Customized Three-Dimensional Printing Bone Plates for Complex Acetabular Fractures: A Biomechanical Testing

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Purpose: The purpose of this study was to investigate the biomechanical properties of 3 internal fixation techniques for complex acetabular fractures. Three-dimensional printing acetabular wing plates is a new minimally invasive surgical technique for complex acetabular fractures; our primary objective was to gather evidence speaking to the biomechanical stability of three-dimensional printing acetabular wing plates methods relative to traditional fixation, with the expectation of biomechanical equivalence.

Methods: Nine pairs of freshly frozen cadaveric pelvises with column acetabular fractures were randomly divided into 3 fixation groups: (A) iliosciatic plates and 2 lag screws; (B) three-dimensional printing (3D- printing) acetabular wing plates and 2 lag screws; and (C) 2 parallel reconstruction plates and 2 lag screws. These constructions were loaded onto a biomechanical testing machine and a force of 10 N/s up to 700 N was applied to vertically transfer the load down the femur to the acetabular fossa. Fracture line displacement and stiffness values of the constructs were measured to estimate their stability.

Results: No plates were broken and no screws were pulled or broken at a force ≤700 N. When the load force reached 700 N, point 1 showed significant differences in the longitudinal displacement of fractures compared to Groups B and A, and B and C in the same load ($P < 0.05$). No significant differences between Group A and C occurred ($P > 0.05$). The performance of Group B was superior to Groups A and C. The results of point 2 showed no significant differences in the longitudinal displacement of fractures in Groups A, B, and C. Point 3 showed no significant differences in the displacement of the fracture line between Groups A and B ($P > 0.05$), both of which were superior to the 2 parallel reconstruction plates and 2 lag screws ($P < 0.05$).The axial stiffness of Groups A, B, and C were 122.4800 ± 8.8480 N/mm, 168.4830 ± 14.8091 N/mm, and 83.1300 ± 3.8091N/mm. Group B was significantly stiffer than A and C ($P < 0.05$). Loads at failure of internal fixation were 1378.83 ± 34.383 N, 1516.83 ± 30.896 N, and 1351.00 ± 26.046 N for Groups A, B, and C, respectively. Group B was significantly superior to Groups A and C ($P < 0.05$). No significant differences were evident between Groups A and C ($P > 0.05$).

Conclusion: Customized 3D-printing acetabular wing plates provide stability for acetabular fractures compared to intraspecific buttressing fixation. Acetabular wing plates effectively fix comminuted quadrilateral region fractures and prevent protrusion of the femoral head.

POSTER ABSTRACTS

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