

# Serum Metal Levels Following Total Ankle Arthroplasty

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## INTRODUCTION:

Wear debris from metal implants can result in local and systemic complications and has become a growing concern. Potential complications include implant loosening, peri-implant osteolysis, adverse local tissue reaction with destruction of surrounding soft tissues, and end-organ deposition leading to cardiac and neurologic compromise. Implant modularity is known to be an important factor in the development of elevated serum metal levels and associated complications. Such components are susceptible to mechanically assisted crevice corrosion and fretting damage that results in metal ion release. Little is known regarding circulating metal levels in patients following total ankle arthroplasty (TAA). The purpose of this study is to quantify post-operative serum metal levels in patients who have undergone primary TAA and to evaluate the impact of tibial component design.

## METHODS:

Twenty patients having undergone primary, unilateral TAA at a single institution from January 2010–January 2023 were recruited. Ten patients with a non-modular tibial component using the Stryker INFINITY Total Ankle System were included in the resurfacing cohort, and 10 patients with a modular tibial component using the Stryker INBONE Total Ankle System were included in the stemmed cohort. A control group consisted of 21 patients without implants from a previous study at the same institution. The tibial components of both implant systems are composed of titanium, aluminum, vanadium and plasma spray coated with unalloyed titanium. Talar components are fabricated from cobalt, chromium, molybdenum alloy. An ultra-high molecular weight polyethylene insert was used in both cohorts. Following study enrollment, subjects attended a one-time visit at minimum 12 months post-operative. Primary outcome measures included serum cobalt, chromium, and titanium levels measured by ICP-MS. Secondary outcome measures included patient-reported outcome measurement surveys.

## RESULTS:

There were no differences in age, gender, body mass index, or follow-up between the control, resurfacing implant, and stemmed implant cohorts. Serum titanium levels were greater in the resurfacing cohort (0.619 µg/L) and stemmed cohort (0.993 µg/L) than in the control cohort (0.150 µg/L) ( $p < 0.001$  and  $p < 0.001$  respectively; Table 1). Serum titanium levels were greater in the stemmed group than in the resurfacing group ( $p = 0.003$ ; Table 1). Serum cobalt and chromium levels did not differ between study cohorts or controls ( $p > 0.05$ ; Table 1). Patient-reported outcomes did not differ between groups ( $p > 0.05$ ).

## DISCUSSION AND CONCLUSION:

Results from this study provide the first evidence that TAA is associated with elevated serum metal levels. In this study, serum titanium levels were elevated following TAA while chromium and cobalt levels were not elevated. Patients with stemmed implants demonstrated higher titanium levels than patients with resurfacing implants. Possible explanations for these findings may be related simply to the greater surface area of the stemmed implants or greater release of metallic debris from tribocorrosion at the numerous modular junctions. These findings prompt the need for additional research in this area.

	Control (n=21)	Resurfacing (n=10)	Stemmed (n=10)	P-values from comparisons*		
				Control versus resurfacing	Control versus stemmed	Resurfacing versus stemmed
Titanium (serum µg/L)						
Median	0.150	0.619	0.993			
(25 <sup>th</sup> -75 <sup>th</sup> percentile)	(0.150-0.150)	(0.519-0.737)	(0.820-1.384)			
(Range)	(0.150-0.330)	(0.310-0.924)	(0.432-1.887)			
Number below detection limit of 0.3 µg/L†	20	0	0			
Cobalt (serum µg/L)				0.149	0.771	0.264
Median	0.075	0.118	0.075			
(25 <sup>th</sup> -75 <sup>th</sup> percentile)	(0.075-0.075)	(0.075-0.230)	(0.075-0.152)			
(Range)	(0.075-0.663)	(0.075-0.361)	(0.075-0.196)			
Number below detection limit 0.15 µg/L†	17	5	7			
Chromium (serum µg/L)				0.205	0.176	0.908
Median	0.050	0.079	0.135			
(25 <sup>th</sup> -75 <sup>th</sup> percentile)	(0.050-0.103)	(0.050-0.299)	(0.050-0.141)			
(Range)	(0.050-0.354)	(0.050-0.363)	(0.050-0.245)			
Number below detection limit 0.1 µg/L†	15	5	4			

\* Mann-Whitney U test.

† Consistent with published precedent, metal level values that were below the detection limit were analyzed as one half the detection limit.