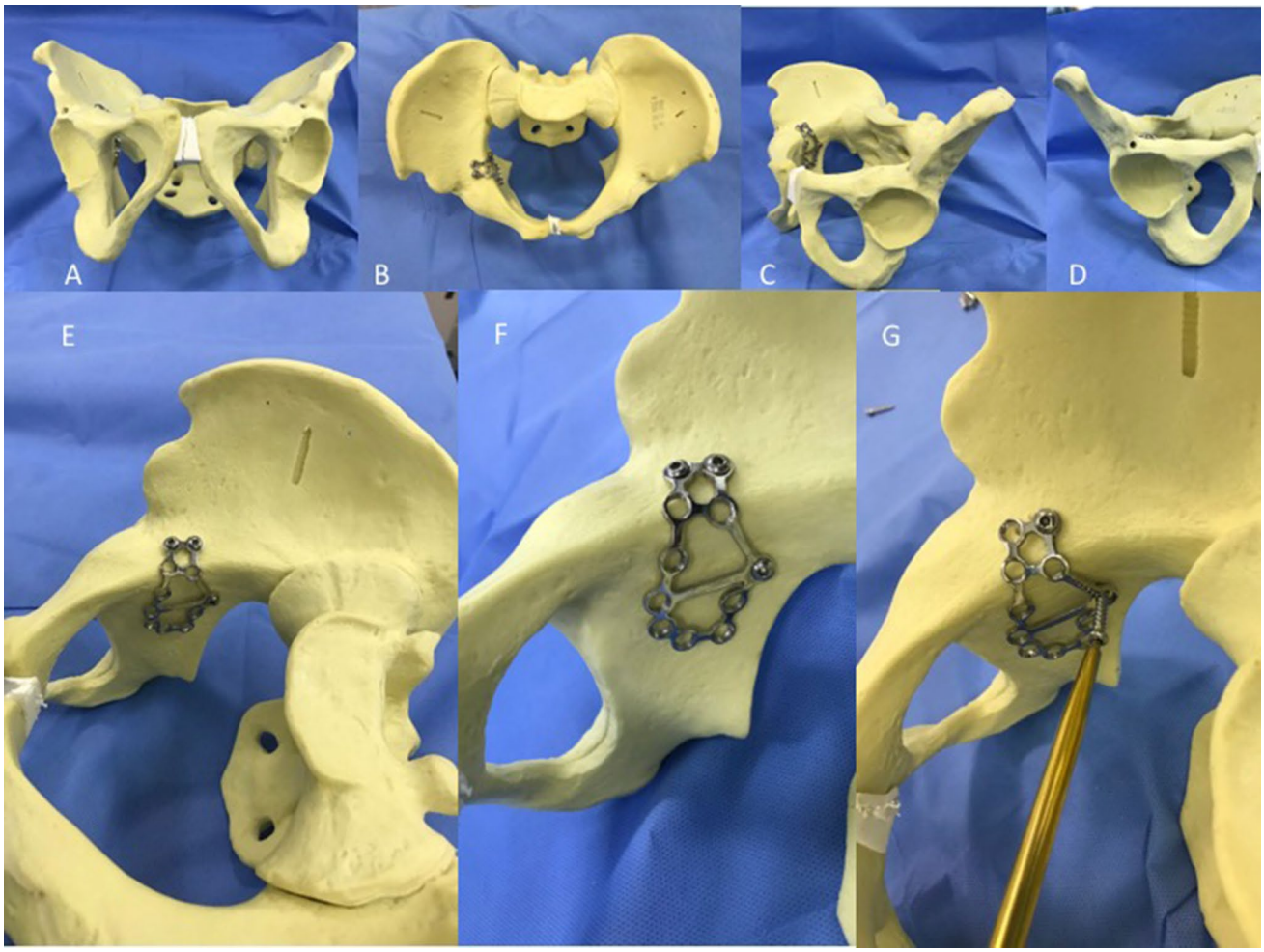

Fig. 1 **a** Outlet view, **b** inlet view, **c** iliac oblique view, **d** obturator oblique view, **e**, **f** spring plate almost covering the entire quadrilateral plate surface, **g** posterior column fixation

