The Epidemiology of Total Hip Arthroplasty Bearing Surface Use in the United States

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Introduction:

Metal on conventional ultra-high molecular weight polyethylene (UHMWPE) bearings have produced excellent long-term results in total hip arthroplasty (THA), with 20 year survivorship of almost 80%. However, the consequences of bearing surface wear, including osteolysis and aseptic loosening, have been a leading cause of late revision THA, especially in younger, more active patients. Hard-on-hard ("premium") bearing surfaces (ceramic-on-ceramic and metal-on-metal) offer the potential to decrease the incidence of THA revisions caused by bearing surface-related failures. Numerous laboratory studies have demonstrated substantial reductions in wear rates associated with both ceramic-on-ceramic (CoC) and metal-on-metal (MoM) bearings relative to metal-on-conventional UHMWPE bearings, and many clinical studies have demonstrated excellent short- and medium-term outcomes in patients with CoC and MoM bearings. However, the specific indications for using these advanced technologies remain controversial.

Beginning in October, 2005, three new modifier codes were added to the International Classification of Diseases, 9th Clinical Modification (ICD-9-CM) procedure codes. These coding changes allow identification of the specific bearing surface used in THA procedures in large administrative databases, and have enabled a large scale evaluation of bearing surface usage throughout the United States. The purpose of this study was to assess current bearing surface utilization in the United States by patient, hospital, and geographic characteristics.

Methods:

The Nationwide Inpatient Sample (NIS) database was used to analyze bearing surface type and demographic characteristics associated with 112,094 primary THA procedures performed in the U.S. between October 1, 2005 and December 31, 2006. The NIS is a stratified, statistically valid survey of hospitals conducted by the Federal Healthcare Cost and Utilization Project (HCUP). All discharge records from each of the selected hospitals are collected and form part of the NIS file for a given year. In 2006, the NIS had a sample size of approximately 8 million records from 1,045 hospitals in 38 states, which represent approximately 20% of all discharges from community hospitals in the United States, regardless of payment source.

The prevalence of each THA bearing surface type (metal-on-polyethylene, metal-on-metal, ceramic-on-ceramic) was calculated using NIS for population subgroups in the United States stratified by age, gender, race, diagnosis, census region, primary payer class, and hospital characteristics (including size, location (e.g., urban or rural), and teaching status).

Results:

Overall, metal-on-polyethylene (MoP) was the most commonly reported THA bearing surface (51%), followed by metal-on-metal (MoM) (35%) and ceramic-on-ceramic (CoC) (14%) The average age for the entire THA patient population was 65, but there were considerable differences in reported bearing surface use across age groups. Among patients 65 and older, 66.6% had MoP, 27.4% had MoM, and only 6.0% had CoC bearing surface for their THA. In contrast, among patients younger than 65, 41.8% had MoM, followed by 35.8% with MoP, and 22.4% with CoC, and these differences were significant (p<0.001). 40% of M-M bearings and 21% of C-C bearings were reported in patients over age 65. There were also significant differences in reported bearing surface use between men and women. The majority of women (57.1%) had MoM compared to only 44.5% among men (p<0.001). MoM bearings were a close second for men (39.7%) but considerably less common among women (30.1%). CoC bearing surface use was 15.9% for men and 12.8% for women. These differences were statistically significant (p<0.001). As might be expected, there was a highly significant difference (p<0.001) in reported bearing use by payer type. Among Medicare patients, 64.9% reported MoP bearings, compared with 28.5% MoM and 6.5% CoC. In contrast, among patients with private insurance, a similar percentage of MoP (37.4%) and MoM (40.6%) bearings were reported, with the remaining 22.0% reporting a CoC bearing. Medicaid patients and patients with no insurance represented only 7% of the THA patients, and reported bearing surface usage was similar to that of patients with private insurance, which may be explained by their similarities in age to privately insured patients.

Among urban non-teaching hospitals, MoP bearings were reported almost twice as commonly as MoM bearings (55.2% vs. 29.6%), while in rural and urban teaching hospitals, MoM bearings were reported almost as commonly as MoP bearings (41.4% vs. 48.5% and 38.9% vs. 47.2%, respectively). In large hospitals, MoP bearings were reported in greater than 50% of procedures, while in small and medium hospitals, MoP (46.9% and 49.4%, respectively) and MoM (38.0% and 36.9%, respectively) bearings were reported in more similar frequencies.

There was also significant regional variation in bearing surface usage across U.S. census regions. THA procedure codes were used in only 40% of primary THA cases in the U.S., and their usage did not appear to increase over time within the study period. However, this limitation is somewhat mitigated by the large number of procedures (over 112,000) included in our study that had an optional code for bearing surface type. Furthermore, bearing surface utilization did not appear to be over- or under-reported in any systematic way that would undermine or call into question the validity of our results. Until such time as a national registry is created and validated for the US, use of administrative databases provides the only avenue to better understand patterns of implant utilization in joint replacement on a nationwide basis. The findings from our study suggest that further investigation is necessary to define the appropriate indications for the use of hard-on-hard bearings in THA patients.

Discussion:

Innovation in THA bearing surfaces has resulted in increased patient and surgeon implant choice in THA. Hard-on-hard “premium” bearings offer the potential to reduce the number of wear-related revisions, particularly in younger, more active patients. However, bearing surface choice is dependent on many factors, and the specific indications and contra-indications for hard-on-hard bearings type remains unclear. Hard-on-hard bearings have been associated with very low wear rates in the laboratory setting. However, despite numerous reports of excellent clinical outcomes at short- and mid-term follow-up, the benefits of hard-on-hard bearings in terms of reducing long-term implant failure and revision rates have not yet been conclusively demonstrated. Furthermore, concerns have been raised about the safety of these new technologies, including ceramic fracture and “squeaking” with CoC bearings and metal ion hypersensitivity and systemic toxicity/carcinogenesis with MoM bearings.

Our study demonstrates that THA bearing usage varies considerably by age, gender, hospital type, and geographic region throughout the U.S. Some of this variation appears to be appropriate, e.g., higher use of MoP bearings in patients over the age of 65, and higher use of MoM bearings in younger, male patients. However, some of the variation, including higher use of MoM bearings in urban teaching hospitals and small and medium hospitals, and higher use of MoM bearings in the South, cannot be explained by differences in prevalence. Furthermore, despite uncertain advantages in older patients, hard-on-hard bearings are commonly reported in patients over age 65.

Our findings are limited by the use of an administrative database, where bearing surface type is an optional modifier code that can be reported in conjunction with the primary procedure code (primary or revision THA). Since their introduction in October, 2005, these optional bearing codes were used in only 40% of primary THA cases in the U.S., and their usage did not appear to increase over time within the study period. However, this limitation is somewhat mitigated by the large number of procedures (over 112,000) included in our study that had an optional code for bearing surface type. Furthermore, bearing surface utilization did not appear to be over- or under-reported in any systematic way that would undermine or call into question the validity of our results. Until such time as a national registry is created and validated for the US, use of administrative databases provides the only avenue to better understand patterns of implant utilization in joint replacement on a nationwide basis. The findings from our study suggest that further investigation is necessary to define the appropriate indications for the use of hard-on-hard bearings in THA patients.

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