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Case Report

Effective treatment of highest instability in a subacute fragility fracture of the pelvis (FFP IV) using a cement augmented transsacral screw only

J. Gewiess *, C.E. Albers, S.F. Bigdon, J.D. Bastian

Department of Orthopaedic Surgery and Traumatology, Inselspital, Bern University Hospital, University of Bern, 3010 Bern, Switzerland

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ABSTRACT

The highest instability in fragility fractures of the pelvis (FFP) is noted in presence of H-, U-type sacral fractures. Suggested surgical treatment options include uni- or bilateral sacroiliac or transsacral screw fixation at different levels or in combination, as well as lumbopelvic and bilateral triangular lumbopelvic stabilization. However, distinct treatment recommendations for this subset of injuries are scarce. We present a case sustaining rapid FFP crescendo instability following initial conservative treatment of a FFP type II injury resulting in a U-type spinopelvic dissociation. Fixation using one percutaneous cement augmented transsacral S1 screw resulted in perpetual clinical improvements in pain and mobility in presence of radiologic fracture consolidation.

Introduction

In fragility fractures of the pelvis (FFP), decision making for treatment is guided by the inability of the pelvic ring to withstand physiological loads without displacement as determined by the degree of instability of various fracture types [1]. H-/U-type fractures (FFP IVb-c) represent the highest instability and resemble spinopelvic dissociation. In these injuries, management options include conservative treatment, minimally invasive and lumbopelvic stabilization (LPS). However, the optimal treatment remains unclear. Presented is a case with rapid crescendo instability (CI) leading to a sacral U-type fracture, which was successfully treated using an in-line cement augmented transsacral S1 screw, which has not been previously reported to be a viable option in such fractures.

Case report

An 83 year-old woman living independently without any need for walking aids prior to trauma presented to a regional trauma center after a stumbling fall from standing height. She indicated tenderness on palpation at the symphysis and the sacrum. CT analysis revealed a bilateral fracture of the pubic rami and a unilateral incomplete sacral ala lesion (FFP IIb; Fig. 1). Comorbidities included arterial hypertonia, renal insufficiency, obesity, and vitamin D deficiency. Osteoporosis was not previously diagnosed. Initial inpatient treatment was conservative (analgesia, mobilization). Two weeks later, autonomy improved from 25/100 to 60/100 points on Barthel Index (0 to 100/100) and the patient was sent for rehabilitation (Barthel Index >50/100 required). Persisting pain despite extended

* Corresponding author at: Freiburgstrasse 18, 3014 Bern, Switzerland.
E-mail address: jan.gewiess@insel.ch (J. Gewiess).

