Does the use of ceramic femoral head versus metal femoral head improve the outcome of primary total hip arthroplasty?

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Response/Recommendation: The use of fourth-generation ceramic femoral heads with highly cross-linked polyethylene may be associated with decreased linear wear rates and improved patient-reported outcomes, when compared to other bearing surfaces.

Level of Evidence: Moderate

Rationale:

Total hip arthroplasty (THA) is a highly successful and cost-effective procedure for the treatment of end-stage osteoarthritis of the hip. However, long-term implant survivorship may be limited by polyethylene wear, osteolysis and adverse local tissue reactions, contributing to the corresponding increase in revision THA procedures worldwide [1–3]. Highly cross-linked polyethylene (XLPE) acetabular liners were first introduced in the 1990s [4]. Given its superior resistance to wear, XLPE liners have now largely replaced conventional polyethylene liners in patients undergoing primary THA [5]. Similarly, ceramic femoral heads have gained traction following promising reports on their long-term survivorship and decreased risk of postoperative periprosthetic joint infections, despite the possibility of component fracture [6–10]. Notwithstanding, the optimal material for use in femoral heads remains unclear. While several studies have shown no difference in wear rates between metal-on-polyethylene (MoP) and ceramic-on-polyethylene (CoP) [11–13], orthopaedic surgeons have cited cost and personal experience as factors influencing their implant selection [14]. In recent years, an increasing number of studies have attempted to clarify if there are differences in implant survivorship, patient-reported outcomes, and reoperation rates between MoP and CoP bearings [15–17].

Despite numerous studies on the survivorship and outcomes of MoP and CoP bearings in primary THA, it is important to note that there is a paucity of high-quality data comparing fourth-generation ceramic and metal femoral heads on XLPE acetabular liners [17]. In a meta-analysis of 6 studies, Gosling et al found no significant difference in revision rates, linear wear, or volumetric wear when comparing MoP to CoP bearings [15]. However, their analysis only included randomized controlled trials. In addition, all patients received non-highly cross-linked polyethylene liners and there was substantial variability in the generation of ceramic heads used in the different studies [15]. In another study, Mertz et al performed a meta-analysis and found fourth-generation ceramic heads had decreased linear wear rates when compared to cobalt-chromium (CoCr) femoral heads [17]. It is also important to note that Mertz et al included both comparative and noncomparative studies that used fourth-generation ceramic and CoCr femoral heads with XLPE acetabular liners, increasing the generalizability and reproducibility of their findings [17]. Upon weighted analysis of 36 studies and 2,316 patients, CoCr femoral heads demonstrated significantly increased rates of annual wear (0.063mm/year ± 0.061, CI: 0.049-0.077) when compared to ceramic femoral heads (0.047mm/year ± 0.057, CI: 0.033-0.062, $p<0.01$) [17]. Additionally, three of the four comparative studies included in the meta-analysis found decreased wear rates with ceramic versus CoCr femoral heads, although none of these associations reached statistical significance [3,18–20]. However, the results of Mertz et al are

limited by the lack of measurement type homogeneity, with each method of measurement demonstrating various amounts of wear [17].

As the number of primary THA procedures performed annually continues to increase [21], it is important to identify implant-specific risk factors that may be associated with a higher risk of revision. Future research should attempt to identify novel implant materials that can both prolong time to revision THA as well as reduce the risk of complications associated with implant wear, osteolysis and adverse local tissue reactions. Based on the available literature, it appears that the use of fourth-generation ceramic femoral heads with highly cross-linked polyethylene may be associated with decreased linear wear and improved outcomes when compared to conventional cobalt-chromium femoral heads.

MeSH Terms

1. Total hip arthroplasty
2. Hip prosthesis
3. Ceramic
4. Metal
5. Polyethylene
6. Arthroplasty, replacement, hip
7. Prosthesis design
8. Prosthesis failure
9. Reoperation
10. Risk factors
11. Follow-up studies

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