Nine-Year Incidence of Kidney Disease in Patients Who Have had Total Hip Arthroplasty

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Abstract: Metal-metal total hip arthroplasty (THA) is contraindicated in patients with impaired renal function due to increased metal ion output relative to other bearings and renal excretion of metal ions. Although one can avoid a metal-metal THA in a patient with renal disease, a patient may be destined to develop renal disease later in life. In this study, we sought to determine the incidence of newly diagnosed renal disease in the 9 years after THA. Using the Department of Veterans Affairs national database, we identified 1709 patients who had a primary THA in 2000 without preexisting renal disease. We found the 9-year risk of developing chronic renal disease after primary THA to be 14% and severe or end-stage renal disease to be 6%.

Metal-on-metal articulations have had a resurgence in popularity. A recent accounting of bearing surface use in the United States found that 35% of all total hip arthroplasties (THAs) were metal-on-metal [1]. Given that more than 200,000 primary THAs are performed annually in the United States [2], more than 70,000 patients have recently been receiving metal-on-metal hip articulations in the United States every year. In addition, metal-on-metal bearings are exclusively used in hip resurfacing procedures, another operation that has gained popularity.

Metal-on-metal articulations for THA have several proposed advantages over traditional metal on polyethylene bearings. They allow very large head sizes and, thus, help to maintain hip stability. They exhibit reduced volumetric wear, possibly reducing problems with osteolysis. Finally, metal-on-metal bearings may allow more vigorous physical activities after hip arthroplasty.

There are also some potential disadvantages to metal-on-metal bearings. All metal implants release metal ions at a rate determined by their surface area, but metal-on-metal articulations in the hip increase the rate of metal ion release to the body because of the sliding of the metal surfaces against each other during weight-bearing. In patients with metal-on-metal THA, serum cobalt and serum chromium concentrations can be as much as 269% and 638% greater than normal, respectively, for the more active and younger patient. In comparison, patients with traditional metal on polyethylene articulations have serum cobalt and chromium levels of 172% and 196% greater than normal [3].

Metal ions in the serum can be concerning for several reasons. They may form metal-protein complexes, free metallic ions, inorganic metal salts or oxides, and can be sequestered in an organic storage form such as hemosiderin. These metallic ions have the capacity to act as haptens (immunologic activators), antichemotactic agents (immunologic suppression), or lymphocyte toxins, cause metal hypersensitivity, and chemical carcinogenesis [4]. Cobalt and chromium particles have been established as carcinogenic and mutagenic in both human and animal models. Although elevated serum metal ion concentrations after metal-on-metal THA have not been definitely proven to be associated with carcinogenicity or other health effects, this remains a concern.

The kidneys are integral to the filtration of waste from the body. Metal ions are removed from the body through the kidneys, and patients with poor kidney function have a decreased capacity to filter metal ions generated from hip arthroplasty implants. Hence, serum metal ion levels become even more elevated in patients with poor renal function [5,6]; and although no specific effects have yet been identified in patients with elevated metal ion levels, these patients may be more susceptible to the potential deleterious effects of the high serum levels of cobalt and chromium. For this reason, it is generally advised that metal-on-metal hip arthroplasties should not be placed in patients with chronic renal disease [6,7].
Clearly, in a patient who has a preoperative diagnosis of chronic kidney disease, a metal-on-metal hip arthroplasty can and should be avoided. One can expect, however, that a certain percentage of patients receiving a THA who do not have renal disease at the time of surgery are destined to develop chronic renal disease later in life. This could be due to hypertension, diabetes, or other known or unknown risk factors that have nothing to do with the hip arthroplasty itself. In this study, we sought to determine how many patients receiving a THA are destined to develop renal disease later in life. We, thus, asked if we did a metal-on-metal articulation on everyone without renal disease at the time of surgery, in what percentage of patients would we potentially regret this decision 9 years after surgery because the patient ultimately developed renal disease?

**Methods**

This was a retrospective database review looking at patients who had THA in any Department of Veterans Affairs hospital between October 1, 1999, and September 30, 2000. The Department of Veterans Affairs VistA database was searched for all inpatient and outpatient encounters of patients who had International Classification of Diseases, Ninth Revision Modification Diagnosis Codes (ICD-9 codes) of 81.51 for primary THA and who had their hip arthroplasty done in this date range.

Using the patient list generated from this query, we then looked at all encounters for these patients during the previous 2 years to find their preexisting diagnoses. We excluded patients who had a prior THA (preexisting ICD-9 code of 81.51) to ensure that the patients selected in this study had primary THA performed in the period of interest.

We then aimed to exclude all patients who had renal disease and would not have been candidates for a metal-on-metal articulation at the time of THA. Although laboratory values such as serum creatinine or creatinine clearance would have given quantitative information about the existence and severity of renal disease before their surgery, we found that laboratory data existing in the database now were incomplete and were, thus, not usable. We chose instead to exclude patients with preexisting renal disease by excluding patients who had been given ICD-9 diagnoses of renal disease (403.xx, 404.xx, 580.xx, 581.xx, 582.xx, 583.xx, 584.xx, 585.xx, or 586) before the date of surgery.