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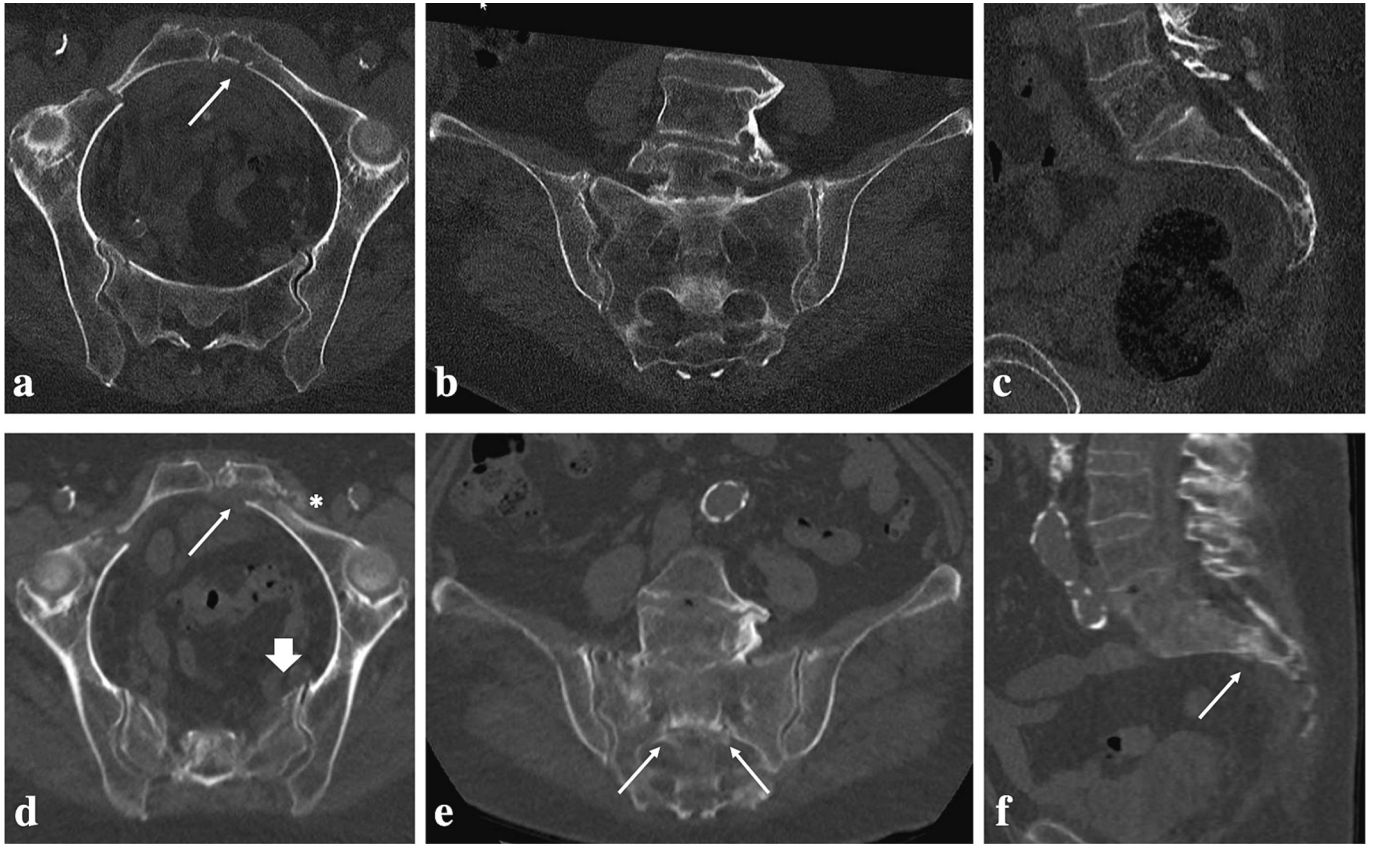

Fig. 1. Reconstructions of initial and follow-up preoperative CT imaging in the (a/d) transverse, (b/e) coronal, and (c/f) sagittal plane showing fracture progression from FFP IIb to FFP IVb within one month. In the transverse plane, signs of crescendo instability are secondary dislocation of the anterior pelvic ring (arrows) despite callus formation (*), and an additional fracture line at the left sacral ala at follow-up study (big arrow in d). In coronal and sagittal planes, the transverse fracture component is visible at follow-up studies (arrows).

