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Original article

Life expectancy of osteoarthritic patients after primary total knee arthroplasty☆

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ABSTRACT

Background: Although an increased life expectancy has been previously reported in patients with osteoarthritis (OA) after undergoing total knee arthroplasty (TKA), the long-living Japanese population may provide a more accurate cohort for determining 10- and 15-year survival rates. The aims of the present study were to (1) determine the survival of patients after TKA, (2) identify the factors important for survival, and (3) compare the survival rate of the OA patients with that of the standardized general population.
Methods: The 5-, 10-, and 15-year survival rates were assessed in 326 consecutive OA patients treated with TKA from January 1998 to December 2013. Eighty-six of the cases were staged bilateral TKAs. All patients were followed until December 31, 2014 or until the time of death. The survival rate of the patients was compared with that of the standardized general population using Kaplan–Meier survival curves.
Results: Fifty-one of the patients died before the end of the follow-up. The cumulative 5-year patient survival was 93.5%, 10-year survival was 82.1%, and 15-year survival was 66.6%. The standardized mortality ratio was 0.916 (95% confidence interval: 0.682–1.204). A Cox proportional hazards model showed that increased age and unilateral TKA were factors related to higher patient mortality rates.
Conclusions: These data suggest that patients undergoing TKA can expect similar life expectancy as the general population, with 66.6% of such patients surviving for at least 15-years. Additionally, patients undergoing bilateral TKAs may have a longer life expectancy than those undergoing unilateral TKA.

1. Introduction

Primary total knee arthroplasty (TKA) is typically used to treat knee joint failure caused by osteoarthritis (OA).[1] The demand for primary TKA procedures is increasing and is projected to continue to grow each year in many countries. TKA is an effective treatment for alleviating knee pain, and patients often recover or improve their physical function. In fact, there is a large body of evidence demonstrating the positive effects of TKA for patients, such as cardiovascular fitness and a return to physical activity,[2] increased bone mineral density of the femur,[3] improved calcaneus bone quality,[4] voluntary quadriceps muscle activation,[5] and dynamic[6] or static body balance.[7] Additionally, several studies have suggested that an increased life expectancy in OA patients treated with TKA may be another positive effect of the treatment.[8–10]

Although many studies have reported short-term mortality after TKA, many of them primarily compared the outcomes among unilateral TKA and simultaneous and staged bilateral TKAs.[11–17] However, several studies have analyzed mid-term or long-term patient survival after TKA. Based on those reports, rheumatoid arthritis (RA),[9,10,18,19] male sex,[9,10] age[9,10,19,20], American Society of Anesthesiologist (ASA) grade,[19,21] body mass index (BMI),[19] diabetes,[8] and history of smoking[19] of patients undergoing TKA are

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reported to be linked to increased mortality in populations mainly from the US[8] and European countries.[10],[18–20] Japan appears to be unique in that the number of TKAs performed here has more than doubled from approximately 30,000 to 70,000 per year[22] over the past 10 years and in that the Japanese population has had the longest extension in life expectancy in the world observed over the past few decades.[23]

The aims of the present study were to (1) determine the survival of TKA patients, (2) identify the factors important for their survival, and (3) compare the survival rates of the OA patients with those of the standardized survival rates from general Japanese population. Thus, the hypothesis of this study was that the unique expansion of the aging population in Japan provides an opportunity to determine the life expectancy of patients after TKA, which may inform patients in other countries.

2. Materials and methods

A total of 326 consecutive patients undergoing TKAs from January 1998 to December 2013 in our facility were investigated. All surgeries were performed by a single surgeon (Y.I.) using a standardized technique. All patients were all followed until December 31, 2014 or death. The preoperative diagnosis indicating TKA was OA. All of the 240 unilateral TKA patients also showed contralateral knee OA at the time of the initial TKA operation, and were assessed by the Kellgren–Laurence OA grade[24] as I (N = 13), II (N = 53), III (N = 74), and IV (N = 100) using weight-bearing standing X-rays. For statistical reasons, only the first operation was included in the present assessment of the 86 patients with bilateral implants. All of these patients underwent scheduled, staged, bilateral TKA. The choice of which side to operate on first was made based on patient preference (when their knee complications including pain and disability were similar on both sides). The second TKA was then performed based on each patient's preference concerning their ability to tolerate additional pain and limitations in their daily activities. The average follow-up duration was 95 months (range: 3–202 months). The mean age of the female patients (N = 280) was 72 (range: 42–90) years, and the mean age of the male patients (N = 46) was 70 (range: 34–84) years.