Fig. 2 **a** Outlet view, **b** inlet view, **c** iliac oblique view, **d** obturator oblique view, **e** buttress plating on the quadrilateral plate area, **f** buttress plate covering almost the entire quadrilateral plate surface, **g** posterior column fixation

Discussion

With the aging population, quadrilateral plate fractures of the acetabulum are increasingly frequent in orthopedic surgeon practice [1]. High-energy trauma also produces complex acetabular fractures which frequently involve quadrilateral plate fragments. Poor bone quality in osteoporotic patients, thinness of the quadrilateral plate, and important neurovascular structures surrounding this complex region make treating quadrilateral plate fractures challenging [6]. Currently available techniques described to fix quadrilateral plate fractures include cerclage wires, reconstruction or distal radius "seven" plates, pre-contoured buttress plates, as well as buttress screws [7–11].

Farid has described the cerclage wire–plate composite for quadrilateral plate fractures of the acetabulum. This construction uses a reconstruction spring plate over the pelvic brim for medial wall buttressing and a cerclage wire or cable passed through the greater sciatic notch into the true pelvis. The author highlighted that applying this technique through anterior approaches is relatively simple and reliable even in difficult fractures. Since all quadrilateral plate implants remain extraosseous, risk of joint penetration is absent [7].

Sen et al. reported the outcomes of 36 patients with comminuted fractures of the quadrilateral plate using an infrapectineal buttress spring plate (Allis T-plate). The vertical part of the T-plate is fixed to the iliopectineal eminence, whereas the horizontal part buttresses the quadrilateral plate. The authors used the ilioinguinal approach, and anatomic reduction was achieved in 83.3% of cases. Excellent and good results according to Merle d'Aubigne score were obtained in 50% and 27.8%, respectively [8].

Karim et al. presented a novel technique using buttress screws to fix quadrilateral plate fractures of the acetabulum. To effectively achieve the three-point fixation principle, the screws were inserted through the plate holes and then outside the bone rubbing on the pelvic surface of the quadrilateral plate. In a 40-patient case series using this technique,