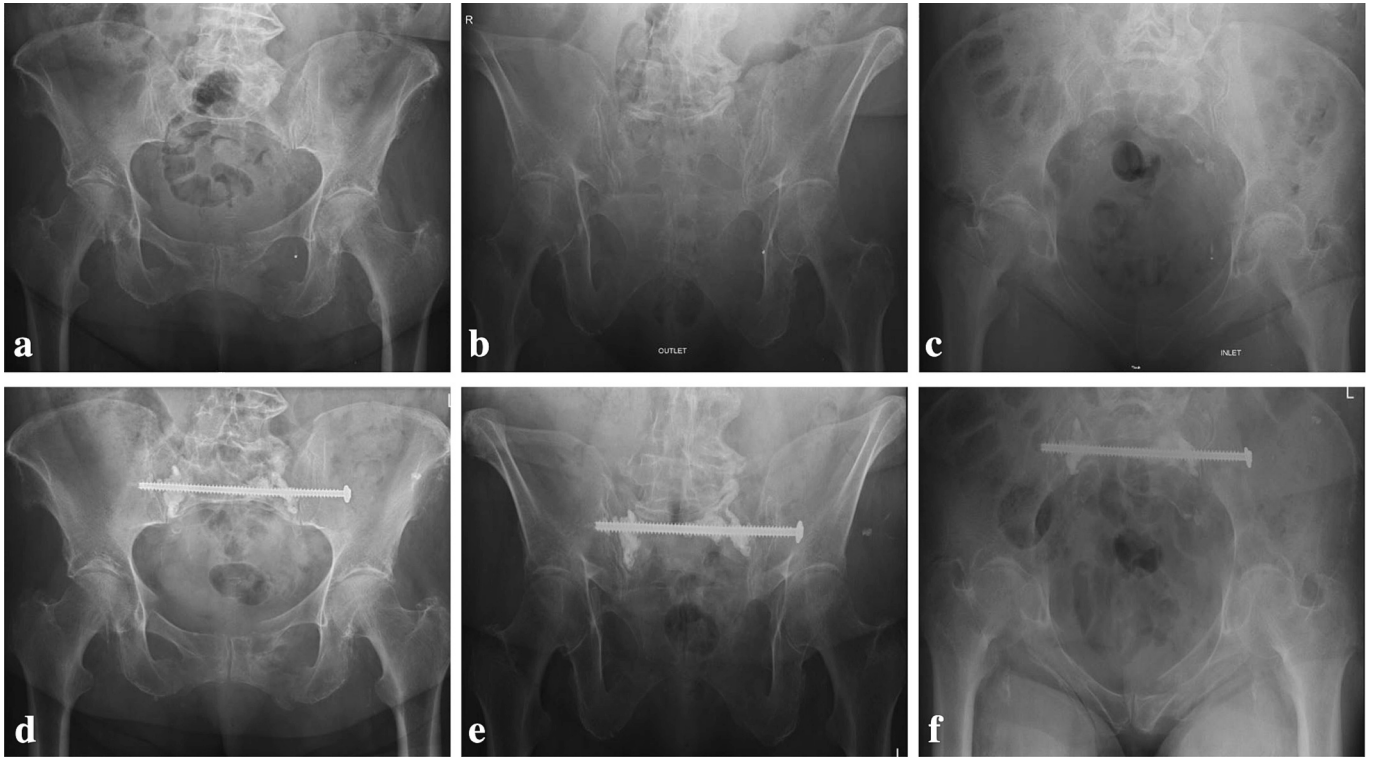

Fig. 2. X-ray studies in (a/d) plain anteroposterior, (b/e) outlet, (c/f) inlet projection before and after PMMA augmented transsacral screw fixation. In spinopelvic dissociation, kyphosis of the upper segment results in the "paradoxical inlet" phenomenon of the sacrum in plain anteroposterior radiographs (a). Correction of the sagittal alignment is not possible using transsacral screws and may require LPS. However, when fixation of the status quo seems adequate, one percutaneous in-line PMMA augmented transsacral S1 screw is a valuable alternative and may easily be combined with sacroplasty. The cement sealed fracture gaps without leakage.

pain medication (paracetamol, metamizole, oxycodone, transdermal fentanyl) made further efforts of mobilization unsuccessful. A follow-up CT study after one month revealed CI with secondary displacement at the anterior pelvic ring despite callus formation, bilateral vertical sacral fractures and a horizontal fracture at the S2 level (U-type; Fig. 1). After transferral to our level I trauma center, transsacral fixation (7.3 mm full thread cannulated screw at the S1 level) with an in-line polymethyl methacrylate (PMMA) augmentation through the cannulation at the lateral masses was performed five weeks after initial presentation (Fig. 2). The recommended postoperative rehabilitation protocol consisted of weight bearing as tolerated supported by crutches for six weeks.

Subjective pain level improved on the Visual Analogue Scale (0 to 10/10 VAS) from 9/10 to 2/10 immediately after surgery. On postoperative day one, the patient was mobilized on crutches; walking distance improved up to 50 m on day three. On day five, dosage of the transdermal fentanyl medication was reduced and after rehabilitation, the patient was discharged home three weeks postoperatively. At six weeks postoperatively, the patient reported on a pain free walking time of 10 min on crutches. At 18 months postoperatively, she used a four-wheel walker at longer walking distances for safety reasons only and scored 20 points on the Elderly Mobility Scale (Table 1). Clinical frailty improved significantly as indicated by a decrease from 7 to 4 on the Clinical Frailty Scale. Overall quality of life equaled the pretraumatic state. Follow-up radiographs showed a stable implant position without signs of loosening or migration (Fig. 3).

At 18 months postoperatively, the formal diagnosis of osteoporosis is still pending, and the only anti-osteoporotic measure taken is vitamin D substitution.

