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Suprapectineal Quadrilateral Surface Buttress Plate Fixation For Osteoporotic Anterior Column Posterior Hemitransverse Acetabular Fractures: A Biomechanical Comparative Study With Standard Techniques

Trauma / Pelvic Trauma / Surgical Treatment

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Background

Among acetabular fracture subtypes, anterior column posterior hemitransverse (ACPHT) patterns show a rising incidence as the population ages. These injuries typically follow a low-energy fall onto the greater trochanter, resulting in femoral head medialization and impaction of the quadrilateral surface. The combination of complex fracture morphology, poor bone quality, and posterior column medialization has led to the development of infrapectineal buttress plates. However, solid biomechanical evidence demonstrating their superiority over the standard low-profile plate remains limited.

Objectives

This study addresses this gap by comparing three plate constructs: a standard low profile pelvic plate (SP), a suprapectineal plate with integrated quadrilateral surface buttress (SSP), and an intrapelvic plate with integrated quadrilateral surface buttress (IPP), using a standardized synthetic ACPHT fracture model. We focused on three main objectives: (1) measuring construct stiffness, load-to-failure (LTF), and fragments displacement; (2) assessing the impact of an additional posterior column screw placed via the quadrilateral buttress plate; and (3) evaluating biomechanical performance after cyclic loading.

Study Design & Methods

Twenty-six hemipelvis models with a density of 429 ± 8 kg/m³, representative of osteoporotic bone, were pre-fractured and fixed according to standard clinical guidelines and the manufacturer's instructions using six 3.5 mm cortical screws. In selected specimens (denoted "_X"), an additional screw was placed into the sciatic buttress. All constructs underwent a pure load-to-failure (LTF) protocol using a mechanical testing press in a single-leg stance configuration. Three specimens were subjected to cyclic loading (40,000 cycles at 800 N) prior to the final load-to-failure test.

Results

The SSP_X construct exhibited the highest LTF (2495.3 ± 530.9 N), significantly outperforming the IPP construct (1144.7 ± 73.7 N). Stiffness ranged from 207.7 ± 30.5 N/mm (IPP) to 292.5 ± 49.0 N/mm (SSP_X), with a significant difference between the two. The X-screw significantly increased LTF (+28.9%), but the stiffness gain (+8.5%) was not significant. Posterior column collapse was consistently observed as the primary failure mechanism. Cyclic loading reduced LTF by 23.0% but modestly increased stiffness by 16.3%.

Conclusions

Marked differences in axial load response were observed among the tested constructs. The standard low-

profile plate combined with an infra-acetabular "corridor" screw can outperform a QLS buttress plate when the latter uses a conventional screw configuration. However, a suprapectineal plate with QLS buttress, incorporating both a corridor screw and a targeted "X" screw directed toward the sciatic buttress, demonstrated the highest load-bearing capacity. Further standardized studies evaluating multiple screw configurations are required to develop biomechanical recommendations regarding optimal screw placement and orientation for each plate design.

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