



Letters to the Editor

Spino-pelvic triangular fixation for unstable U-shaped sacral fractures and Tile C pelvic ring disruptions: The relentless pursuit of vertical, lateral, and anteflexion rotational stability



Dear Editor,

Unstable U-shaped sacral fractures and pelvic ring disruptions represent a biomechanical surgical challenge because of the need to restore the lines of forces which run through the sacrum and the iliac bone arches in order to allow early weight bearing, reduce mechanical pain, and try to obtain proper bone alignment to improve neurological deficit and ease the upcoming neuropathic pain [1–3]. Joo and Grauer [4] present the so-called “posterior superior iliac rim screw” in order to strengthen classic spino-pelvic construct in series of 3 patients, among whom there were 2 cases of unstable Tile C pelvic ring disruption with Denis type 2 vertical sacral fracture (Fig. 1), and 1 case of unstable sacral sarcoma. Although the expression “posterior superior iliac rim screw” seems appealing at first glance, it is nonetheless not new and calls for a quick historical review of the contemporary evolution of spino-pelvic fixation.

Percutaneous ilio-sacral screw stabilization

Ilio-sacral screw stabilization was introduced by Nork (2001) [5] for moderately displaced, that is, Roy-Camille type 1 [6], U-shaped sacral fractures. It is possible to reduce slightly displaced U-shaped sacral fractures, or Denis type 1 (sacral alar) [3] and even some type 2 (transforaminal) Tile C pelvic ring disruptions using ilio-sacral screw (Fig. 1). Nevertheless, this technique finds its limits both for its inability to reduce important vertical displacement, and for its weak capacities to support vertical and rotational loads running through the sacrum and the sacro-iliac joint:

- First, given its transverse axis, ilio-sacral screw fixation is theoretically not design to support important vertical load,
- Second, even with the use of 2 bilateral S1 and S2 ilio-sacral screws, it remains difficult to avoid anteflexion-related rotational instability of such unstable fractures (Fig. 2) [7].

Triangular spino-pelvic construct

Given the lack of proper biomechanical solution in face with unstable spino-pelvic trauma, Schildhauer et al. [8] introduced the visionary concept of triangular spino-pelvic fixation using:

- Lumbo-iliac fixation to restore vertical load support,
- And ilio-sacral screw to restore lateral load support (Fig. 2).

This construct allows to restore both the arcuate-shaped bone arches running through the sacrum, the sacro-iliac joint and then the ilium, and also the lateral stabilization system provided by the 3 main sacro-iliac ligaments, namely the sacro-iliac, sacro-spinous, and sacro-tuberous ligaments. Since then, Schildhauer construct has become the gold standard technique for stabilization of unstable spino-pelvic trauma [9].

Modified triangular spino-pelvic fixation

Mouhsine et al. [10] presented a modified construct using lumbo-iliac fixation for vertical load sharing, and multiple complementary transverse connectors to treat horizontal instability, thus avoiding the placement of ilio-sacral screw which may carry significant morbidity in unexperienced hands (Fig. 2) [11].

Use of bilateral dual iliac screws to strengthen lumbo-iliac construct

Although surgical stabilization of unstable spino-pelvic trauma may ease mechanical pain and allow earlier weight bearing [7], it remains associated with significant rates of mechanical failure (9%–13%), hardware prominence (21%–100%), and pseudarthrosis [9,12]. Hence, Lyo et al. [13] reported the use of bilateral dual iliac screws in lumbo-iliac fixation with an aim to reduce the displacement and strengthen the vertical load sharing in case of importantly displaced Roy-Camille type 3 (anteriorly displacement) U-shaped sacral fracture. Yu formalized the biomechanical advantages of dual iliac screws over a single screw on each side of lumbo-iliac construct [14]:

- In compression, dual upper-lower iliac screws (one in the upper column and one in the lower column of the iliac bone) restored 98%, and dual lower-only iliac screws restored 108% of the load resistance of an intact pelvis, compared to 73% to 76% for single iliac screws ($p < .05$).
- In torsion, dual upper-lower iliac screws restored 105%, and dual lower only iliac screws restored 109% of the load resistance of an intact pelvis, compared to 72% to 79% for single iliac screws (Fig. 2).

Since sacral alar-iliac screws (Chang, [15]) had been introduced as an alternative screw placement technique for classic iliac screw [16], Mattei and Fassett [17] proposed the use of dual S1 and S2 sacral alar-iliac screw as a salvage technique after mechanical failure or pseudarthrosis of classic triangular spino-pelvic fixation. S3 sacral alar-iliac screws (Mattei [18]) can also be employed as a salvage technique in case of hardware failure or in case of comminuted S1 and S2 fracture, that is, Strange-Vognsen type 4 sacral fracture (Fig. 1).

