The Journal of Arthroplasty xxx (2016) 1–6

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Cause-Specific Mortality Trends Following Total Hip and Knee Arthroplasty

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ARTICLE INFO

Article history:
Received 30 June 2016
Received in revised form
13 September 2016
Accepted 9 October 2016
Available online xxx

Keywords:
total knee arthroplasty
total hip arthroplasty
mortality
standardized mortality ratio
cause-specific mortality
dementia

ABSTRACT

Background: While studies have demonstrated that mortality after total hip (THA) and total knee (TKA) arthroplasty is better than the general population, the causes of death are not well established. We evaluated cause-specific mortality after THA and TKA.

Methods: The study included population-based cohorts of patients who underwent THA ($N = 2019$) and TKA ($N = 2259$) between 1969 and 2008. Causes of death were classified using the International Classification of Diseases 9th and 10th editions. Cause-specific standardized mortality ratios (SMR) and 95% confidence intervals (CI) were calculated by comparing observed and expected mortality. Expected mortality was derived from mortality rates in the United States white population of similar calendar year, age, and sex characteristics.

Results: All-cause mortality was lower than expected following both THA and TKA. However, there was excess mortality due to mental diseases such as dementia following both THA (SMR 1.40, 95% CI 1.08, 1.80) and TKA (SMR 1.49, 95% CI 1.19, 1.85). There was also excess mortality from inflammatory musculoskeletal diseases in THA (SMR 3.50, 95% CI 2.11, 5.46) and TKA (SMR 4.85, 95% CI 3.29, 6.88). When the cohorts were restricted to patients with osteoarthritis as the surgical indication, the excess risk of death from mental diseases still persisted in THA (SMR 1.36, 95% CI 1.02, 1.78) and TKA (SMR 1.52, 95% CI 1.20, 1.91).

Conclusion: THA and TKA patients experience a higher risk of death from mental and inflammatory musculoskeletal diseases. These findings warrant further research to identify drivers of mortality and prevention strategies in arthroplasty patients.

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are increasingly common procedures for the management of advanced osteoarthritis [1]. Life expectancy following these procedures, however, is not fully understood. So far, the majority of the mortality studies following THA and TKA are limited to early postoperative mortality [2-4]. The small number of studies on long-term mortality patterns demonstrates that mortality among patients undergoing THA and TKA is better than the general population for about 8-10 years following surgery, but then levels off, and in some cases surpasses expected mortality after 10 years [5-10]. Early mortality advantage is largely attributed to selection of healthier patients for surgery. Yet, it is unknown why the early mortality advantage disappears over time. One possibility is that the comorbid conditions are responsible for the increased risk of death after 10 years. For example, in a cohort of 57,979 Swedish TKA patients, the risk of death was increased from cardiovascular, gastrointestinal, and urogenital diseases after 12 years following surgery [7]. This finding is mainly confined to younger TKA patients. These comorbid conditions, however, are also common causes of death in the general population, and thereby confound our understanding of mortality following these procedures. There is limited understanding of the causes of death in the rapidly

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.10.009.

Influence on practice: This work will affect patient follow-up after arthroplasty.

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http://dx.doi.org/10.1016/j.arth.2016.10.009
0883-5403/

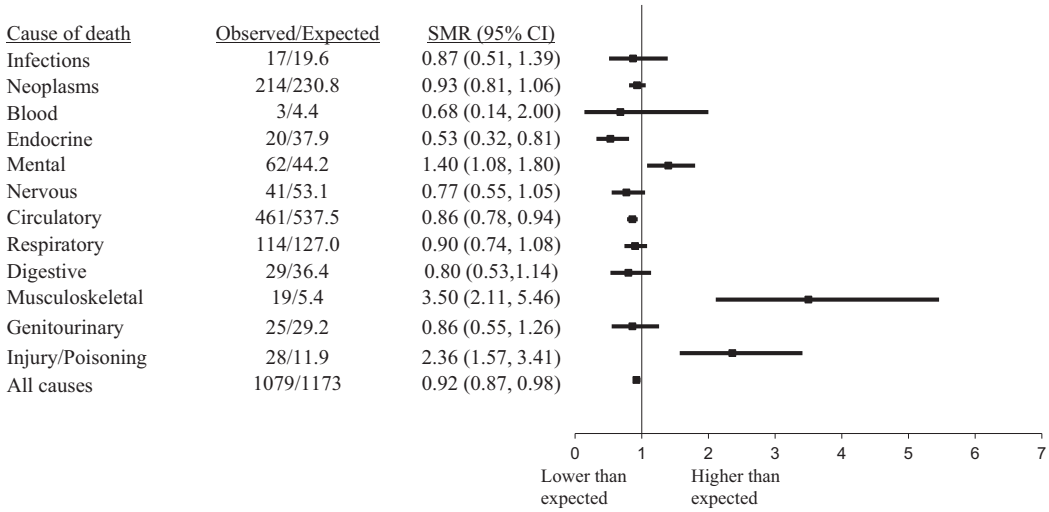

Fig. 1. Observed vs expected underlying causes of death following THA.

growing arthroplasty population. In order to address this issue further, we examined cause-specific mortality patterns following THA and TKA.

