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Comparison of Postoperative Complications Following Metal-on-Metal Total Hip Arthroplasty With Other Hip Bearings in Medicare Population

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ABSTRACT

Background: The use of metal-on-metal (MoM) hip bearings has declined in the recent years due to strong evidence of their high complication rates and early failure. Hip implants with highly cross-linked polyethylene liners and ceramic bearings have become the modern implants of choice. We sought to determine if MoM implants are associated with higher complication and revision rates when compared to other hip bearings in the Medicare population.

Methods: We retrospectively reviewed a Medicare database (2005-2011) for patients who underwent a primary total hip arthroplasty with a MoM, metal-on-polyethylene (MoP), ceramic-on-polyethylene (CoP), or ceramic-on-ceramic (CoC) implant (minimum 2 years of follow-up). Patient comorbidities and medical/surgical complication rates were analyzed at various time points postoperatively.

Results: We identified 288,118 patients, including 81,520 patients with a MoM implant, 162,881 with MoP, 33,819 with CoP, and 9898 with CoC implant. Surgical complication rates were higher for MoM implants including infection, osteolysis/polywear, mechanical complications, and need for hip irrigation and debridement. Overall revision rates were significantly higher for MoM implants (5.28%) compared to MoP (4.28%, odds ratio [OR] 1.26, $P < .001$) and CoP (3.52%, OR 1.55, $P < .001$) but only by one to two percent. MoM revision rates were similar to CoC implants (4.94%, OR 1.00, $P = .096$).

Conclusions: MoM implants were associated with higher revision rates (5.28%) compared to MoP (4.28%) and CoP (3.52%) implants in the Medicare population. Both complication and revision rates were comparable to CoC implants.

Metal-on-metal (MoM) hip bearings have become the focus of scrutiny and regulation due to growing evidence of their high complication and revision rates. The conventional metal-on-polyethylene (MoP) hip bearing popularized by Charnley in the 1960s continues to be the most common hip implant used, largely due to its longstanding track record and safety profile. Unfortunately, conventional low-molecular-weight polyethylene has shown to have high volumetric wear rates when used with cobalt-chromium femoral heads. Polyethylene wear particles can cause severe local osteolysis, implant loosening, and ultimately implant failure [1]. MoM bearings gained early popularity in the 2000s due to their theoretical advantages of generating less wear particles and allowing for a larger femoral head to improve hip stability and range of motion [2]. Their use expanded from 7% of all hip bearings used in 2001 to 31% by 2011 [3]. It is estimated that greater than 1 million MoM bearings were implanted since the mid 1990s.

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The protocol was reviewed by the Duke Medicine Institutional Review Board for Clinical Investigators and deemed to meet the definition of research not involving human subjects as described in 45 CFR 46.102(f), 21 CFR 56.102(e) and 21 CFR 812.3(p) and satisfies the Privacy Rule as described in 45CFR164.514. This institutional review board declaration is in effect from December 3, 2013 and does not expire. Further documental available for review on request.

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Over the last few decades there has been growing data that metal ion wear debris generated from MoM hip bearings can be just as damaging, if not more so, than the wear particles generated from conventional polyethylene [4–9]. Retrieval studies have shown that the MoM interface between the metal liner and femoral head generates cobalt and chromium metal ions that exert both local and systemic effects [5]. Locally the metal ions are uptaken by inflammatory cells and activate a lymphocyte dominated immune-regulatory cascade that leads to adverse local tissue reactions. This includes formation of large sterile fluid collections known as pseudotumors, along with soft tissue necrosis and bone osteolysis [6,7]. These local tissue reactions are believed to be the main cause for early implant failure and need for revision. Systemically, metal ions can be absorbed into various body fluids including blood, serum, plasma, cerebral spinal fluid, and urine [6]. Numerous case reports have suggested that the systemic circulation of metal ions is responsible for symptoms such as peripheral neuropathy, hearing loss, ocular toxicity, visual impairments, thyroid toxicity, and cardiomyopathy [10]. There is also concern that these metal ions exert carcinogenic effects on body tissues, yet no studies to date have confirmed this causative relationship in vivo. These reports on the adverse effects of metal ions have led to the recall of several MoM hip bearings and increased regulation for their use. Consequently, the use of MoM implants has decreased to a low of 1% of all hip implants used as of 2012 [3].

