Biomechanical Analysis of Lumbopelvic Fixation Versus Posterior Sacroiliac and Anterior Pubic Symphysis Fixation in an Unstable Vertical Sacral Fracture Cadaveric Model

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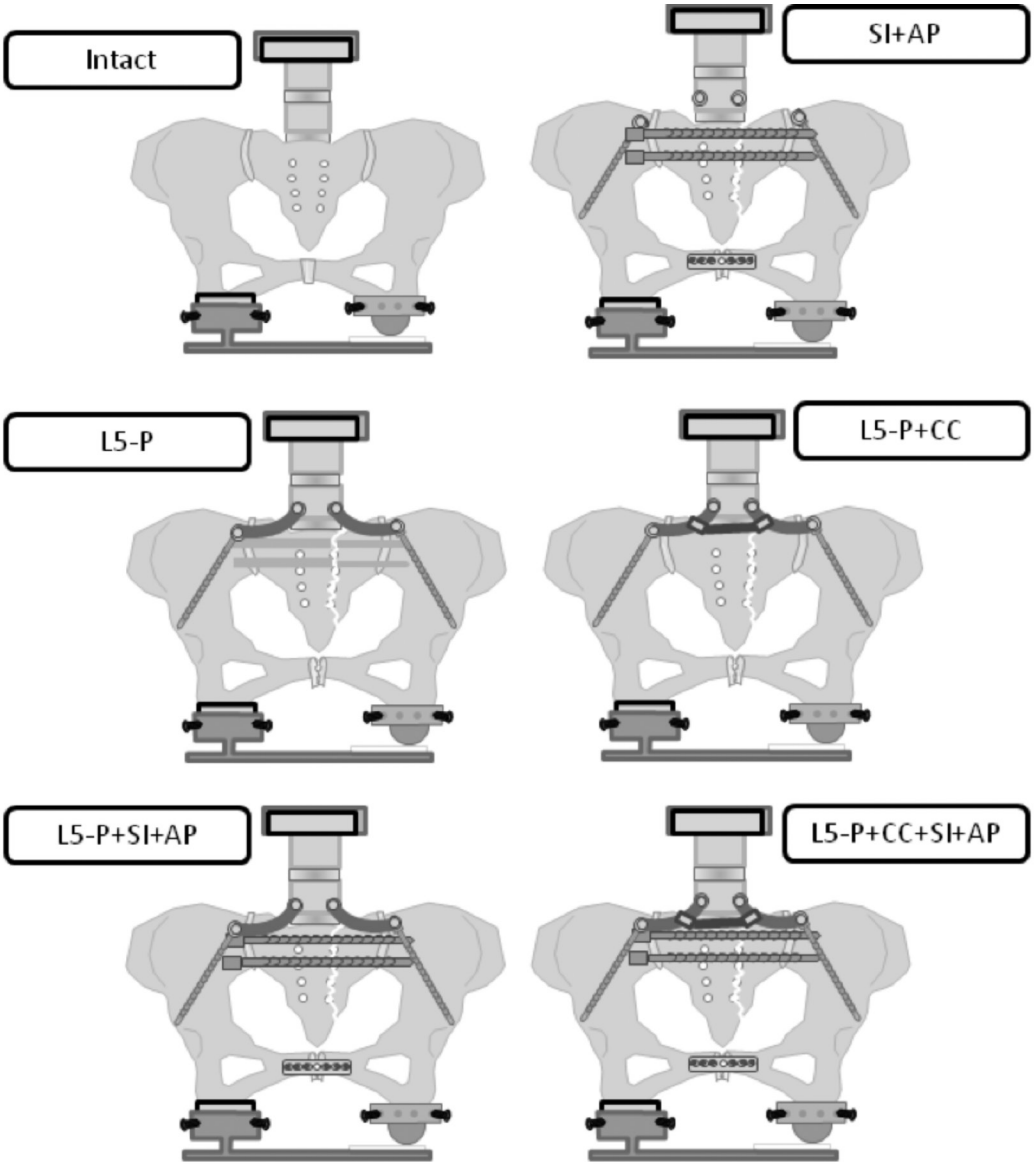
Purpose: Optimal fixation of unstable pelvic ring and sacral fractures is unknown. We hypothesized that a minimally invasive percutaneous lumbopelvic fixation (LPF) would have superior mechanical performance to traditional fixation for unstable pelvic ring fractures. This technique would be especially useful for reduction of blood loss, operative time, and infection in the setting of polytrauma.

Methods: We used seven L4-pelvic fresh-frozen nonosteoporotic cadaveric specimens. They were tested in a bilateral stance testing apparatus in a "floating hip" model. Specimens were tested in flexion-extension (FE), lateral bending (LB), and axial rotation (AR). Each specimen was tested intact. Then a vertical zone 2 fracture was created with a saw and the pubic symphysis was cut to simulate the unstable fracture pattern. Five constructs were tested (Figure 1): (1) LPF (bilateral L5-pelvis fixation using cannulated iliac screws), (2) LPF plus a cross-connector, (3) anterior symphyseal plate with transsacral screws at S1 and S2, (4) combination of LPF with plate and screw, and (5) combination with cross-slink (constructs 2 and 3). We defined our outcome measure of pelvic ring stability as the relative displacement between the iliac crests during maximum range of motion. The measurements were analyzed using one-way analysis of variance ($P < 0.05$).

Results: LPF allowed for significantly more motion in FE (1027%, $P < 0.03$) and AR (980%, $P < 0.02$) compared to all other constructs, and was only comparable to LPF with cross-connect in LB (947%, vs. with cross-connect 754%, $P = 0.901$; $P < 0.01$ for all other constructs in LB) for pelvic ring stability. Surprisingly, the combined lumbopelvic-SI (sacroiliac) fixation with (FE: 108%, LB: 188%, AR: 106%) or without (FE: 129%, LB: 205%, AR: 112%) a cross-link did not impart increased pelvic ring stability as compared to SI fixation with anterior plating (FE: 105%, LB: 154%, AR: 90%, $P = 1.00$ for all comparisons and modes of bending). Cross-links improve the mechanics of LPF, especially in flexion-extension and rotation.

Conclusion: In contrast to our hypothesis, LPF performed relatively poorly in this model and added little mechanical stiffness to the more commonly used pelvic fixation with an anterior plate and transsacral screws. Additionally, anterior plate and posterior screws outperformed LPF (without cross-connects) alone ($P < 0.05$). Use of the floating hip model realistically simulated pelvic instability. In light of this, it is possible that LPF does not provide as much mechanical rigidity to complex pelvis fractures as previously thought.

- The FDA has not cleared this drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 600.



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