The starting point for the survival analysis was the date of the first TKA. The patients were then followed until December 31, 2014 or death. The overall survival of the patients after the first TKA was analyzed using the Kaplan–Meier method, and the factors contributing to statistically significant differences in survival were identified using log-rank tests with Bonferroni-corrected multiple comparisons. Previous studies[8–10,19,20,25] have suggested that a variety of factors influence survival after TKA. Among these factors, we determined the effects of age at the time of surgery, sex, unilateral versus bilateral surgery, ASA physical status before surgery, BMI, smoking status, use of anticoagulation medication, and presence of complicated diseases such as hypertension, hyperlipidemia, and diabetes mellitus on patient survival. Multivariate Cox regression analysis was performed to determine the factors that were most strongly associated with patient survival.

The expected mortality rate of the patients after the first TKA was calculated based on the age- and sex-specific mortality rates in the Japanese population from 2000 to 2015.[26] The standardized mortality ratio (SMR) was calculated by dividing the observed number of deaths by the expected number of deaths. The 95% confidence intervals (CI) of the SMR were calculated, and the statistical significance of each SMR was assessed using the chi-square test for fitness. The statistical analyses were performed in IBM SPSS Statistics ver. 20 (IBM Japan, Tokyo, Japan). P-values less than 0.05 were considered statistically significant.

3. Results

During the follow-up period, 51 of the 362 patients died. Their causes of death after TKA are shown in Table 1. None of the patients died from TKA surgery-related complications. The cumulative 1-year patient survival was 99.4%, 5-year patient survival was 93.5%, the 10-year patient survival was 82.1%, and the 15-year patient survival was 66.6% (Fig. 1A).

The univariate analysis showed that age at TKA ($p < 0.001$) (Fig. 1B), bilateral vs. unilateral treatment ($p < 0.001$), and ASA grade ($p = 0.035$) were significantly related to the survival rate (Table 2), but there was no effect of patient sex (Fig. 1C, Table 2). Significant differences by age were also found between the 65 to 75 and over 75 groups ($p = 0.001$), and between the less than 65 and over 75 groups ($p = 0.007$), but no difference was found between the less than 65 and 65 to 75 groups ($p = 1.000$). The Cox proportional hazard model showed that the factors of unilateral treatment and advanced age were related to a higher mortality rate (Table 3). Because age was not a significant factor ($p = 0.585$) between unilateral and bilateral TKAs according to the Wilcoxon rank sum test, bilateral TKA was recognized as a positive factor for survival rate independent of age.

The SMR of this cohort of TKA patients was not significantly different ($p = 0.529$) than that of the general population. Furthermore, the SMRs of neither sex (female: $p = 0.527$; male: $p = 0.896$) nor any age group (<64 years old: $p = 0.218$; 65 to 74 years old: $p = 0.167$; ≥75: $p = 0.529$) were different (Table 4) than those of the general population (Table 5).

4. Discussion

The results of this study suggest three important findings. First, the overall survival rates were 0.994 at 1 year, 0.935 at 5 years, 0.821 at 10 years, and 0.666 at 15 years post-TKA. Second, the factors that significantly affected the survival rates as shown by univariate analysis were age, bilateral vs. unilateral treatment, and ASA grade. Of those three factors, age and bilateral vs. unilateral treatment were found by Cox multivariate analyses to be independent factors. Third, the mortality rate of the patients after TKA, as determined by SMR, was not significantly different from that of the general population.

This study has a few limitations. One is that the number of patients analyzed might be considered relatively low for this type of study. Another is that the proportion of males to females was unequal. This higher prevalence of OA and TKA operations in females is a common finding in Japanese ethnic groups. This might be explained by racial difference in disease demographics and sex-based distinctions in the incidence of bow-leggedness. Finally, because only patients in ASA I or II were included, there were no patients who suffered from more debilitating medical conditions that substantially increased their risk of serious perioperative complications or death. Despite these limitations, this study has several advantages, including a 100% follow-up rate of the patients

Table 1
Causes of death in patients after total knee arthroplasty.

	Number
Malignancy	11
Pneumonia	11
Cerebrovascular disease	10
Cardiovascular disease	7
Senile Deterioration	7
Renal insufficiency	2
Digestive disease	1
Other (Accident etc.)	2
Total	51