INTRODUCTION:
Metal-on-metal articulating surfaces are becoming increasingly popular for hip replacement surgery. The use of metal-on-metal however has heightened concerns about the degree and magnitude of metal particle generation and the accompanying increase in circulating metal ion concentrations. Although serum and urine metal ion concentrations in patients with metal-on-metal total hip arthroplasty (THA) have been reported,

data for metal-on-metal surface arthroplasty (SA) is still limited,

and to the best of our knowledge, no study exists comparing the two in an identical protocol with implants of similar metallurgy from the same manufacturer. This ongoing study examines the serum chromium (SrCr) and cobalt (SrCo) and urine chromium (UrCr) levels in patients with metal-on-metal THA and metal-on-metal SA.

METHODS AND IMPLANTATION:
This is a prospective longitudinal study. This study was approved by our institutional review board, and all subjects consented prior to participating in the study. Group 1 consisted of 8 patients with surface arthroplasties (SAs) of the hip. The patients were implanted with the Conserve
tm surface replacement. The acetabular component consists of one piece and has sintered CoCr (F75) beads on the outer surface designed for improved fixation to obtain initial stability. The femoral component is an hemispheric CoCr (F75) shell with a chamfered cylindrical design and a short tapered stem to enhance alignment and stability. The femoral head size ranged from 46 to 52 mm. There were 7 males and 1 female with an average age at implantation of 49 years (range 28 - 62 years).

Group 2 consists of 7 patients with metal-on-metal total hip arthroplasties (THAs). All seven patients had CoCr stems: four of the stems were cemented Perfecta PDA (ASTM F799), two were cemented Perfecta IMC (ASTM F799) and one had a cementless Extended Porous (ASTM F75). The acetabular components were all cementless Transcend® Quadrant Shells, with an outer shell composed of Ti alloy. ASTM F136, coated with sintered cpTi beads (ASTM F67) and Transcend® CoCr liners (ASTM F75). The outer diameter ranged from 48 to 58 mm. The femoral heads were all CoCr (ASTM F75) six were 32 mm and one was 28 mm in diameter. There were 5 males and 2 females with an average age at implantation of 54 years (range 33 - 73 years). The components from both groups of patients, were manufactured by Wright Medical Technology Inc. (Arlington TN, USA). Serum and urine samples were collected pre-operatively and at 3, 6, 12, 24 and 36 months post implantation. Serum was assayed for Cr (SrCr) and Co (SrCo) and urine for Cr (UrCr) concentration using graphite furnace atomic absorption spectrophotometry. The detection limits in serum were 0.03 ng/ml (ppb) for Cr and 0.3 ppb for Co and 0.015 ppb for Cr in urine. Intergroup comparisons were made using the Wilcoxon-Mann-Whitney test.

RESULTS:
Fig. 1-3 are box plots showing median SrCr, UrCr and SrCo levels, respectively, for the two groups. The pink, empty, boxes are the SAs, group 1, and the blue, filled, boxes are the THAs, group 2. The solid line within the box is the median, the horizontal edges of the box are the 25th and 75th percentiles and the whiskers extending below and above the boxes are the 10th and 90th percentiles. The solid circles represent the outlying points. For both groups, post-op metal levels are elevated compared to their pre-op levels, with the exception of one case from group 2, whose SrCo levels at 3, 6, 24 and 36 months were the same as the pre-op levels (i.e.undetectable). In the patients with SAs, median SrCr levels were highest at 3 months post-op and then declined. UrCr levels were highest at 12 months, and SrCo levels were higher at 3 months and decreased until 36 months post-op at which time there were slightly higher than their previous time period. In patients with THAs, median SrCr and SrCo levels continue to increase up to 24 months post-op and decreased by 36 months post-op. Median UrCr levels continued to increase as time post-op increased. The median metal levels of the THAs were higher at 6, 12, 24 and 36 months post-op compared to those of the SAs, however the only statistical significant difference between the two groups was seen for SrCo at 12 months post-op (M-W-W p<0.4). One case in group 2, (THAs) had markedly elevated SrCr and SrCo levels at 36 months post-op (represented as an outlier on figures 1 and 3). The implant is well-functioning and the patient is very satisfied with her clinical outcome. X-rays revealed osteolysis surrounding one of the acetabular fixation screws.

DISCUSSION:
The data presented here demonstrate that SAs’ and THAs’ with metal-on-metal articulations result in elevated metal ion levels in both serum and urine following implantation. The THAs had consistently higher median levels than the SAs’ after the 3 month post-op period, but for the most part these differences were not statistically significant with the numbers studied. Unlike the SAs the THAs have two metal/metal modular connections (acetabular shell/liner and femoral head/neck) which are potential sites for the generation of CoCr fretting corrosion debris. In addition, the femoral stem in the THA has a far greater surface area than the small stem in the SA. The head also may impact the wear rate. Larger heads are associated with greater sliding distances, (which tend to increase wear), greater velocity (which tends to improve lubrication and decrease wear), and lesser contact stresses (which tend to decrease wear). Which effect predominates in-vivo is difficult to predict, and can only be ascertained by implant retrieval analysis, or possibly by the determination of metal transport and excretion. This study suggests that the larger head sizes associated with metal-on-metal SAs (approximately 50% larger than the THAs in this study) do not lead to higher levels of circulating or excreted metal. The fact that the THA outlier with the highest metal levels demonstrated screw-associated lysis at three years post-op is noteworthy and suggests that the metal levels may be a useful marker for implant performance.

REFERENCES:

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