Is the Construct Stability of the Acetabular Cup Affected by the Acetabular Screw Configuration in Bone Defect Models?

Hyungchul Park[1], Ji Hoon Bahk[2], Woo Lam Jo[1], Seung Chan Kim, Soon Yong Kwon[3], Joo-Hyoun Song[4], Kee-Haeng Lee, Se Won Lee[5], Young Wook Lim[1]
[1]Seoul St. Mary's Hospital, [2]Seoul St. Mary's Hospital, The Catholic University, [3]St Paul's Hospital, Catholic University, [4]St. Vincent's Hospital, [5]Yeouido St. MaryS Hospital

INTRODUCTION:

In revision surgery with significant segmental acetabular defects, adequate implant selection and fixation methods are critical in determining successful bony ingrowth. Commercially available total hip prosthesis manufacturers generally offer additional multi-hole options of acetabular shells with identical designs for use in revision THAs where screw holes configurations vary from product to product. This study aims to compare the mechanical stability of the two types of acetabular screw constructs for the fixation of acetabular components: spread-out and pelvic brim-focused configurations (Table 1).

METHODS:

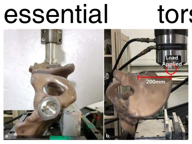
We prepared 40 synthetic bone models of the male pelvis. In half of the samples with acetabular defects, identical curvilinear bone defects were manually created using an oscillating electrical saw (Fig.1). On the right side, multi-hole-cups in which the direction of the screw holes are centered on the pelvic brim (brim-focused) and on the left side, multi-hole-cups with the direction of the screw hole spread throughout the acetabulum (spread-out) were implanted into the pelvic synthetic bones (Fig.2). Coronal lever out and axial torsion tests (Fig. 3) were performed with a testing machine, measuring load versus displacement (Fig.4).

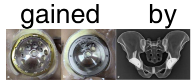
RESULTS:

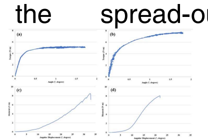
The average torsional strengths were significantly higher in the spread-out group over the brim-focused group regardless of the presence of the segmental defect of the acetabulum (p<0.001). But for the lever-out strength, the spread-out group exhibited significantly higher average strength over the brim-focused group for the intact acetabulum (p=0.004), whereas the results were reversed in the brim-focused group when the defects were generated (p<0.001). The presence of acetabular defects reduced the average torsional strengths of the two groups by 68.66% vs. 70.86%. In comparison, the decrease in the average lever-out strength was less significant for the brim-focused group than the spread-out group (19.87% vs. 34.25%, p<0.001) (Table 2).

DISCUSSION AND CONCLUSION:

For intact acetabuli, constructs of multi-hole acetabular cups with the spread-out screw holes configuration exhibited statistically better axial torsional strength and coronal lever-out strength than brim-focused configuration. With the presence of posterior segmental bone defects, the spread-out constructs demonstrated significantly better tolerance to axial torsional strength. Still, they exhibited inverted results of higher lever-out strength in the pelvic brim-focused constructs. Thus, planning revision THA in a hip with significant acetabular segmental bone defects, adjunctive brim-focused acetabular screw placement might aid initial mechanical stability in terms of lever-out strength, in addition to essential torsional stability gained by the spread-out configuration of acetabular screws.







Screw hole configuration	Manufacturer	Product name	Cup shape	Surface coating	Screw holes	Cup size
Brim-focused	Corentec (Cheonan, Korea)	Bencox® Hybrid cup	Hemi-spherical	Plasma porous sprayed Ti	11	58mm O.D.
Spread-out	Zimmer Biomet (Warsaw, IN)	G7® Acetabular System Multi-hole	Hemi-spherical	Plasma porous sprayed Ti	5	58mm O.D.

	Without acetabular defect			With acetabular defect		
Groups	Spread-out	Brim-focused	P	Spread-out	Brim-focused	P
Average axial torsion strength ± SD (range), N·m	26.27 ± 2.12	22.82 ± 1.81	<0.001†	8.23 ± 1.26	6.65 ± 1.58	<0.001†
Average coronal lever-out strength ± SD (range), N·m	15.05 ± 1.16	12.92 ± 0.91	0.004†	9.90 ± 1.61	10.35 ± 1.69	<0.001†

† These P values were less than 0.05