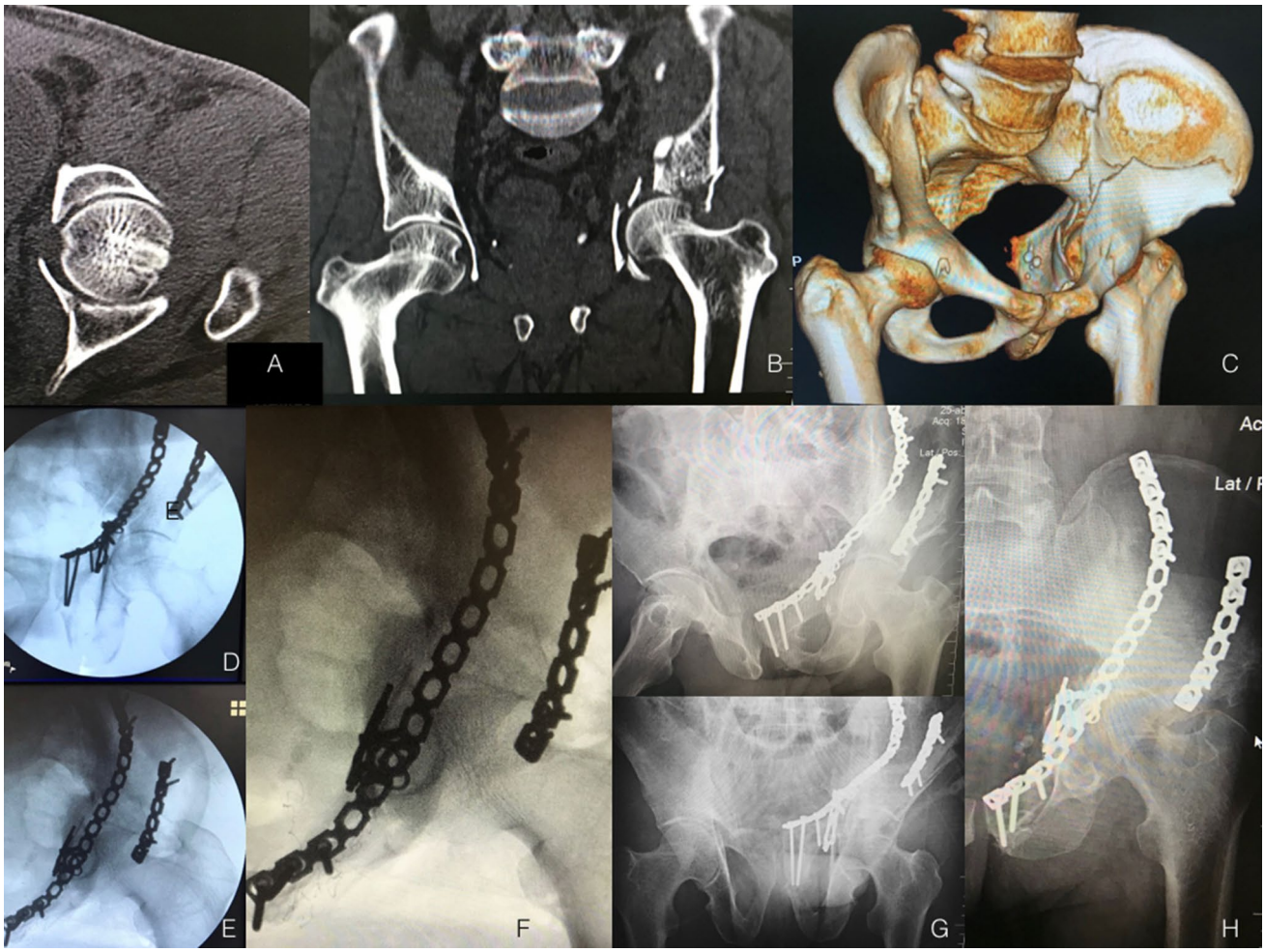

Fig. 3 **a** Axial view of CT scan, **b** coronal view of CT scan, **c** 3D reconstruction CT scan, internal view of quadrilateral plate, **d** intraoperative outlet view, **e** intraoperative inlet view after reduction and fixation with a calcaneal plate buttressing the quadrilateral plate of the acetabulum, **f** intraoperative inlet view showing fracture reduction and fixation, **g** obturator oblique and outlet views after 5-month postoperative follow-up, **h** fracture healing after 5 months

the authors reported no major complications and a Merle d'Aubigne score with 13 cases excellent, 23 good, 3 fair, and just one poor outcome [9].

It is noteworthy that experienced surgeons who treat complex acetabular fractures can generally achieve anatomic reduction, even for comminuted quadrilateral plate fractures. However, even with the extremely creative surgical techniques described above, obtaining stable fixation using conventional implants remains defiant.

Since modern pre-contoured implants for the quadrilateral plate are in limited use worldwide due to economic issues, we believe the unconventional use of a stainless steel calcaneus plate bent through the quadrilateral plate which buttresses the fragments and covers almost the entire quadrilateral surface is an interesting strategy to incorporate into the orthopedic surgeon practice. In addition, the presented technique allows for the posterior column fixation, thus enhancing stability.

This study presents some limitations: small sample size as well as lack of a comparison group and biomechanical analysis evaluating the benefit and safety of calcaneus plate off-label use to buttress the quadrilateral plate area. However, the technique has already yielded early promising results by applying the same fixation principles as modern pre-contoured quadrilateral plate implants [12–16].

In summary, here we present a unique technique in obtaining increased surface area buttress coverage in the setting of comminuted quadrilateral plate fractures. Especially for those orthopedic surgeons practicing in areas with limited access to the new modern quadrilateral plates, using the stainless steel calcaneus locking plate is a viable alternative.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest related to this manuscript.

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