

Serum Bone Turnover Biomarkers in Revision Surgery for Shoulder Arthroplasty Loosening

Justin T. Smith MD^{1,2}, Spencer K. Wilhelm BS¹, Erin A. Baker MS¹, J. Michael Wiater MD, Kevin C. Baker PhD¹
¹Beaumont Health System, Royal Oak, MI ²Northwestern University Feinberg School of Medicine, Chicago, IL

Disclosures: Justin T. Smith MD (N), Spencer K. Wilhelm BS (N), Erin A. Baker MS (5-Arthrex, Stryker Orthopaedics, Stryker Trauma), J. Michael Wiater MD (3B-DePuy, Biomet, Zimmer; 4-Eleven Blade Solutions, Inc.; 5-Synthes, Tornier, Zimmer), Kevin C. Baker PhD (5-Arthrex, Stryker Orthopaedics, Stryker Trauma)

INTRODUCTION:

With increased volumes of shoulder arthroplasty being performed worldwide, there is interest in developing assays that can enhance decision making regarding the need for revision procedures. Component loosening remains as an important clinical challenge in shoulder arthroplasty and is one potential target for the development of prognostic assays. The purpose of this study was to compare the levels of circulating biomarkers associated with bone metabolism in patients with well-functioning shoulder arthroplasty components versus patients scheduled for revision arthroplasty due to component loosening, or implant failure.

METHODS:

Twenty participants were recruited into the study, nineteen having received a primary shoulder arthroplasty for treatment of osteoarthritis (OA) and one for a proximal humerus fracture. The experimental group (n=10) consisted of participants suffering prosthesis failure and scheduled for revision shoulder arthroplasty. The control group (n=10) consisted of participants with no prosthetic complications. Patients were selected so that the mean post-operative times were comparable (4years +/- 2months). Serum samples were collected and quantitatively assayed by enzyme linked immunosorbent assay (ELISA) for bone alkaline phosphatase (BAP), pro-collagen type I c-terminal peptide (PICP), osteoprotegerin (OPG), and parathyroid hormone (PTH). This data was then compared to the presence of loosening as assessed intra-operatively, lifestyle factors, and degree of loosening measured radiographically. A ten point radiographic scale was used to assess the severity of component loosening (Table 1).

RESULTS SECTION:

There were no statistical differences between the two groups in terms of BMI (p=1.00) or gender (p=0.910), though patients undergoing revision were significantly younger (p<0.001) than patients with well-functioning implants. In radiographic analysis, the experimental group exhibited significantly more total radiographic findings of component loosening (4/10) as compared to the control group (0.9/10) (p<0.001). Patients with well-functioning implants demonstrated higher levels of BAP (1.05 ng/mL vs. 0.91 ng/mL), PICP (0.47 ng/mL vs. 0.45 ng/mL) and PTH (69.67 ng/mL vs. 42.8 pg/mL), but lower OPG (23.6 pg/mL vs. 31.1 pg/mL), though these differences were not statistically significant. Serum biomarker levels did not correlate with radiographic parameters or intra-operative findings of loosening.

DISCUSSION:

As component loosening remains a common cause for revision shoulder arthroplasty in patients without infection, a panel of biomarkers focused on bone metabolism could provide prognostic information to physicians. Patients with well-functioning implants tended to have higher levels of markers associated with bone anabolism, though these findings did not correlate with radiographic observations and failed to achieve significance. Our group is currently incorporating additional circulating markers that are indicative of bone catabolism, such as tartrate-resistant acid phosphatase-5b (TRAP-5b) and cross-linked c-terminal and n-terminal peptides of type I collagen (CTX-I, NTX-1).

SIGNIFICANCE: This study attempts to identify easily obtained serum biomarkers indicative of arthroplasty loosening, the most common cause of prosthesis failure. Use of these markers may allow for earlier diagnosis and intervention of a prosthesis beginning to undergo loosening.

Table 1. Radiographic Grading of Shoulder Loosening

	<i>Ten Point Radiographic Loosening Score</i>	
	<i>Revision Surgery for Loosening (Avg Score)</i>	<i>Control Shoulder Prostheses (Avg Score)</i>
<i>Osteolysis of the Greater Tuberosity or Calcar</i>	0.80 ± 0.79	0.6 ± 0.52
<i>Radiolucent lines around the humeral component</i>	0.70 ± 0.48	0.00 ± 0.00
<i>Radiolucent lines around glenoid component</i>	0.40 ± 0.52	0.20 ± 0.42
<i>Wear of the glenoid bone with Hemiarthroplasty</i>	0.40 ± 0.52	0.00 ± 0.00
<i>Tilting or Subsidence of the humeral and/or glenoid component</i>	0.50 ± 0.53	0.00 ± 0.00
<i>External Stress Shielding</i>	0.10 ± 0.32	0.00 ± 0.00
<i>Internal Stress Shielding</i>	0.50 ± 0.53	0.10 ± 0.32
<i>Spot Welding</i>	0.20 ± 0.42	0.00 ± 0.00
<i>Condensation line along tip of Stem</i>	0.40 ± 0.52	0.00 ± 0.00
<i>*Total Score</i>	4.00 ± 2.05	0.9 ± 0.88

Table 1: A ten point radiographic scale was used to grade loosening in all studied shoulder arthroplasties. Osteolysis of the greater tuberosity/calcar was graded as complete (2pt), partial (1pt), or none (0pt). All other categories were graded as a yes (1pt) or no (0pt).
**The average cumulative scores were significantly greater in patients undergoing revision surgery for shoulder loosening (p<0.001) as compared to control.*