In Vivo Serum Metal Ion Levels in Primary Anatomic and Reverse Total Shoulder Arthroplasty after 5-Year Follow-up

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INTRODUCTION: It is well established metal on metal total hip arthroplasty can lead to elevated serum metal ion levels, even in well-functioning prostheses.[1-3]Elevated metal ions levels may result in local and systemic complications and may be indicative of prosthesis wear or failure. Despite the fact there are no metal on metal articulations in shoulders, there are several metal on metal junctions, which could potentially lead to metal wear and debris. One recent study indicated anatomic and reverse shoulder arthroplasties do not lead to increased serum metal ion level at one-year follow-up.[4] To our knowledge, there are no longer term studies. The purpose of this study is to quantify in vivo metal ion levels in anatomic and reverse shoulder arthroplasty at five-year minimum follow-up to evaluate if serum metal ion levels increase over time. Our hypothesis is Total Shoulder Arthroplasty (TSA) and Reverse Total Shoulder Arthroplasty will not have increased metal ion levels unless there is some type of mechanical failure.

METHODS: We prospectively analyzed serum cobalt, chromium, and titanium levels in a cohort of 52 adult patients who underwent primary anatomic (n=39) and reverse (n=13) TSA by two surgeons at our large, university-affiliated practice with an average of 5 years follow-up. Patients with replacements of other joints, revision arthroplasty, other metal implants, and chronic kidney disease were excluded. This study was approved by the IRB. Subjects' samples were drawn into 3 BD Vacutainer® Trace element K2 EDTA (K2E) 10.8 6.0 mL blood collection tubes. Chromium levels were quantified as µg/L but cobalt and titanium levels were seen only if the levels were above the lower detection limit (3 µg/L and 10.0 µg/L respectively). The cohort was described using univariate statistics and within variable associations were assessed using mixed model linear regression.

RESULTS:

The average patient age was 68.4 ± 10.8 (range = 27 - 87) years with an average follow-up of 6.0 ± 1.3 (median = 6, IQR = 5 - 6.5) years from the index procedure, and 30 (56.6%) were male. The average BMI was 29.5 ± 5.8 kgm^{-2} (median = 28.1, IQR = 24.8 – 33.0) and the most common diagnosis were primary osteoarthritis (n = 35, 67%) and rotator cuff tear (n = 4, 8%). The mean blood concentration of Chromium was 0.89 ± 0.46 (median = 0.80, IQR = 0.60 – 1.10) µg/L. We did not find a statistically significant association on linear regression between Chromium blood levels and duration of follow-up (F=0.498, p = 0.881), age (F = 1.015, p = 0.362), BMI (F = 2.12, p = 0.151), sex (F = 0.52, p = 0.475) or surgical procedure (F = 0.003, p = 0.960). No patient had serum Titanium levels above the minimum detection threshold of 10.0 µg/L and only 1 patient had Cobalt levels above the minimum detection threshold (3 µg/L). This patients (76 y/o male, BMI = 24.9 kgm^{-2}) also had elevated chromium levels (patient level = 3.5 µg/L, remaining average = 0.83 ± 0.27 µg/L) and superior migration of the humeral head was observed on follow-up X-rays, but no other major finding was observed.

DISCUSSION AND CONCLUSION:

Serum Chromium concentration after five years minimum from TSA is nearly double compared to previously reported data (0.48 µg/L) from two years after TSA[4]. Chromium levels noted in our study were similar to those reported in total hip replacement at five years follow-up[5]. There was no significant correlation between reverse TSA, anatomic TSA, or specific implant type to elevated metal ion levels. Cobalt and Titanium levels remained below detectable limit. Our study provides the longest follow-up of metal ion levels in TSA literature. These are preliminary results. Patient recruitment and data collection are ongoing.

SIGNIFICANCE:

The preliminary results of our study provide the longest-term follow-up of shoulder metal ion levels in reverse and primary shoulder arthroplasty.