Discussion

CI is present in 40 % of patients with continuing pain or restricted mobility and effectively prevented using operative fixation [2]. H-/U-type fractures may arise from low energy trauma in osteoporotic bone or parallel the end-stage morphologic manifestation of CI and resemble spinopelvic dissociation. Conservative treatment is often initiated but showed a 100 % failure rate in cases with H-/U-type insufficiency fractures [3]. Surgical options include minimal invasive (e.g., sacroiliac [SI], and/or transsacral screws) and more invasive procedures (bilateral triangular lumbopelvic stabilization [LPS]) with or without PMMA augmentation. Formal indications of either method have been recently suggested but are not yet widely adopted in clinical practice [3–5]. In traumatic H-/U-type fractures, finite element analyses revealed that LPS is superior to transsacral fixation in terms of translational and rotational stability [6]. Thus, from a biomechanical perspective, single-level transsacral fixation may be considered insufficient in H-/U-type FFP.

In contrast to that finding in a preclinical setting, we observed improvements in patient related outcome measurements (Table 1) in the presented case. The presented fixation performed well compared to reported outcomes after treatment of FFP IV fractures [7,8]. Compared to other possible treatment options (conservative, one/two single/double level SI, one/two single/double level transsacral screws and combinations, LPS), the rationale for therapeutic success of one single level in-line PMMA augmented transsacral S1 screw in the presented case with the highest grade FFP (IVb) might be explained as follows:

Firstly, from a biomechanical perspective, the CI H-/U-type FFP lasts the integrity of ligamentous tension (anterior, posterior, interosseous SI ligaments) and therefore rather resembles an FFP II than true spinopelvic dissociation. This may facilitate a fixation using one single level augmented transsacral screw. Due to excessive sagittal plane rotation observed in displacement of the anterior or posterior ring, extensive soft tissue damage following true traumatic spinopelvic dissociation, or in bilateral posterior injuries located within the SI joint or ilium (FFP IVa and c), some authors advocate the use of two screws or LPS [5]. From clinical experience, we did not observe symptomatic or radiographic signs of insufficient support against rotational instability using one single-level augmented transsacral screw in CI H-/U-type FFP.

Secondly, advantages of transsacral screw fixation compared to LPS include decreased operative time, blood loss, and wound complication rates [9]. Especially in the presence of cachexia and sarcopenia, transsacral fixation offers the benefit of using a minimally invasive approach avoiding vulnerable anatomic regions (lying supine, performance of personal hygiene). Importantly, and in contrast to LPS, transsacral screw fixation may be performed in supine position, which essentially facilitates anesthetic handling of the often multimorbid elderly patient.

Thirdly, the implementation of combined sacroplasty in transsacral screw fixation provides additional resistance against vertical shear and may reduce the moment resulting from a long screw. We believe, that bilateral PMMA augmentation at the weakest point (lateral masses) instead of the sacral body in transsacral screw fixation enhances the construct's resistance against vertical and rotational forces [11]. Additionally, in elderly and anguished patients with reduced bone healing capacity, augmentation at the vertical fracture lines contributes to early pain reduction and bypasses the need for fracture healing. Given the rarity of symptomatic vascular or neuronal complications following sacroplasty, its implementation in the transsacral screw fixation procedure is considered safe [10].

Anatomic and fracture configurations must be considered when pondering fracture fixation means in (CI) H-/U-type FFP (e.g.,

Table 1
Patient reported outcome measurements preoperatively and at final follow up at 18 months postoperatively.

	EMS	CFS	EQ-5D-3L
Preoperative	n.a.	7	0.788
18 months postoperative	20/20	4	0.788

CFS - Clinical Frailty Scale; EMS - Elderly Mobility Scale; EQ-5D - European Quality of Life 5 Dimensions 3 Level Version; n.a. - not available.

