Progression of Changes in Glenoid Morphology Following Humeral Head Resurfacing with Biologic Glenoid Resurfacing in Young Patients (≤60 years) at Midterm Follow-up

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INTRODUCTION: Glenoid erosion has been identified as a common etiology for revision after humeral head resurfacing arthroplasty. A revision rate of 32.5% in a cohort of patients less than 55 years of age was identified by McBride et al in an analysis of a large national registry. Humeral head resurfacing with biologic resurfacing of the glenoid is an alternative to isolated humeral head resurfacing or hemiarthroplasty. Ideally, the biologic graft material provides short-term protection of the glenoid surface theoretically minimizing the potential for glenoid erosion. Few studies have attempted to quantify glenoid erosion associated with this surgery. The purposes of this study were to 1) systematically evaluate radiographs to accurately quantify the radiographic changes from early post-operative, short-term and final follow-up and 2) to assess if the measures stabilized or continued to progress over time

METHODS: 74 patients aged ≤ 60 years with at least 5-year follow-up after undergoing resurfacing hemiarthroplasty with biologic resurfacing of the glenoid were identified. Surgeon, humeral device, HADTM material and rehabilitation protocol were consistent. Radiographic analysis (n=40) was limited to patients with adequate early post-operative (10 days to 5.4 months), short-term (12 – 36 months) and final follow-up imaging (≥ 60 months). Assessment of images was completed by one individual blinded to clinical outcomes and proficient in the use of GNU Image Manipulation Program (GIMP) software. The difference in measurement between early post-operative and short-term and early post-operative and latest follow-up images were quantified. Measures included medialization, changes in acromial index (AI), joint space, superior humeral migration (SHM), critical shoulder angle (CSA), and β-angle (Figure 1a). Paired t-tests were calculated to determine if there were statistically significant changes in any measures from short-term to final follow-up. A post hoc power analysis was completed which demonstrated 89% power to detect a 2.5mm change in medialization with a cohort of 40 subjects.

RESULTS: Forty patients (33 males/7 females) with a mean age of 51.6 years (±7.5) had adequate imaging to be included in the radiographic assessment. Reasons for exclusion from the radiographic cohort included lack of postoperative radiographs at the short-term interval, lack of follow-up in the clinic or poor-quality radiographs. Mean time from date of surgery (DOS) to early post-operative was 2.6 months (±1.2), from DOS to short-term was 26.3 months (±3.8), and DOS to final 81.7 months (±20.3, range, 60 to 127). Assessment of changes from early post-operative to short-term imaging were as follows: medialization 2.27 mm (±4.84); AI ratio 0.04 units (±0.09); joint space -0.65 (±1.43) mm, CSA 1.29° (±5.11); β-angle -0.78° (±7.21), and SHM -2.80m (±2.50). Changes observed from short-term to final imaging were as follows: medialization 1.77 mm (±3.66); AI ratio 0.05 units (±0.09); joint space -0.10 (±1.50) mm, CSA 1.21° (±3.92); β-angle -3.10° (±6.63), and SHM -1.55mm (±2.60). There were no statistically significant changes when comparing results of the early to short-term images changes with the short-term to final image changes indicating the measures stabilized between these time points. However, AI ratio and SHM did reach statistical significance (p<0.05) when evaluating changes from early imaging to final and medialization (p=0.10) and β-angle (p=0.052) trended toward significance (Figs 1b-d, 2).

DISCUSSION AND CONCLUSION: To our knowledge, this study is the first to attempt to objectively measure progression of changes in glenoid morphology over three post-operative time points in patients who underwent humeral head resurfacing with biologic glenoid resurfacing. All measures progressed across all time points analyzed but changes observed from between short-term and final follow-up did not reach significance indicating the measures tend to stabilize between those time points. However, it is unclear whether erosion stabilized as the study was not powered to detect less than 2.5 mm of medialization with only 54% of the potential cohort meeting inclusion criteria. The long-term characteristic of this cohort (final imaging from 60 to 127 months) likely contributed to the significant changes observed in SHM as incidence of rotator cuff disease has been reported to increase over time.

Figure 1a: Image demonstrating landmark lines applied to all images to obtain relevant measures

1b: Medialization and AI ratio: Red line represents YZ measurement & Green lines comprise the AI ratio (XZ/WX)

- **Medialization:** change in YZ distance
- **AI ratio:** ratio of lines XZ and WX (XZ/WX)
- **SHM:** change in AB distance
- **β-angle:** angle formed by line X and line along the floor of the supraspinatus fossa
- **CSA:** angle formed by line X and the line drawn from the lateral border of the acromion to the inferior margin of the glenoid

	Short Term	Final	p-value
Medialization (mm)			
• Mean(SD)	-2.3 (4.5)	4.0 (4.6)	0.10
• Range	-9.6 to 13.4	-6.4 to 18.1	
AI ratio			
• Mean(SD)	0.04 (0.09)	0.08 (0.11)	0.033
• Range	-0.18 to 0.26	-0.13 to 0.46	

1c: SHM as measured by AB distance: Yellow line represents AB distance

1d: CSA (green) and β-angle (red)

	Short Term	Final	p-value
SHM (mm)			
• Mean(SD)	-2.5 (2.5)	- 4.0 (2.8)	0.01
• Range	-7.8 to 3.0	-11.8 to 4.2	
Joint space (mm)			
• Mean(SD)	-0.7 (1.4)	-0.8 (1.7)	0.80
• Range	-3.7 to 3.8	-5.8 to 3.7	

	Short Term	Final	p-value
CSA (degrees)			
• Mean(SD)	1.3 (5.1)	2.5 (4.9)	0.30
• Range	-11.5 to 13.7	-11.7 to 12.1	
β-Angle (degrees)			0.052
• Mean(SD)	-0.8 (7.2)	-3.9 (6.8)	
• Range	-14.0 to 20.4	-17.8 to 10.5	

Figure 2: Changes in SHM, YZ distance and AI ratio at the 3 imaging time points;
SHM p-values: p=0.001 between 1st image and ST; p = 0.01 between ST images and Final.
YZ distance and AI ratio measures not significant.