As an alternative to MoM implants, ceramic-on-ceramic (CoC) implants were introduced as another hard-on-hard bearing with similar theoretical advantages of lower wear rates and less osteolysis than MoP implants. CoC implants reached a peak in use of 11% of all hip bearings in 2004 but did not experience the same surge in popularity as seen with MoM implants [3]. CoC bearings have been associated with head or liner component fracture during implantation along with an undesirable squeaking noise in vivo. Ceramic implants also carry a higher cost compared with other bearings [11]. These factors have likely contributed to the decline in their use to 1% of all hip bearings as of 2011. Recent studies still support CoC use in younger patients given the lower rates of revision, osteolysis, loosening, and dislocation when compared to conventional MoP [11].

While the use of MoM and CoC implants has declined over the last decade, there has been a rise in the use of ceramic-on-polyethylene (CoP) implants. As of 2011, only 6% of all hip implants used were CoP but this has since increased to 38% as of 2012 [3]. The CoP implants still carry the risk of osteolysis from polyethylene wear particles; however, they have shown to have lower wear rates than MoP implants [12]. Furthermore, the use of highly cross-linked polyethylene has significantly improved wear properties of polyethylene liners. When CoP implants have been compared to MoP in the literature with regards to outcomes and need for revision, results have been variable [13]. Most studies have failed to find a significant difference between ceramic or cobalt-chromium femoral heads when coupled with polyethylene thus far, but long-term follow-up studies may show differently.

There have been several studies and meta-analyses comparing outcomes of all the different types of hip implants. The goal of this study was to determine if MoM implants are associated with higher complication and revision rates when compared to other hip bearings, specifically in the Medicare population. To date, this is one of the largest retrospective studies comparing complication and revision rates of the various hip bearings.

Methods

Data Collection

We conducted a retrospective review of a Medicare database between 2005 and 2011 containing 100% of inpatient and 100% of outpatient administrative records using PearlDiver Technologies. First, all patients who underwent a primary total hip arthroplasty (THA) were identified using both the corresponding International Statistical Classification of Diseases and Related Health Problems -9 (ICD-9) procedure code (81.51) and Current Procedural Terminology code (27130). By looking at distinct patient volumes, no patients were double counted but all primary THAs were included. Using the PearlDiver Boolean command language, we used the ICD-9 diagnosis code V43.64, “hip joint replacement,” and used this to isolate the cohort of patients who had this diagnosis before their date of primary THA. We then excluded these patients from our final cohort. Next, we used another function in the PearlDiver command language to find the cohort of patients who received more than one primary THA during the timeframe of the database. We also excluded this group from our final cohort. This effectively isolated a cohort of patients with only one primary THA. Finally, we used the bearing specific ICD-9 procedure codes for MoP, MoM, CoC, and CoP (00.74, 00.75, 00.76, 00.77) and found the cohort of patients who were both coded with a primary THA and the respective bearing during the same hospital stay. This gave us a cohort of 288,118 patients with primary THAs. Within this cohort, 81,520 patients had a MoM bearing surface THA, 162,881 patients with MoP bearing surface THA, 33,819 with CoP bearing surface THA, and 9898 with CoC bearing surface THA. Then, using relevant ICD-9 and Current Procedural Terminology codes, we identified the rates of various postoperative complications that occurred within 30 days, 60 days, 90 days, 1 year, and overall. Comorbidities of the cohorts were identified based on the most up-to-date standardized Elixhauser comorbidity measure and relevant ICD-9 diagnosis codes.

Statistical Analysis

Patients were categorized into one of the 4 groups for statistical analysis based on the type of hip bearing received: MoM, MoP, CoP, or CoC. We performed comparative analysis between groups using both chi-square test and Fisher exact test, with statistical significance defined as P value less than 0.05. In one analysis, we used the MoP group as a control to determine odds ratio [OR] of all comorbidities and complications for each group. In the second analysis, we used the MoM as the control group to calculate the OR. Only variables with a P value $< .05$ based on both chi-square test and Fisher exact test were deemed statistically significant.

Results

Between 2005 and 2011, we identified 162,881 patients in the Medicare database who received a unilateral MoP hip implant, 81,520 patients with a MoM implant, 33,819 patients with CoP implant, and 9898 patients with CoC implant (Table 1). Between 2005 and 2011, there was a gradual decrease in the number of patients with an MoM implant where conversely the number of patients receiving a CoP implant increased from year to year (Fig. 1). MoP implants were consistently used in 50-60% of patients over the 7-year period, whereas CoC implants were used in less than 5% of patients most years.

MoM vs MoP Outcomes

Patients who received an MoM implant were overall younger in age (OR 1.77 for age younger than 65 years, $P < .001$; OR 1.243 for age 65-69 years, $P < .001$) with a higher proportion being male (OR 1.279, $P < .001$) when compared to patients who received an MoP implant (Table 1). There were comparable rates of certain comorbidities