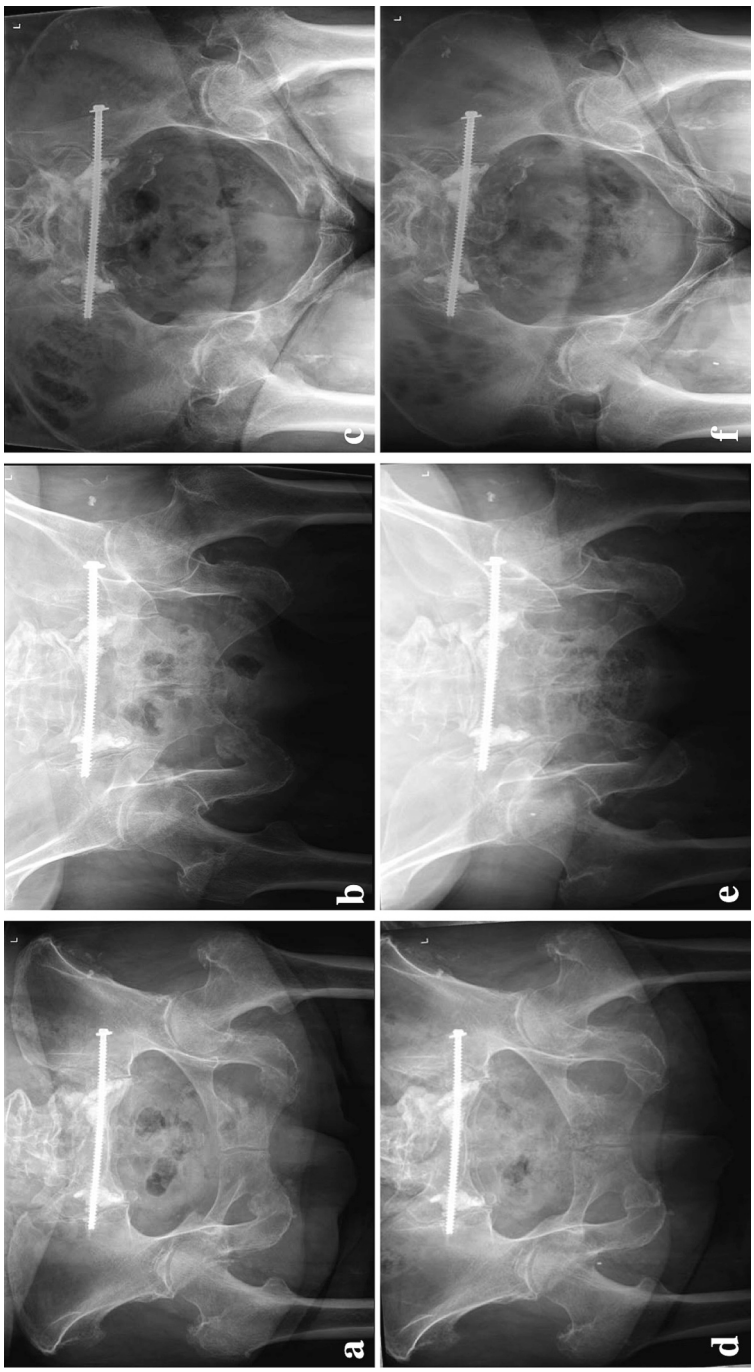

Fig. 3. Follow-up x-ray studies in (a/d) plain anteroposterior, (b/e) outlet, (c/f) inlet projection at six weeks and 18 months postoperatively. The transsacral screw remained stable over time and did not break or become loose. No further fracture progression occurred during follow-up.

intolerable fracture displacement, mediolateral displacement, kyphosis, spinal deformities, previous surgical interventions, dysmorphic sacrum, spinopelvic disharmony). In cases with suspected increased lever arm and resulting strain or anatomical exceptions precluding from safe transsacral screw placement, the authors advocate the use of a more rigid stabilization (e.g., two/double-level transsacral, combined [bilateral] SI screws, or LPS) [5]. However, a cement augmented transsacral screw fixation offers various potential advantages (e.g., shorter operative time, less blood loss, less wound disorders, and easier anesthetic handling) compared to such techniques.

In the presented case, using one percutaneous in-line PMMA augmented transsacral S1 screw facilitated sufficient stability to ensure fracture healing comparable to other reported techniques (e.g., two single level transsacral, double level transsacral/SI screws, LPS). In conclusion, it may be a valuable alternative in CI H-/U-type FFP. Because the roles of posterior and anterior displacement, ligamentous integrity, and fracture progression remain unclear, future studies evaluating clinical, biomechanical, and anatomic aspects are needed for refinement of indications and therapeutical decision-making in H-/U-type FFP.

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Approval code issued by the institutional review board (IRB)

This study is only a retrospective description of a clinical case and a narrative review, it does not present any type of change in conduct or follow-up. Therefore, approval by the IRB or ethics committee is not required.

Statement of informed consent

The patient was informed that data concerning the case would be submitted for publication and agreed with the creation and publication of this article.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

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