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Projected Increase in Periprosthetic Joint Infections Secondary to Rise in Diabetes and Obesity

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ABSTRACT

Total joint arthroplasties (TJAs) are projected to increase, along with increased complications like periprosthetic joint infections (PJIs). However, no study has projected TJAs secondary to PJI and how these relate to comorbidities in these patients. The NIS database was assessed from 1993 to 2000 to evaluate primary and revision TJAs, and projections were made until 2028. ICD-9 codes were used to identify patients with obesity, diabetes, and PJI. Rates of diabetes and adult obesity are predicted to increase for both genders, and patients receiving revision surgery for PJI are predicted to increase over time; males had higher rates than females. With an exponential increase of PJI secondary to diabetes and obesity, it is imperative that orthopedists intervene in these patients prior to TJA to decrease PJI's burden.

Periprosthetic joint infection (PJI) is a devastating complication following total joint arthroplasty (TJA) and is certainly a challenging problem to treat. The incidence of PJI following primary total hip arthroplasty (THA) is 1% to 2% [1,2], while that following primary total knee arthroplasty (TKA) is 1% to 4% [3,4]. While multiple risk factors can predispose a patient to PJI, specific comorbidities that are associated with an increased risk of PJI include diabetes mellitus and obesity [5,6]. These two risk factors are increasing in prevalence; diabetes is projected to triple by the year 2050 from the 8% prevalence rate in 2007 [7], and the incidence of obesity has rapidly been increasing in the United States over the last decade [8]. Treating these patients, especially surgical management of these patients with degenerative joint disease along with their revision surgeries, will likely become a greater economic burden to society.

TJA is a relatively successful surgical procedure that allows for the majority of patients to return to pain-free activities. However, along with the increasing demand for primary THA and TKA, there is a projected increase in revision TJA over the coming decades secondary to many causes, including PJI [9]. Previous predictions have been made based on the projected estimates of historical data using the Nationwide Inpatient Sample (NIS) [9,10]; however, no study has been conducted to evaluate the burden of PJI secondary to comorbidities such as diabetes and obesity.

Thus, the purpose of our study is to predict the trend of primary and revision TJAs secondary to PJI and how they trend with the comorbidities of diabetes and obesity in the TJA population.

Methods and Materials

The NIS database was queried from 1993 to 2011 to evaluate patients who underwent primary THA, primary TKA, revision THA, and revision TKA. Bilateral TJA patients were excluded. We used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) to identify patients with diabetes (ICD-9 code 250.x and 249.x), obesity (ICD-9 code 278.00–278.01 or V85.2–V85.4 in any diagnosis field), and those requiring a revision TJA for PJI (ICD-9 code 996.66). We used the historical occurrence of these diagnoses for the basis of predicting future rates along with demographics.

These predictions were extended to 2030. To create these predictions, a full model was created based on the following groupings, (age + year)*(operation*joint*gender), where '*' denotes statistical interaction. This model allows the effects of predictive variables to be dependent on each other. Terms not associated with the predictive power of the model were systematically removed. The projected median age for gender, joint, and operation were used for the age term in the prediction. Although it is possible to create a more complicated model in which multiple percentiles of age can be used, the goal of this study was to illustrate trends. In the figures presented in this study, the demarcation between NIS data (1993–2010) and projections (2011–2030) was made apparent

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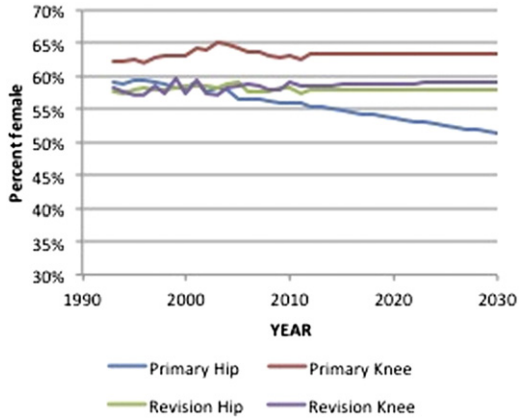

Fig. 1. Primary and revision total joint arthroplasties are projected to increase for females, except for primary total hip arthroplasty.

by the transition from a variable line (1993–2010) to a smooth line (2011–2030).

Statistical analysis was performed via logistic regression with gender distributions estimated as a function of year, the joint involved (hip or knee) and the surgical procedure (primary or revision), so that they could be included in other projections. Quantile regression was used to estimate the median age as functions of year, joint involved, surgical procedure, and gender. Analyses were done using the 'rms' and 'quantreg' packages in R version 2.15.1.

Results

For all primary and revision TJA, except for primary THA, the rate of females undergoing these procedures was predicted to rise modestly. For primary THA, the percentage of female patients undergoing operative treatment fell from 59.22% in 1993 to 55.86% in 2011, and this was projected to further fall by the year 2030 to 51.38% (Fig. 1). By 2030, it is estimated that there will be approximately 572,000 THA and 3.48 million TKA performed in the United States [9].

