Serum Metal Ion Concentrations in the Setting of an Oncologic Endoprosthesis: Is there Cause for Concern?
Matthew T Houdek, Mark Joseph Heidenreich1, Cory Gene Couch, Cody Wyles, Peter S Rose1, Michael J Taunton2, Hilal Maradit-Kremers1, Daniel J Berry1, David G Lewallen1
1Mayo Clinic, 2Mayo Grad School of Medicine

INTRODUCTION:
Multidisciplinary management consisting of surgery and chemotherapy has improved survival in patients with extremity bone sarcomas. Although chemotherapy is essential in survival, its use is associated with late complications including cardiomyopathy and renal failure. Limb salvage utilizing endoprostheses has become the primary means for reconstruction following oncologic resection. Endoprostheses are commonly made of cobalt-chromium (CoCr) alloy and titanium (Ti) which can undergo wear and corrosion with release of Co, Cr, and Ti ions into the surrounding tissue and blood. Elevated serum levels of Co and Cr are associated with cardiac, renal, and neurotoxicity, and as such has the potential to potentiate renal and cardiac failure in this vulnerable population. Currently there is a paucity of data examining the serum concentration of these metal ions in patients with an endoprosthesis. The purpose of the current series was to evaluate the serum concentration of Co, Cr, and Ti metal ions in patients with endoprostheses.

METHODS:
Serum samples of Co, Cr, and Ti were obtained from 20 (9 male: 11 female) patients with a history of an endoprosthetic reconstruction of the lower extremity. The mean age at the time of surgery was 46±20 years and the mean time from surgery to the serum collection was 13±10 years. The most common diagnosis was osteosarcoma (n=10). Fourteen (70%) had a history of receiving chemotherapy which would impact cardiac or renal function. Implants included distal femoral replacements (n=14), proximal femoral replacement (n=4), and total femoral replacement (n=2).
Reference ranges for the serum values included Co and Cr < 1 ppb, Ti < 2 ppb. Risk stratification was based on the current American Association of Hip and Knee Surgeons, the American Academy of Orthopaedic Surgeons, and The Hip Society recommendations for low (<3 ppb), moderate (3-10 ppb), and high (>10 ppb) risk patients.

RESULTS:
The Co levels were elevated in 13 (65%) patients and Cr levels were elevated in 7 (35%); of these 6 (30%) patients had elevated Co and Cr levels. In patients with elevated serum ion values, the mean Co level was 9.3 (range 1.4-35) ppb and the mean Cr level was 5.5 (range 1.3-21.7) ppb. The Ti levels were elevated in 4 (20%) patients. The mean Ti level in patients with elevated levels was 13.5 (range 3-42) ppb.
Based on the current recommendations for risk-stratification, 12 (60%) would be low risk, 4 (20%) would be moderate risk, and 4 (20%) would be considered high risk. There was no difference in the time from implant placement to serum collection in patients with elevated serum metal ion values and those without elevated values (12±9 vs. 16±12 years, p=0.32). In addition, there was no difference in the time from implant placement to serum collection in patients with a low risk or moderate/high risk groups (13±9 vs. 14±11 years, p=0.83).
In patients with elevated metal ion values 12 (92%) had a reconstruction utilizing a Stryker (Mahwah, New Jersey) GMRS implant while 1 (8%) was reconstructed with a Zimmer/Biomet (Warsaw, Indiana) OSS implant. In patients without elevated levels, implants included Stryker GMRS (n=5), Depuy (Warsaw, Indiana) LPS (n=1), and Zimmer/Biomet (n=1).

DISCUSSION AND CONCLUSION: In certain patients with an oncologic modular endoprosthesis, serum metal ion values are elevated. Currently there is a lack of data to guide clinicians on if metal-ion levels should be checked on patients with these implants and if these elevations can impact the patient’s clinical outcome. The results of the current study indicate that Co levels were elevated in many of these patients, with 40% of patients being at least moderate risk for complications associated with their implant. Further studies are needed to determine if these ion levels change over time and if these serum ion levels lead to cardiac and renal complications.