Synovial Barium and Zirconium Ions are Promising Markers for Aseptic Loosening

Aleksander P. Mika, Charles Trevor Crellin, Jacob Michael Wilson, Stephen Matthew Engstrom[1], Gregory G Polkowski[2], John R Martin
[1]Vanderbilt Univ-Vanderbilt Ortho Inst, [2]Vanderbilt Orthopaedics

INTRODUCTION:

Implant loosening following primary total knee arthroplasty (TKA) remains the most common aseptic indication for revision. Aseptic loosening can be difficult to diagnose as radiographic findings may be absent. Therefore, effective screening tests are needed. The purpose of this study was to evaluate if synovial Barium and/or Zirconium levels would be elevated in cases of confirmed aseptic loosening. We hypothesized that loose implants release detectable amounts of these bone cement radiopacifiers and would be possible markers of aseptic loosening.

METHODS:

Patients undergoing revision TKA at a single institution were prospectively enrolled in this study. Synovial fluid was sampled at the time of revision surgery prior to arthrotomy, any instrumentation, or cement manipulation. Synovial fluid samples were processed and then analyzed by inductively coupled plasma mass spectrometry. Detection of Barium or Zirconium was considered a positive result if the sample exceeded the lowest calibration standard (22 µg/L). Components were assessed intraoperatively and determined to be either well fixed or loose by the fellowship-trained arthroplasty surgeon of record.

RESULTS:

Twenty patients (7 aseptic loosening, 13 well-fixed) were prospectively enrolled in this study. The mean barium and zirconium levels were 314.21 µg/L vs. 32.46 µg/L (p=0.0937), and 45.24 µg/L vs. 0 µg/L (p=0.01) for loose versus well-fixed implants, respectively (Figure 1). Zirconium was 57.14% sensitive and 100% (Table 1) specific for component loosening while Barium was 85.71% sensitive and 53.85% specific (Table 2).

DISCUSSION AND CONCLUSION:

Aseptic loosening remains a challenging clinical diagnosis. While the current sample size is limited, our results indicate that the common cement radiopacifiers Barium and Zirconium are promising synovial fluid markers that are elevated in patients with implant loosening. These synovial fluid markers demonstrate potential to improve the diagnosis of aseptic loosening. We continue to enroll patients and are planning future multicenter studies to confirm these preliminary results.

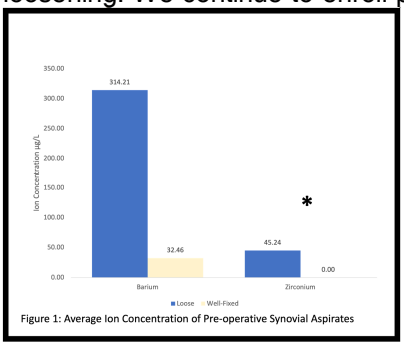

Figure 1: Average Ion Concentration of Pre-operative Synovial Aspirates

Table 1: Zirconium		Implant Well Fixed	
		(+)	(-)
Detectable Ion Level	(+)	4	0
	(-)	3	13
Sensitivity and Specificity		**Sensitivity**: 4/4+3 = 57.14%	**Specificity**: 13/13+0 = 100.00%

Table 2: Barium		Implant Well Fixed	
		(+)	(-)
Detectable Ion Level	(+)	6	6
	(-)	1	7
Sensitivity and Specificity		**Sensitivity**: 6/6+1 = 86.71%	**Specificity**: 7/7+6 = 53.85%