MECHANICAL COMPARISON OF ACETABULAR REVISION CONSTRUCTS FOR THE TREATMENT OF PELVIC DISCONTINUITY

+Hur, J; Coburn, JC; Moore, DC; Crisco, JJ; Limbird, RS
Department of Orthopaedics, Brown Medical School/Rhode Island Hospital, Providence, RI, USA
johnhur@cox.net

INTRODUCTION

Pelvic discontinuity is a severe form of acetabular deficiency in revision total hip arthroplasty in which there is complete separation of the superior and inferior hemipelvis. It remains one of the most difficult problems in acetabular reconstruction. Before the hip joint can be reconstructed, the pelvic discontinuity is bone grafted then bridged and stabilized with a revision construct. Excessive motion at the discontinuity may jeopardize the bone graft’s ability to achieve bony union, leading to failure of the reconstruction.

Current options to mechanically stabilize pelvic discontinuity include porous coated cups with posterior column plating and various reconstruction cages with cemented polyethylene cups. It is suggested that posterior column plating in addition to reconstruction cages may further reduce micromotion. The benefits of this added stability, however, may or may not outweigh the risks associated with more extensive surgery.

These revision strategies have been clinically reported and have met with varied success. The purpose of this study was to mechanically test and compare the initial stability of several acetabular revision construct strategies, with and without posterior column plating, to determine which best reduced micromotion.

METHODS

A pelvic discontinuity model was created in composite hemipelves designed for biomechanical testing (Pacific Research Laboratories, Inc., WA). A miter block was used to reproduce a juxtaectal transverse osteotomy through each acetabulum (Fig. 1a). The acetabular revision constructs tested included the: 1) ZTTII porous coated cup (Depub, Warsaw, IN) with screw augmentation and a posterior column reconstruction plate (Synthes, Oberdorf, CH), 2) Antiprotrusio Cage (Depub, Warsaw, IN) and a cemented cup with (APC+) and 3) without (APC-) a posterior column reconstruction plate, and 4) GAP Ring (Osteonics, Rutherford, NJ) and a cemented cup with (GAP+) and 5) without (GAP-) a posterior column reconstruction plate

Each of the five revision strategies was built and tested in five different models (n=5/group). The APC and GAP constructs were first tested with the posterior reconstruction plate. The plate was then removed without removing the pelvis from the testing jig and the constructs were then tested again, without the plate. The ZTTII cup was only tested with the posterior column plate.

The stabilized models were mounted in a custom jig that attached the hemipelvis through the sacroiliac joint via a deformable plastic spacer to allow for a more flexible interface. The pubic symphysis simply abutted the lower wall of the jig without any fixation (Fig. 1b). The hemipelvis was axially loaded through the acetabulum with a 28mm femoral head component. The load was directed 45 degrees superomedially and 25 degrees posteriorly to create three point bending through the discontinuity and simulate the hip joint reaction force vector. The loading protocol included ten cycles of quasistatic loading in a triangular load profile to 2000N. An Optotrak system (Northern Digital, Inc.) with an experimental accuracy of .01mm, measured the rigid body motion of the superior and inferior fragments. Discontinuity marker points were also digitized to measure micromotion at the discontinuity.

Maximum displacements at anterior, medial, and posterior marker points were measured and analyzed. Significance was determined using an unpaired ANOVA with a Tukey-Kramer posttest over all constructs and paired t-tests on the APC+/- and GAP+/- constructs.

RESULTS

Generally, micromotion increased with increasing load and the posterior column moved the most in all instances. The posterior column displacements showed statistical differences between constructs. There were no differences between the APC+ and APC- constructs whereas the GAP+ construct showed significantly less motion than the GAP-construct (p < 0.05). APC+ had significantly less motion than GAP- (p < 0.05). Medial and anterior locations showed consistent results across constructs with the ZTTII cup showing more motion than the others.

DISCUSSION

This study mechanically compared five different acetabular construct strategies in a sawbones model of pelvic discontinuity. There was no significant difference in maximal displacement at the discontinuity between the porous coated cup with a posterior plate and the reconstruction cages with a posterior plate (APC+ and GAP+). The APC construct did not benefit from the addition of the posterior plate. The GAP Ring, however, did exhibit more displacement along the posterior column without the posterior plate. The power of the study may not be great enough to detect small differences. These laboratory results, with ideal materials, suggest that the benefits of added fixation may not outweigh the risks associated with more extensive surgery. Poorer bone stock may necessitate added fixation. The surgeon must weigh the differences in bone quality and fixation stiffness against the additional surgical complexity and its associated risks.

REFERENCES


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