This list of patients with a primary THA performed in a Department of Veterans Affairs medical center between October 1, 1999, and September 30, 2000, who did not have a diagnosis of renal disease before surgery formed the cohort of interest. Taking this list, the VistA database was queried again for all inpatient and outpatient encounters in this cohort from 2000 to 2009 looking for any new diagnoses of renal disease. Although chronic renal disease (ICD-9 codes 403.00-403.91, 404.00-404.10, 582-582.9, 585-585.9) was of particular interest, we also searched for patients who had episodes of acute renal disease (ICD-9 codes 580-580.9 and 584-584.9) and for patients who were given diagnoses of renal disease of unspecified chronicity (ICD-9 codes 581-581.9, 583-583.9, and 586).

Filtering of data and statistical analysis was performed by the Statistical Analytical System 9.1.3 software package (Cary, NC). We calculated the 9-year incidence of any renal disease, chronic renal disease, severe chronic renal disease, and end-stage renal disease in this cohort of patients.

**Results**

Between October 1, 1999, and September 30, 2000, we identified 1940 patients who underwent primary THA in a Department of Veterans Affairs Medical Center. One hundred ninety-eight patients were excluded because they had a prior diagnosis of THA, partial THA, or revision THA (ICD-9 codes 81.51-81.53) leaving 1742 patients. Of these, 33 had a prior diagnosis of kidney disease and may not have been candidates for a metal-on-metal hip arthroplasty. This left 1709 patients who formed the cohort of interest in this study. These patients averaged 76.1 years at the time of surgery and were 97.6% men.

In the 9 years after the primary THA, 336 (20%) of these 1709 patients were given a renal disease diagnosis of some kind in the 9 years after hip arthroplasty (Table 1). Two hundred forty patients (14%) were given a diagnosis of chronic renal disease of varying severity, 60 patients (4%) were given a diagnosis of acute renal disease, and 36 patients (2%) were given a renal disease diagnosis in which the chronicity of disease was unspecified.

Among the 240 patients with chronic renal disease, 143 (8% of the original cohort) were given a diagnosis of mild to moderate chronic kidney disease, meaning they had a glomerular filtration rate between approximately 30 and 90 mL/min. Twenty-two patients developed end-stage renal disease and an additional 75 patients developed severe (National Kidney Foundation stage IV or V) chronic kidney disease in the 9 years after THA. Patients with stage IV chronic kidney disease have a glomerular filtration rate less than 30 mL/min. Patients with stage V chronic kidney disease have a glomerular filtration rate less than 15 mL/min and can be considered for dialysis. Thus, 6% of the original cohort of 1709 patients developed severe chronic kidney disease or end-stage renal disease in the 9 years after THA.

**Discussion**

The prevalence of chronic kidney disease has grown over 40% during the past decade to 14.8% [8], likely because of the rising rates of diabetes and hypertension, the 2 greatest risk factors for chronic kidney disease, in the general population. Understanding that metal-on-
metal hip arthroplasty is not advisable in patients with chronic kidney disease, orthopedic surgeons should consider the risk that their patients may develop renal disease in the years subsequent to THA.

Of important note, the patient population studied was not reflective of the general US THA population, and care should be exercised when extrapolating the results of this study to the general population. Patients receiving THA in Department of Veterans Affairs medical centers are overwhelmingly men, whereas in the general population, more than half of THA patients are women. Health status and socioeconomic conditions in patients cared for in Department of Veterans Affairs hospitals are well known to differ from the general population [9]. Specifically relating to this study, 22% of the total joint arthroplasty patients in the VA system are persons with diabetes [10], an important risk factor for chronic renal disease, whereas persons with diabetes make up approximately 8.5% of the total joint arthroplasty patients in the United States [11]. Thus, based on diabetes prevalence, the estimates drawn from this study on the risk of developing chronic renal disease after THA may be higher than in the general population.

The prevalence of hypertension, another important risk factor for renal disease, in the veteran and the general US total joint arthroplasty population has not been as well studied as diabetes. The prevalence of hypertension in US adults aged 60 to 69 years, which spans the typical age of patients having hip arthroplasty, is 62% and rising [12]. Veterans are overwhelmingly men, but at least in the general US population, it appears that women have a higher prevalence than men of hypertension [12]. There are no good recent data available on the prevalence of hypertension, specifically in veterans of appropriate age for joint arthroplasty.

