The Knee xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

The Knee

Annual trends in knee arthroplasty and tibial osteotomy: Analysis of a national database in Japan

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ARTICLE INFO

Article history:
Received 20 February 2017
Received in revised form 29 April 2017
Accepted 8 June 2017
Available online xxxx

Keywords:
Epidemiology
Osteonecrosis
Tibial osteotomy
Total knee arthroplasty
Unicompartmental knee arthroplasty

ABSTRACT

Background: Various nationwide studies have reported differing annual trends in utilization of knee arthroplasty and tibial osteotomy. Using the Diagnosis Procedure Combination database in Japan, the present series examined annual trends and demographics in total knee arthroplasty (TKA), unicompartmental knee arthroplasty (UKA) and tibial osteotomy.
Methods: All patients were identified who underwent TKA, UKA or tibial osteotomy for osteoarthritis, osteonecrosis or rheumatoid arthritis of the knee between July 2007 and March 2015.
Results: A total of 170,433 cases of TKA, 13,209 cases of UKA and 8760 cases of tibial osteotomy were identified. The proportion of patients undergoing UKA rose from 4.0% in 2007 to 8.1% in 2014 ($P < 0.001$), and that of tibial osteotomy from 2.6% in 2007 to 5.5% in 2014 ($P < 0.001$); the proportion undergoing TKA fell from 93.4% in 2007 to 86.3% in 2014 ($P < 0.001$). Between 2007 and 2014 the proportions of patients with osteonecrosis who underwent UKA and tibial osteotomy increased from 34.7% and 11.6% to 38.6% and 16.2%, respectively ($P = 0.001$ for UKA and $P = 0.004$ for tibial osteotomy). The proportions of patients with osteonecrosis undergoing UKA or tibial osteotomy were significantly greater than those with other diagnoses ($P < 0.001$ for both).
Conclusions: The popularity of UKA and tibial osteotomy in Japan increased during the period 2007–2014 at the expense of TKA. The proportions of UKA and tibial osteotomy in patients with osteonecrosis also increased, and were larger than those in patients with other causative diseases.

1. Introduction

Total knee arthroplasty (TKA) is the standard surgical treatment for osteoarthritis (OA), osteonecrosis (ON) and rheumatoid arthritis (RA) in middle-aged and older patients [1–6]. Unicompartmental knee arthroplasty (UKA) and tibial osteotomy are treatment options for unicompartmental OA or ON; [1,4,6–9] in these cases, the choice of procedure is informed by factors such as the patient's age, physical activity level, and degree of deformity [1,4,10–13].

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http://dx.doi.org/10.1016/j.knee.2017.06.005
0968-0160/

Unicompartmental knee arthroplasty is an effective surgical treatment for unicompartmental OA or ON [4,6,11,14–17]. The merits of UKA include preservation of soft tissues and bones, less blood loss, fewer complications, faster postoperative rehabilitation, and better clinical outcomes than TKA [4,10,11,18,19]. Tibial osteotomy may also be indicated for unicompartmental knee disease; the procedure aims to preserve the joint and correct malalignment of the lower limb [20,21]. Typical candidates for tibial osteotomy are active individuals under the age of 65 years [12,13,22–24]; there is good evidence that tibial osteotomy has excellent clinical outcomes [7,9,12,13,23,24]. Nevertheless, UKA and tibial osteotomy are contraindicated in multicompartmental disease, severe flexion contracture, or inflammatory conditions such as RA [23,25]. Consequently, TKA remains the most frequently performed procedure, as it is indicated for diverse degenerative or inflammatory disorders of the knee, including end-stage OA and RA. Further, UKA is reported to have higher revision rates than TKA [4,10,14,26–28], and tibial osteotomy has substantial rates of conversion to TKA; [7,29] the lower reoperation rate after TKA [10] is considered to be a substantial advantage over UKA and tibial osteotomy — even for patients with unicompartmental disease. The relative advantages and disadvantages of TKA, UKA and tibial osteotomy mean that there is no consensus on the optimal choice of procedure.

Differing trends in the utilization of knee arthroplasty and tibial osteotomy have been reported from various nationwide studies; [22,26–28,30–37] they are probably influenced by differences in populations' lifestyles and demographic characteristics, and healthcare systems.