Methods

We conducted a retrospective cohort study in Olmsted County, Minnesota, using the resources of the Rochester Epidemiology Project, a comprehensive medical records linkage system [11,12]. Olmsted County (2010 population: 144,248) is particularly well suited for a study of this nature due to its relative geographic isolation and small number of medical providers. The Rochester Epidemiology Project collects data from all healthcare providers in the area, and thereby creates a population-based infrastructure with effectively complete ascertainment and follow-up of patients who had undergone THA or TKA.

The study population included previously described cohorts of all Olmsted County residents who underwent primary THA (n = 2019) or TKA (n = 2259) between January 1, 1969 and December 31, 2008 [10]. Patients were followed up longitudinally until death or August 31, 2014. Only 2.4% of the cohort was lost to follow-up. For individuals who were deceased, the causes of death were ascertained through review of medical records and death certificates and classified using the International Classification of Diseases, 9th edition (ICD-9) and 10th edition (ICD-10). ICD-9 categories were converted to ICD-10 categories prior to analysis. The causes of death could not be determined in 36 (1.8%) of the deaths in the THA cohort and 34 (1.5%) of the deaths in the TKA cohort.

At the time of surgery, the median age of the 2019 THA patients was 68 years (minimum 15, maximum 97) and 1181 (58%) patients were female. The median age of the 2259 TKA patients was 69 years (minimum 14, maximum 93) and 1420 (63%) patients were female. The underlying surgical indication was osteoarthritis in 1611 (80%) of the THA and 1938 (86%) of the TKA patients.

Statistical Analyses

Statistical analyses were performed separately for the THA and TKA cohorts. All calculations were repeated by limiting the cohort to 1611 THA and 1938 TKA patients with osteoarthritis as the underlying surgical indication. Death rates following THA and TKA were evaluated using a person-years approach, in which the observed number of deaths in each cohort was compared with the expected number of deaths over the follow-up period. Expected survival was generated using the life tables for the United States white population. The results were reported as standardized mortality ratios (SMRs) with corresponding 95% confidence intervals (CI). The CIs were calculated assuming that the expected rates were fixed and the observed deaths followed a Poisson distribution. The SMRs were calculated separately for men, women, and combined. There was no evidence to suggest that the SMR differed between men and women, and therefore the combined results were reported. The person-years analysis included follow-up time so that separate calculations could be made for the first year after arthroplasty, 1-10 years following surgery, and beyond 10 years after surgery. In the calculations of the SMRs for these temporal subsets, only events and person-years of exposure during the follow-up time window of interest were considered.

Results

Over a mean follow-up of 11.9 (±7.4) years, 1079 of the 2019 THA patients died as compared with 1173 expected deaths (SMR 0.92, 95% CI 0.87, 0.98). THA patients had a significantly reduced risk of death from circulatory and endocrine diseases, as indicated by the CIs <1.00 (Fig. 1). However, the observed number of deaths was significantly higher than the expected number of deaths for mental and behavioral diseases (SMR 1.40, 95% CI 1.08, 1.80), musculoskeletal and connective tissue diseases (SMR 3.50, 95% CI 2.11, 5.46) and injuries, poisoning, and certain other consequences of external causes (SMR 2.36, 95% CI 1.57, 3.41). A similar pattern was observed in the TKA cohort (Fig. 2). Over a mean follow-up of 11.2 (±5.8) years, 1012 of the 2259 TKA patients died as compared with 1245 expected deaths (SMR 0.81, 95% CI 0.76, 0.86). Despite a significantly reduced risk of death from several common causes, TKA patients experienced a significantly higher risk of death from mental and behavioral diseases (SMR 1.49, 95% CI 1.19, 1.85) and musculoskeletal and connective tissue diseases (SMR 4.85, 95% CI 3.29, 6.88) (Fig. 2). The excess musculoskeletal mortality was due to patients with inflammatory arthritis where the cause of death was rheumatoid arthritis or other inflammatory arthritis in 9 of the 19 musculoskeletal deaths in THA patients, and 22 of the 31 musculoskeletal deaths in TKA patients. The remaining musculoskeletal deaths were osteomyelitis or infective arthritis cases. The excess mortality due to mental and behavioral diseases was almost