Optimizing Intra-Operative Impingement-Free Motion During Reverse Shoulder Arthroplasty

Jie Yao, Ermyas Kahsai[1], Frederick A Matsen[2], Scott Telfer[1], Jason Hsu
[1]University of Washington, [2]Univ of Washington Med Ctr

INTRODUCTION:

Introduction: During reverse shoulder arthroplasty (RSA) surgery, intraoperative trialing of the glenosphere and/or polyethylene liner may reveal problematic areas of impingement and allow surgeons to select the ideal final components to optimize impingement-free motion. The purpose of this study was to report the effect of changes in glenosphere and polyethylene liner parameters on impingement-free motion in an RSA model.

METHODS:

Methods: This was a computer modeling based study. Using 20 fine slice computed tomography scans of arthritic shoulders, computer models of lateralized RSAs in these 20 shoulders were generated. These models allow for range of motion modeling and calculation of impingement-free motion. The RSAs were placed into a standard position for each shoulder model.

For each of the 20 shoulder/RSA models, **eight conditions** were tested, varying either the glenosphere or polyethylene liner:

1. **Control condition:** a glenosphere radius of 18 mm, glenosphere lateralization of 2 mm, glenosphere offset of 0 mm, neutral polyethylene depth, neutral polyethylene height, and neutral polyethylene offset.
2. **Increased polyethylene insert depth:** same as control condition but +2 mm polyethylene depth.
3. **Increased polyethylene insert height:** same as control condition but +4 mm polyethylene height.
4. **Increased polyethylene insert lateral offset:** same as control condition but +3 mm polyethylene offset shifting the bony humerus medially.
5. **Decreased glenosphere radius:** same as control condition but a glenosphere radius of 16 mm.
6. **Increased glenosphere radius:** same as control condition but a glenosphere radius of 20 mm.
7. **Increased glenosphere lateralization:** same as control condition but a glenosphere lateralization of 6 mm.
8. **Increased glenosphere inferior offset:** same as control condition but a glenosphere offset of +3 mm.

For each condition, the model was taken through the following movements: **(1) abduction and external rotation**, **(2) abduction in the scapular plane**, and **(3) adduction in the scapular plane**. Impingement-free ranges of motion for each condition were recorded.

RESULTS:

Results: With abduction and external rotation, the condition with the greatest impingement-free motion was increased glenosphere lateralization with an average area under the curve of 74% ± 5% (**Figure 1, Table 1**). With abduction in the scapular plane, the condition with the greatest improvement in impingement-free motion was increased glenosphere lateralization (**Table 1**). With adduction in the scapular plane, the condition with the greatest improvement in impingement-free motion was increased glenosphere inferior offset (**Table 1**). Changing the polyethylene liner had little effect on impingement-free motion (**Table 1**).

DISCUSSION AND CONCLUSION:

Conclusions: A more lateralized center of rotation of the glenosphere increases impingement-free motion in abduction in the scapular plane and abduction and external rotation. The polyethylene liner parameters have minimal effect on impingement-free motion.

Figure 1. Changes in impingement-free motion for abduction-external rotation with changes to implant parameters. Control condition defined as glenosphere radius of 18 mm, glenosphere lateralization of 2 mm, glenosphere offset of 0 mm, neutral polyethylene depth, neutral polyethylene height, and neutral polyethylene offset.

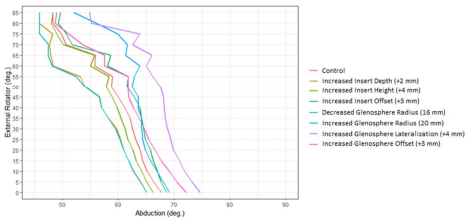

Table 1. Impingement-free motion with changes to implant parameters. AUC = area under the curve.

Condition	Impingement-Free Motion in Abduction-External Rotation: AUC (%; +/-SD)	p†	Change in Impingement-Free Motion in Abduction (deg; +/-SD)	p†	Change in Impingement-Free Motion in Adduction (deg; +/-SD)	p†
Control‡	65.6 +/- 6.3	NA	0 +/- 0	NA	0 +/- 0	NA
Increased Poly Insert Depth (+2 mm)	61.6 +/- 6.7	0.11	-1.3 +/- 2.8	0.062	-7.4 +/- 2.3	**<0.001***
Increased Poly Insert Height (+ 4mm)	64.6 +/- 5.9	0.65	1.6 +/- 4.5	0.164	0 +/- 0	NA
Increased Lateral Poly Insert Offset (+3 mm)	67.7 +/- 6.5	0.37	1 +/- 1.8	0.030	0 +/- 0	NA
Decreased Glenosphere Radius (16 mm)	61.3 +/- 6.9	0.09	-1.8 +/- 2.6	0.128	-7.8 +/- 3.1	**0.033***
Increased Glenosphere Radius (20 mm)	70.1 +/- 4.0	**0.03***	1.2 +/- 3.4	0.171	15.2 +/- 9.6	**<0.001***
Increased Glenosphere Lateralization (+4 mm)	74.4 +/- 5.3	**<0.001***	4.8 +/- 4.4	**<0.001***	10.5 +/-3.4	**<0.001***
Increased Glenosphere Inferior Offset (+3 mm)	68.2 +/- 7.2	0.30	2.4 +/- 2.7	**0.001***	24.6 +/- 18.0	**<0.001***

†Compared to baseline. ‡Control condition defined as glenosphere radius of 18 mm, glenosphere lateralization of 2 mm, glenosphere offset of 0 mm, neutral polyethylene depth, neutral polyethylene height, and neutral polyethylene offset.