It is predicted that the burden of OA will become a major global socio-economic issue due to the aging of populations and increased incidence of obesity [38,39]. Given Japan's status as one of the most aged nations [40], establishing the trends in surgical intervention for degenerative knee disease in Japan will likely be a useful means of illuminating future changes in other societies.

Osteonecrosis of the knee can be differentiated into spontaneous and secondary types; it is typically a unicompartmental disease characterized by the sudden onset of knee pain [41,42]. Surgical treatment options for ON include TKA, UKA and tibial osteotomy, and many studies have reported good postoperative results for each procedure [5,6,8,43–46]. To date, there has been no nationwide study of the trends in surgical procedures used to treat ON of the knee.

The present study had two objectives: (1) to use a national database to examine recent trends and characteristics of knee arthroplasty and tibial osteotomy in Japan, and (2) to establish the trends in surgical approaches to treating ON of the knee. There were two hypotheses: (1) there would have been increases in the proportion of patients with degenerative knee disease undergoing UKA and tibial osteotomy at the expense of TKA, as described in a study from Korea; [31] and (2) the proportions of patients with ON undergoing UKA or tibial osteotomy would be higher than patients with OA or RA, because ON is typically a unicompartmental disease [41,42].

2. Materials and methods

Inpatient data were collected from the Japanese Diagnosis Procedure Combination (DPC) database, the details of which have been described previously [47–49]. Briefly, all academic hospitals are obliged to contribute to the database, but participation by community hospitals is voluntary. The DPC database contains discharge abstracts and administrative reimbursement data for inpatient episodes obtained from the participating hospitals. Data were collected for six months (July to December) of each year from 2007 to 2010, but since 2011 have been collected continuously. As the database conforms to the Japanese academic year, which starts in April and ends in March, data were input into the DPC for the following periods: July to December 2007; July to December 2008; July to December 2009; July 2010 to March 2011; April 2011 to March 2012; April 2012 to March 2013; April 2013 to March 2014; and April 2014 to March 2015. In 2014, 1133 hospitals participated and provided data for 7.82 million patients, representing 56.4% of all inpatient admissions to acute care hospitals in Japan. To ensure accuracy of the data, the doctor responsible for each patient's care is required to register the diagnoses using International Classification of Diseases, 10th Revision (ICD-10) codes, and the types of surgery or intervention coded by the Japanese original K-codes, with reference to the medical records. The Institutional Review Board approved the study design and waived the requirement for informed consent, as all data in the DPC were anonymous.

Patients who underwent knee arthroplasty (K-code: K082-1) or tibial osteotomy (K-code: K054-2) for a primary diagnosis of OA (ICD-10 code: M17), ON (ICD-10 code: M87) or RA (ICD-10 code: M05 or M06) of the knee were included in the analysis; patients whose primary diagnosis was OA with a concomitant diagnosis of ON were classified as ON for subsequent analyses. The following data were extracted from the database: diagnoses, inpatient surgical procedures, special treatment materials reimbursed during hospitalization (for example the prosthesis used in surgery), and demographic data such as age and sex. The study discriminated between TKA and UKA by the prosthesis registered in the database; those in whom only the patellofemoral joints were replaced or types of replacement were not recorded were excluded from the analysis. Bilateral cases were counted as two separate procedures.

Data were used from July 2007 to March 2015, a total of 75 months. First, the annual trends in surgical procedures (TKA, UKA and tibial osteotomy) and causative diseases (OA, ON and RA) during the study period were examined. A secondary analysis was then performed on patients after dividing them into one of four age categories: <55 years; 55–64 years; 65–74 years; and ≥75 years. Next, annual trends categorized by sex and age were analyzed, in this case with age groups defined as <55 years, 55–64 years, 65–74 years, 75–84 years and ≥85 years. Then, an analysis was undertaken of annual trends by sex in cases with a diagnosis of ON, and the proportions of patients with ON undergoing each surgical procedure were compared with the rest of the cohort. Finally, the age distribution of cases with ON was examined.

The Cochran–Armitage test was used for trend analysis and the Chi-squared test was used to compare categorical data. The SPSS statistical software package (version 23.0; IBM, Armonk, NY, USA) and R version 3.1.3 (The R Foundation, Vienna, Austria) were used for all analyses. The threshold for statistical significance was $P < 0.05$.

Please cite this article as: Kawata M, et al, Annual trends in knee arthroplasty and tibial osteotomy: Analysis of a national database in Japan, Knee (2017), http://dx.doi.org/10.1016/j.knee.2017.06.005