The median age for both genders and all surgical procedures is predicted to decrease over time, as illustrated in (Fig. 2). While revision THA patients are predicted to be older than primary THA and revision TKA patients are projected to be younger than primary TKA patients, there were overall consistent trends in decreased age between male and female patients. For males, those undergoing primary THA will be younger than those undergoing primary TKA. Conversely, for females, primary THA patients will be older than primary TKA patients. Regarding revision surgery, females undergoing revision THA will be older than males undergoing revision THA, while females undergoing revision TKA will be younger than their male counterparts.

The rates of diabetes and adult obesity are predicted to increase for both males and females in primary and revision TJA. Specifically for diabetes, patients undergoing primary TKA have higher rates of diabetes than those undergoing primary THA, with revision surgeries having higher rates than primary surgeries (Fig. 3). Overall, there is an increase in the rate of diabetes of 5.42% per year in males undergoing primary TJA and 5.89% increase per year for male patients undergoing revision TJA, respectively, and an increase for females of 4.8% in primary TJA and 5.26% in revision TJA. The rate of patients with diabetes undergoing revision TKA in 1993 was 11.72% for males and 10.25% for females, with a predicted rise in this figure to 51.6% for males and 47.69% for females by 2030. There were no statistically significant differences between diabetic males and diabetic females.

Similar to diabetes, the rates of obesity are predicted to climb for males and females, as well as for primary and revision TJA. The only gender-related difference is that for females. The rate of obesity in primary THA is similar to that of revision THA and revision TKA, while the rate of obesity in males in primary THA is closely related to that of revision TKA. Overall, there will be an increase in obesity in males of 11.9% per year for THA patients and 11.16% per year for TKA patients, and an obesity increase for females of 9.57% per year for THA patients and 8.85% per year for TKA patients. The rates of patients with obesity undergoing revision TKA in 1993 were 3.79% for males and 7.21% for females, with a predicted rise in this figure to 67% in males and 67.6% in females by 2030 (Fig. 4).

The number of patients requiring revision surgery for PJI is also predicted to increase over time, with males having a higher rate than females, and revision THA surgeries a having higher rate than revision TKA (Fig. 5). Based on the statistical model, PJI rates in THA are increasing at approximately 2% a year more rapidly than PJI rates in TKA. Male patients undergoing revision TKA will have predicted rates of PJI in 2030 of 41.72%, compared to a rate of 6.98% in 1993. The rate for PJI in females is estimated to be 30.02% in 2030, while it was only 5.8% in 1993.

Discussion

In the current economic climate, it is essential to predict the future burden of TJA and PJI in order to allocate adequate resources to fund both the training of orthopedic surgeons and the building of an infrastructure to facilitate this increased demand. Kurtz et al [10] estimated that by 2014 the total cost required to treat PJI would be over $1 billion. Thus, the purpose of this study was to estimate the rate of primary and revision TJA secondary to PJI, and their correlation with obesity and diabetes.

With regard to gender, younger males will undergo primary THA compared to primary TKA, while older females will undergo primary THA and younger females will undergo primary TKA. However, based

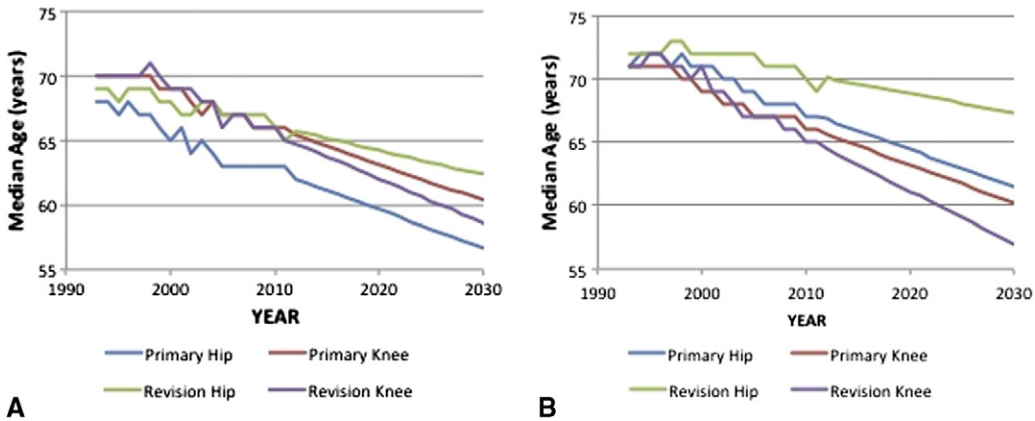

Fig. 2. Projected age of primary and revision total joint arthroplasties for (a) males and (b) females.