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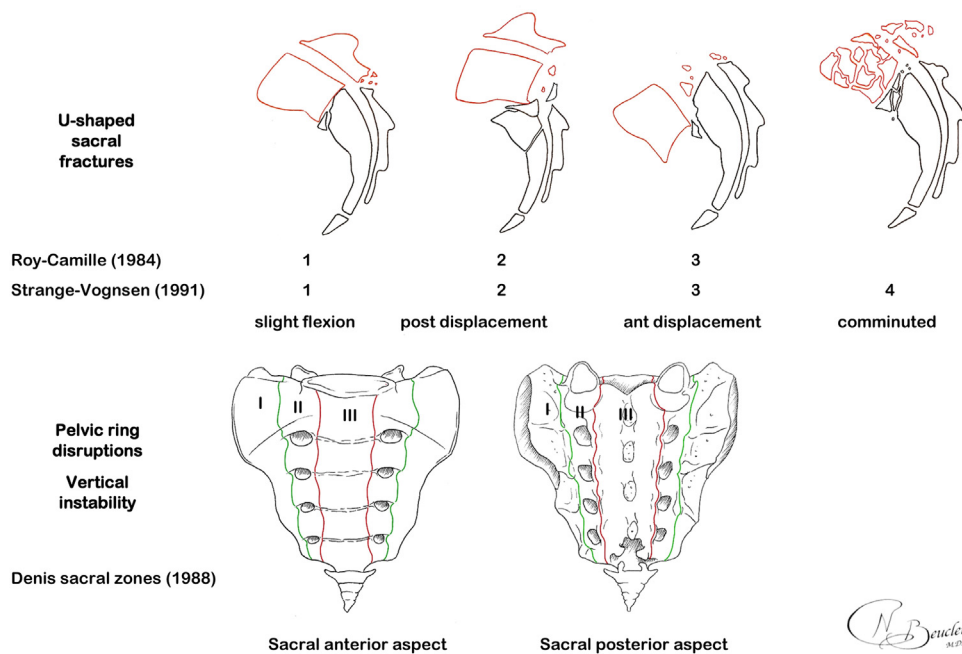


Fig. 1. Artistic view of the main classifications of sacral fractures. (Upper part of the figure) U-shaped sacral fracture, classification of Roy-Camille (1984) indicating the displacement of the upper sacral fragment, which was revised by Strange-Vognsen (1991) a few years afterwards. (Lower part of the figure) Tile C pelvic ring disruption, also called vertical shear pelvic ring fracture: Denis classification (1988) of the vertical fracture passing through the sacrum, depending on its location in relation to sacral foramens. Pencil drawings performed by Dr Nathan BEUCLER.

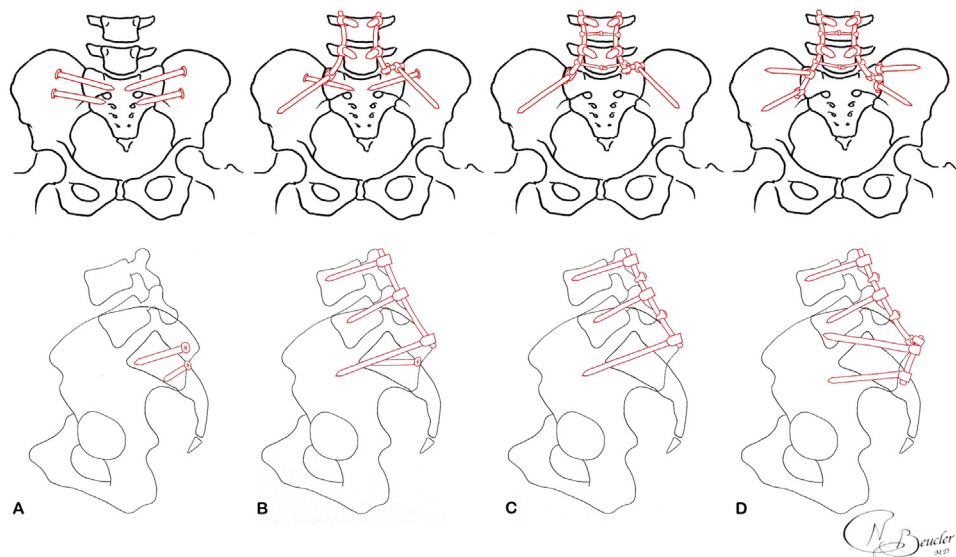


Fig. 2. Artistic view of the main surgical techniques for spino-pelvic fixation. (A) Ilio-sacral screw fixation (2001). (B) Schildhauer triangular spino-pelvic fixation (2003) combining ilio-sacral screw and lumbo-iliac fixation. (C) Modified triangular spino-pelvic fixation (Mouhsine, 2006) using lumbo-iliac fixation with multiple transverse connectors. (D) Lumbo-iliac fixation using bilateral dual iliac screws. Pencil drawings performed by Dr Nathan BEUCLER.

Conclusion

What is coined the “posterior superior iliac rim screw” by Joo et al. [4] constitutes the reappraisal of the dual upper and lower iliac column screws studied, among others, by Yu et al. [14]. Nevertheless, this case series is a reminder that spino-pelvic construct finds its place for multiple indications, among which unstable trauma but also unstable sacral neoplasm, and that the operating surgeon should be aware of the myriad of sacral and iliac screw placement techniques at his disposal in order to use the one best suited for the patient.

Ethical approval

None required.

Figure publication

I, Dr Nathan BEUCLER, corresponding author of this manuscript, certifies that I have performed the pencil drawings represented in Figs. 1 and 2. I give the right to publish these drawings without any restriction to the North American Spine Society Journal.

Declaration of Competing Interest

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