Effect of Total Hip Arthroplasty Bearing Type on Risk of Revision in the Younger Population via the American Joint Replacement Registry

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INTRODUCTION: Continued advancements in total hip arthroplasty (THA) implant designs and tribology, particularly fourth generation ceramics as well as ceramicized metal, may offer improved durability in younger, higher-demand patients through reduction in wear-related complications such as aseptic loosening and instability. The impact of this theoretically improved tribology, however, has not been well-characterized. Previous studies have suggested that despite theoretical wear benefits and increased costs, so-called “hard-on-hard” bearings still demonstrate increased revision rates. Many of these studies, however, were performed with alumina ceramics and predated the advent of alumina matrix composite (AMC) ceramics in 2003, or had difficulty overcoming selection bias, with these bearings preferentially chosen in more “at-risk” patients. The impact of AMC ceramic and its theoretical ability to optimize wear performance while minimizing catastrophic failure risk has not been well understood, especially in younger patients. As such, the aim of this study was to compare the revision rates of modern bearing couples in the younger THA population in the United States.

METHODS:

American Joint Replacement Registry (AJRR) data was analyzed between January 2012-June 2022 for patients who underwent a primary THA, age between 18-53 years, had a 1-year follow-up visit, and received one of six bearing types (Ceramic on Ceramic [CoC], Ceramic on Cross-linked Polyethylene [CoP], Ceramic on Antioxidant Polyethylene [CoAOP], Ceramicised Metal on Cross-linked Polyethylene [CMoP], Cobalt Chromium on Cross-linked Polyethylene [aka “metal on polyethylene,” MoP], and Cobalt Chromium on Antioxidant Polyethylene [MoAOP]). Analysis of variance, Chi-square and Fisher’s Exact tests were performed on demographic and revision data. Cox regression analyses were conducted to determine the cumulative percent revision between the bearing types while controlling for age and sex.

RESULTS:

A total of 101,313 primary THA cases were identified for this study. Patients had an average age of 47.87 (± 6.86) years, were mostly males (53.68%), white (84.28), and had a primary diagnosis of osteoarthritis (86.25%). The majority received a CoP bearing (64.2%). All bearing couples performed well with a 10-year survivorship over 96%. When compared to MoP, lower all-cause revision rates were seen with CoAOP (CIs: 0.64, 0.94, $p = 0.003$), and CoP (CIs: 0.64, 0.84, $p < 0.001$), with CMoP (CIs: 0.59, 0.87, $p < 0.001$) demonstrating the lowest overall revision rates. A significantly lower cumulative percent of revision for aseptic loosening was identified for CoAOP (HR = 0.41; CIs: 0.27, 0.64; $p < 0.001$), CoP (HR = 0.55; CIs: 0.41, 0.74; $p < 0.001$), and CMoP (HR = 0.42; CIs: 0.56, 0.70; $p < 0.001$) when compared to MoP. In addition, MoP demonstrated a significantly higher cumulative percent of revision due to aseptic loosening (HR = 7.58; CIs: 1.06, 54.24; $p = 0.04$), specifically when compared to CoC. Lastly, CMoP demonstrated a significantly lower cumulative percent revision for fracture when compared to MoP (HR = 0.37; CIs: 0.14, 0.96; $p = 0.04$) and CoC (HR = 0.19; CIs: 0.05, 0.78; $p = 0.02$).

DISCUSSION AND CONCLUSION:

All cause revision rates in this younger population remain low, at less than 4% at ten years, irrespective of bearing, with ceramicized metal on cross-linked polyethylene demonstrating the best all-cause revision performance. Head composition remains a major driver of survivorship, with ceramic and ceramicized metal outperforming cobalt chrome uniformly. Despite a theoretical reduction of fracture risk, even fourth generation CoC bearings continue to underperform “hard-on-soft” bearings with respect to all-cause revision and specifically, aseptic loosening. Ceramic or ceramicized metal, on a polyethylene bearing (cross-linked, with or without antioxidant properties), should be considered the gold standard in this patient population.

Figure 1. Cumulative Percent Revision Curves for All Cause Revision.

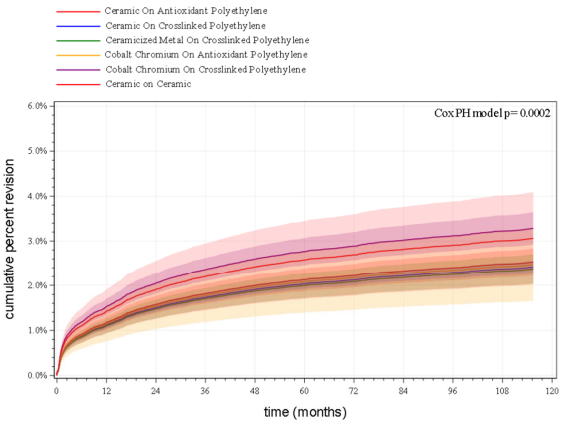

Table 1. Revision Data by Bearing Type.

	Ceramic on Antioxidant Polyethylene	Ceramic on Cross-linked Polyethylene	Ceramic on Ceramic	Ceramicized Metal on Cross-linked Polyethylene	Cobalt Chromium on Antioxidant Polyethylene	Cobalt Chromium on Crosslinked Polyethylene	Overall	p-value
	(N = 12,312)	(N = 65,059)	(N = 1,169)	(N = 10,084)	(N = 1,596)	(N = 11,093)	(N = 101,313)	
All-Cause Revision (%)								
No	12,042 (97.81)	63,744 (97.98)	1,136 (97.18)	9,887 (98.05)	1,561 (97.81)	10,770 (97.09)	99,140 (97.86)	**<0.001**[a]
Yes	270 (2.19)	1,315 (2.02)	33 (2.82)	197 (1.95)	35 (2.19)	323 (2.91)	2,173 (2.14)	
Revision for Aseptic Loosening (%)								
No	12,281 (99.75)	64,852 (99.68)	1,168 (99.91)	10,060 (99.76)	1,592 (99.75)	11,023 (99.37)	100,976 (99.67)	**<0.001**[b]
Yes	31 (0.25)	207 (0.32)	1 (0.09)	24 (0.24)	4 (0.25)	70 (0.63)	337 (0.33)	
Revision for Fracture (%)								
No	12,300 (99.90)	64,986 (99.89)	1,166 (99.74)	10,079 (99.95)	1,596 (100.00)	11,077 (99.86)	101,204 (99.89)	0.11[b]
Yes	12 (0.10)	73 (0.11)	3 (0.26)	5 (0.05)	0 (0.00)	16 (0.14)	109 (0.11)	

Bolded = Statistically Significant; [a] = Chi-square Test Statistic; [b] = Fisher's Exact Test Statistic