It should be noted that the findings of this study are based on ICD-9 codes and not on laboratory values of creatinine clearance. We assumed that these ICD-9 codes were entered accurately and were based on laboratory values, but we cannot confirm this to be the case. Although there could have been borderline cases that may have altered the exact percentages reported in this article, it is unlikely

### Table 1. Renal Disease Diagnoses Developed in the 9 Years After THA (1709 Total Patients)

<table>
<thead>
<tr>
<th>ICD-9 Code</th>
<th>Description</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>403.01</td>
<td>Hypertensive chronic kidney disease, malignant, with chronic kidney disease stage V or end-stage renal disease</td>
<td>2</td>
</tr>
<tr>
<td>403.11</td>
<td>Hypertensive chronic kidney disease, benign, with chronic kidney disease stage V or end-stage renal disease</td>
<td>6</td>
</tr>
<tr>
<td>403.91</td>
<td>Hypertensive chronic kidney disease, unspecified, with chronic kidney disease stage V or end-stage renal disease</td>
<td>56</td>
</tr>
<tr>
<td>404.02</td>
<td>Hypertensive heart and chronic kidney disease, malignant, without heart failure and with chronic kidney disease stage V or end-stage renal disease</td>
<td>1</td>
</tr>
<tr>
<td>585.4</td>
<td>Chronic kidney disease stage IV (severe)</td>
<td>9</td>
</tr>
<tr>
<td>585.5</td>
<td>Chronic kidney disease stage V</td>
<td>1</td>
</tr>
<tr>
<td>585.6</td>
<td>End-stage renal disease</td>
<td>22</td>
</tr>
<tr>
<td>Total chronic and severe kidney disease</td>
<td>97</td>
<td></td>
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<thead>
<tr>
<th>ICD-9 Code</th>
<th>Description</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>403.1</td>
<td>Hypertensive chronic kidney disease, benign, with chronic kidney disease stage I through IV, or unspecified</td>
<td>4</td>
</tr>
<tr>
<td>403.9</td>
<td>Hypertensive chronic kidney disease, unspecified with chronic kidney disease stage I through stage IV, or unspecified</td>
<td>27</td>
</tr>
<tr>
<td>404.01</td>
<td>Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified</td>
<td>1</td>
</tr>
<tr>
<td>585.1</td>
<td>Chronic kidney disease stage I</td>
<td>2</td>
</tr>
<tr>
<td>585.2</td>
<td>Chronic kidney disease stage II (mild)</td>
<td>5</td>
</tr>
<tr>
<td>585.3</td>
<td>Chronic kidney disease stage III (moderate)</td>
<td>14</td>
</tr>
<tr>
<td>585</td>
<td>Chronic kidney disease including chronic uremia</td>
<td>48</td>
</tr>
<tr>
<td>585.9</td>
<td>Chronic kidney disease unspecified</td>
<td>42</td>
</tr>
<tr>
<td>Total chronic and mild to moderate or unspecified</td>
<td>143</td>
<td></td>
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<thead>
<tr>
<th>ICD-9 Code</th>
<th>Description</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>584.5</td>
<td>Acute renal failure with lesion of tubular necrosis</td>
<td>4</td>
</tr>
<tr>
<td>584.9</td>
<td>Acute renal failure, unspecified</td>
<td>56</td>
</tr>
<tr>
<td>Total acute</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>ICD-9 Code</th>
<th>Description</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>581.89</td>
<td>Nephrotic syndrome, other, glomerulonephritis</td>
<td>1</td>
</tr>
<tr>
<td>581.9</td>
<td>Nephrotic syndrome, with unspecified pathologic lesion in kidney</td>
<td>8</td>
</tr>
<tr>
<td>583.1</td>
<td>Nephritis and nephropathy with membranous glomerulonephritis</td>
<td>1</td>
</tr>
<tr>
<td>583.81</td>
<td>Nephritis and nephropathy, not specified as to acute or chronic</td>
<td>6</td>
</tr>
<tr>
<td>583.9</td>
<td>Nephritis and nephropathy with unspecified pathologic lesion in the kidney</td>
<td>4</td>
</tr>
<tr>
<td>586</td>
<td>Renal failure, unspecified, includes uremia</td>
<td>16</td>
</tr>
<tr>
<td>Total unspecified chronicity</td>
<td>36</td>
<td></td>
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that such borderline cases would have changed our
general findings and conclusions substantially.

We found that, in veterans undergoing primary THA
between October 1, 1999, and September 30, 2000, 14%
developed a new diagnosis of chronic kidney disease, with
6% developing chronic kidney disease severe enough to
consider dialysis (National Kidney Foundation grade IV or
worse). Even if the rate of developing chronic kidney
disease in the general population was one third the rate in
veterans, given the large number of THA procedures
performed in the United States alone (estimated to be
200,000 in 2005) [2] and the reported prevalence of
metal-on-metal THA in the United States (35% in 2006)
[1], approximately 3300 patients per year in the United
States will develop chronic kidney disease in the 9 years
after THA. If metal-on-metal use remains at 35%, given
the trends in chronic kidney disease epidemiology and the
projected increased number of THA being performed, the
numbers of at-risk patients will likely increase.

Development of renal disease after a metal-on-metal
THA represents a potential problem for patients. In light
of this, consideration might be given to avoid metal-on-
metal THA in patients with severe diabetes and
hypertension who are not yet exhibiting any renal
issues at the time of surgery. Monitoring of renal
function in patients with metal-on-metal bearings,
with additional surveillance for high-serum metal ion
concentrations or adverse tissue reactions should chron-
ic renal disease develop, may be indicated.

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