Observations on Retrieved Humeral Polyethylene Components in Reverse Total Shoulder Arthroplasty
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PURPOSE:
Analyses of polyethylene components retrieved from revision of total knee, hip, and conventional shoulder arthroplasty have been effective in defining the impact of design, patient, and surgical factors on implant performance. The objective of our study was to establish associations between pre-revision radiographic assessment, clinical performance, and polyethylene wear analysis in patients with failed reverse total shoulder arthroplasties (TSA).

MATERIALS & METHODS:
From 2005 to the present, 14 consecutive reverse TSA humeral polyethylene components were collected from revision surgeries of eleven patients (mean age of 66.6 ± 10.2 yrs) at a single institution. The retrieved glenoid components were cataloged for damage mapping as part of an ongoing IRB-approved institutional implant retrieval program. Retrospective review of the medical records and pre-revision radiographs were available for all patients.

The polyethylene humeral bearing surfaces were examined using 31x magnification in a light stereomicroscope. Nine wear modes (abrasion, burnishing, scratching, pitting, delamination, wear through, surface deformation, third body wear, fracture) were subjectively scored for each surface. Each surface was divided into anterior, posterior, superior, and inferior quadrants for grading using an established scoring system1 and each quadrant was given a subjective damage score of 0-3 for each wear mode. The quadrant scores were then summed to arrive at a composite score, with a maximum score of 12 for each damage mode.

The most recent pre-revision plain radiographs were scored according to an accepted glenoid notching classification system2. In addition, periprosthetic lucencies of both the glenoid and humeral components were digitally measured utilizing a modification of a previously established method in which the width of the lucencies (absent, < 2mm, or ≥ 2mm) were measured in 4 zones surrounding the glenoid, and 7 zones surrounding the humerus3,4. A score of 0 was assigned to the absence of radiolucent lines, 1 for a lucency < 2mm, and 2 for a lucency ≥ 2mm. Periprosthetic radiolucent areas were independently scored by two observers who then arrived at a consensus regarding location and severity of osteolysis and/or radiolucent lines. Lastly, the inclination and height of the glenosphere relative to the lateral border of the acromion were measured on each radiograph digitally.

A two-tailed T test was calculated to compare differences in severity of wear between respective quadrants, and to compare average wear scores for each damage mode. A p-value ≤ 0.02 was statistically significant. Associations between pre-revision radiographic notching, periprosthetic radiolucent areas, glenosphere positioning, and polyethylene wear were calculated utilizing correlation coefficients.

RESULTS:
Scratching and abrasion were the most common types of wear damage present, seen in 14 and 13 components, respectively. Abrasion occurred with the greatest frequency and severity in the inferior quadrant, consistent with impingement between the medial edge of the humerosocket and the lateral edge of the scapula. More than half (57%) of the polyethylene components demonstrated embedded 3rd body debris, and 43% showed pitting, indicating that despite the short average period of implantation (0.46 ± 0.50 yrs), fatigue failure mechanisms still affected polyethylene wear. Regardless of the mode, the inferior quadrant suffered the greatest amount of wear damage, with a mean total score of 5.9, followed by the anterior (4.2), posterior (3.3) and superior (3.1) regions [Figure 1]. The difference between the inferior and anterior quadrant was statistically significant (p=0.02).

Six of the 14 components had dislocation, and 2 had glenosphere dissociation on final pre-revision radiographs. Six shoulders had evidence of scapular notching [Figure 2]; five shoulders scored had grade 1 notching while one shoulder had grade 2 notching. No significant association was found between scapular notching and glenosphere positioning, or between scapular notching and overall polyethylene wear scores. Glenoid periprosthetic lucencies were present in 85%, and humeral periprosthetic lucencies in 69%, but no frank loosening of either the glenoid baseplate, or the humeral component was appreciated intraoperatively. Increasing glenosphere tilt/inclination was associated with decreased superior glenoid radiolucency, total glenoid radiolucency, and total polyethylene wear scores.

DISCUSSION:
Impingement of the humeral polyethylene at the lateral edge of the scapula leads to inferior quadrant wear and associated polyethylene failure. The presence of 3rd body debris and pitting also indicate that implant instability may predispose the components to fatigue wear mechanisms. The long term clinical effects of glenoid notching and periprosthetic lucencies have yet to be elucidated, but appropriate glenosphere positioning is essential to improve component stability and polyethylene wear. Analysis of retrieved humeral polyethylene components, along with patient, design, and surgical factors, provide important information on the causes of component failure.

REFERENCES: