ORTHOPAEDIC SURGERY

Geographical variation in incidence of primary total hip arthroplasty: a population-based analysis of 34,642 replacements

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Abstract

Background Considerable variation in total hip arthroplasty (THA) incidence between regions has been described. The aim of this study was to evaluate geographical variation in the incidence of primary THA for OA in Finland and to analyze variables associated with this variation.

Methods Using Hospital Discharge Register, 34,642 THAs performed for primary OA over the 1998 and 2005 period were identified. Incidence indices for 21 hospital administrative regions were determined. Logistic regression analysis and generalized linear models were used for studying the association of potential explanatory factors for the variation in the incidence of THA.

Results Incidence indices of THA varied from 1.9- to 3.0-fold during the study period. A high ratio of primary THA for primary OA to primary THA for any reason was associated with a high absolute incidence of primary THA ($P < 0.001$). Neither average incomes nor morbidity were associated with the incidence of THA.

Interpretation When hip surgery was performed on a larger scale, threshold for performing THAs due to primary OA was higher. Socio-economic status had no apparent effect on THA rate. Surgeon decision-making related factors influence THA rates when there are only a few surgeons responsible for performing THAs in a region.

Keywords Total hip arthroplasty · Variation of incidence · Population-based

Introduction

Total hip arthroplasty (THA) is the gold standard treatment for severe osteoarthritis (OA) refractory to conservative treatment. The first modern THA was performed by Sir John Charnley in 1961 [1]. Currently, it is estimated that more than 400,000 THAs are performed worldwide every year [2].

Several studies have shown that the incidence of THAs varies substantially between different countries [3, 4]. Reported crude primary THA rates varied between 50 and 130 procedures/100,000 inhabitants in OECD countries in the 1990s [3]. The low THA rates of Asian people living in San Francisco [5], in Hawaii [6], in Singapore [3] and in South Korea [7] indicate different prevalence of osteoarthritis in different ethnic groups. Very low prevalence of hip osteoarthritis among Chinese elderly in Beijing, China, compared with whites in the United States has also been published [8]. Osteonecrosis of the femoral head is a far more common diagnosis leading to THA in Asia than in Europe. Therefore, it is not possible to compare incidence ratios of THA for osteoarthritis directly between European and Asian countries. The prevalence of clinical hip OA between the different regions of Finland has been reported to be equivalent [9, 10].

Variation in surgery rates of THA within a single country has already been reported in several studies during the

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1970s and 1980s [11–13]. Moreover, the incidence ratio of THA has been shown to vary from 1.25 to 4.7 between regions of the same country [14–17]. Several studies have examined explanatory variables related to regional variation of THA such as relative population and surgeon density, socio-economic factors, and surgeon enthusiasm [14, 15, 18–28].

The aim of the current study was to determine the geographical variation in the incidence of primary THA for primary OA in Finland and to analyze variables associated with this variation.

Methods

The Finnish healthcare system

The whole Finnish population is covered by general public insurance. There are 20 hospital districts responsible for the management of hip surgery. About 7,500 total hip replacements are nowadays performed yearly in Finland [29]. In public Finnish hospitals, there is no incentive for the surgeon to perform another total hip replacement, i.e., he or she is not paid more if 101 THRs are performed instead of 100 annually. The proportion of total hip replacements performed in private hospitals was 11.3% in 2003 [30]. In Finland all hospitals are obliged to report all surgical procedures requiring an overnight stay in the National Institute for Health and Welfare. This Hospital Discharge Register was the main database used in the current study.

Inclusion criteria

The study population was formed by selecting from the Hospital Discharge Register patients with International Classification of Diseases code [31] for primary OA or secondary OA for developmental dysplasia of the hip (M16.0, M16.1, M16.2 and M16.3), associated with a code [32] for primary THA performed between years 1998 and 2005. Operation codes included the following: NFB30 for cementless THA, NFB40 for hybrid THA, NFB50 for cemented THA, NFB60 for demanding THA and NFB99 for other THA procedures such as hip resurfacing. Patients with a diagnosis of secondary OA for developmental dysplasia of the hip (M16.2 and M16.3) were included because there is variation in the use of codes for primary OA and for OA due to developmental dysplasia.

Exclusion criteria

Patients who had congenital hip dislocation have a different diagnosis code (Q65.0–Q65.9) to those of secondary OA for developmental dysplasia of the hip and were thus excluded from this study. Patients living throughout the time of study period in the autonomous province of Ahvenanmaa were excluded from the study, because an unknown number of those patients were operated on in Sweden. Only 0.5% of Finnish citizens live in the province of Ahvenanmaa [33]. In total, 50 patients were excluded because they were living abroad.

Regions

Numbers and incidences for THA and OA were reported separately for each hospital region. The municipality of residence of each patient determined the hospital region to which he or she belonged. According to Finnish law, all inhabitants of Finland must belong to one of the hospital regions. The data from the largest hospital region of Helsinki and Uusimaa (HUHD) was divided into two districts as the HUHD population accounts for 30% of the inhabitants in Finland. The subgroups were Helsinki for Helsinki city and Uusimaa for the rest of the Helsinki metropolitan area, which are comparable in size. The hospital region data were then calculated on a yearly basis for the years 1998–2005 inclusive. These data also include THAs performed in private hospitals region-by-region.

Statistical methods

Regional incidences were reported both as unadjusted and adjusted for age and gender to improve comparisons. Patients were divided into the following cohorts: those under 40 years, those from 40 to 85 years, and those over 85 years. The 40 to 85 year old cohort was further divided into nine sub-cohorts, each sub-cohort comprising a 5-year increment, up to 85 years. Adjustments were performed in relation to the average level of the year concerned (index 100).

We estimated the variation of regional rates by the method of extreme quotients (EQ = minimum/maximum) [17].

In order to find out which variables were associated with the relative frequency (i.e. regional incidence) of primary THA operations in regions, statistical modeling was performed. Least squares with fixed effects panel model was used for our data set. In the panel model, the number of years investigated was 8, and the number of regions was 21 each year making 168 observations in total.

Variables tested to explain regional variation

Yearly regional indices of the incidence of THA for primary OA were explained by the following independent variables: the region-specific ratio of primary THA for primary OA to that of primary THA for any reason, the

need-adjusted expenses of specialized care [34], the proportion of patients aged from 18 to 64 years having permanent disability pension for orthopedic disorders or connective tissue diseases, the morbidity-index, the average income in a region as estimated by state taxation, the relative number of orthopedic surgeons and anesthesiologists, the population density and the average distance the inhabitants of the region had to travel to the nearest hospital performing the THAs.

Ratio of primary THA for primary OA to primary THA for any reason

The region-specific ratios of primary THA for primary OA (NFB30–NFB99 for diagnosis codes M16.0, M16.1, M16.2, M16.3) to primary THA for any reason (NFB30–NFB99 for any reason) were obtained from the individual data of the Hospital Discharge Register (see Inclusion criteria).

Need-adjusted expenses of specialized care

Need-adjusted expenses of specialized care were defined as net expenses of a municipality and region in relation to the need for those services by the population [34]. The data of need-adjusted expenses of specialized care were gathered from the SOTKAnet Indicator Bank [35]. The SOTKAnet Indicator Bank is a Stakes information service that provides key population welfare and health data from 1990 onwards for all Finnish municipalities. Thus SOTKAnet data are organized in terms of the current administrative division into municipalities. The SOTKAnet is based on data gathered by Stakes and those obtained from other agencies that gather welfare and health data.

Morbidity index

The morbidity index describes the health of the population of a specific municipality in relation to the average (set at a base index value of 100) for the country's total population. The figure is calculated for each municipality in Finland, as such and as gender- and age-standardized. The index is

based on three register variables: mortality, the proportion of the working-aged population receiving disability pension for any reason, and also the proportion of the total population entitled to special refunds on medicines. Each variable has been separately calculated in proportion to the average of the total population of the country and 100 as the index base. The final index value is given as the mean of the three sub-indices [35].

Other variables

Data of the average incomes of the region as estimated by state taxation, data on population density, and data on distances to the nearest hospital were obtained from the Statistics Finland. Data of the number of orthopedic surgeons and also the number of anesthesiologists were obtained from the Finnish Medical Association. Data on patients with disability pension due to orthopedic disorders were obtained from the SOTKAnet Indicator Bank.

Results

General results

Over the 1998–2005 period, 44,093 primary THAs were performed in Finland. Of these, 34,675 were performed due to primary OA (79% of all primary THAs) (Table 1).

The number of primary THAs for primary OA increased by 67% over the 8-year period (Table 1). The incidence per 100,000 inhabitants of primary THAs for primary OA was 112 in 2005 (Table 2). There was a tendency for the relative proportion of men to increase towards the end of the study period (Table 1).

There was considerable geographical variation in THA incidence rates. The relative differences in rate between the highest- and lowest-scoring region adjusted for age- and gender was threefold in 1998, 1.9-fold in 2005 and from 2.0 to 2.3-fold in all other years studied (Table 2).

The adjusted incidence index for the capital, Helsinki, was continually below the average of the whole country (Fig. 1).

Table 1 The number of all primary THAs, the number of all primary THAs for primary OA, the mean age of the patients (in years) and the proportion of men of all patients (%) operated on in Finland over the 1998–2005 period

|	1998	1999	2000	2001	2002	2003	2004	2005
The number of all primary THAs	4,538	4,660	4,984	5,197	5,755	6,153	5,859	6,947
The number of primary THAs for primary OA	3,421	3,506	3,878	4,099	4,517	4,891	4,643	5,720
Mean age (in years)	68.3	68.3	68.1	68.0	68.1	67.6	67.7	67.9
Gender (proportion of men, %)	40.2	42.2	42.5	42.4	41.5	43.8	44.9	44.9

Table 2 The unadjusted incidence of primary THAs for primary OA per 100,000 inhabitants for the whole country, including the highest and the lowest regional incidences and the age- and gender-adjusted incidence indices of primary THAs for primary OA for the whole country, including the highest and the lowest regional adjusted incidence indices for the 1998–2005 period

	1998	1999	2000	2001	2002	2003	2004	2005
Incidence in the whole country	67	69	76	80	89	96	91	112
The highest regional incidence	147	110	109	144	128	147	138	163
The lowest regional incidence	45	46	43	48	66	68	58	69
Adjusted incidence index in the whole country	100	101	110	114	124	133	124	150
The highest regional adjusted incidence index	219	160	156	169	176	200	184	190
The lowest regional adjusted incidence index	73	72	69	77	86	91	87	104

100 is taken as the average for the whole country in 1998 and, thus, 1998 is taken as the base year

Fig. 1 Districts, adjusted indices of regional incidence, and 95% confidence intervals of the index, years 1998–2005 summed together. Adjusted indices were compared up to the level of the whole country in year 1998 (the whole country 1998–2005 = 100)
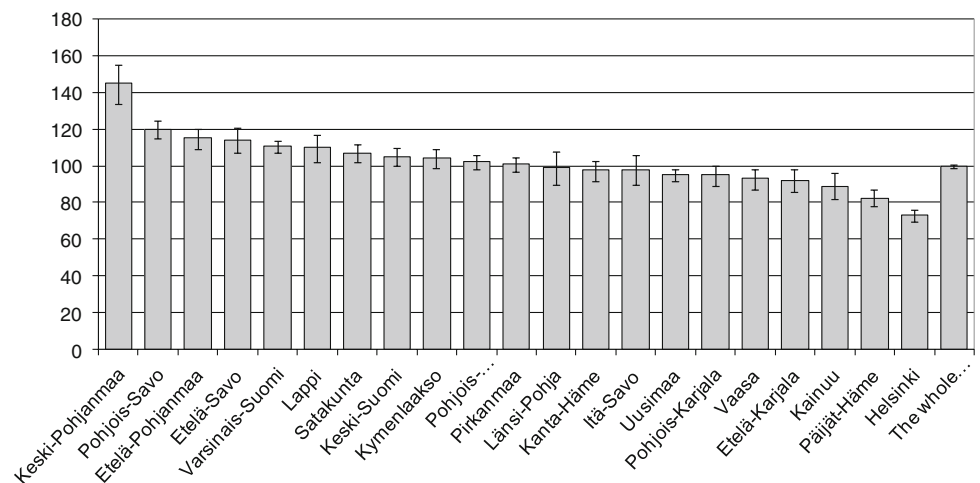
Association between variables and THA rate

A high ratio of primary THA for primary OA to primary THA for any reason ($P < 0.001$) and also high need-adjusted expenses of specialized care ($P < 0.001$) were associated with a high incidence rate of THA for primary OA.

In contrast, a large proportion of patients aged between 18 and 64 years having permanent disability pension because of orthopedic disorders or connective tissue disease was associated with a low incidence rate of THA for primary OA ($P < 0.001$).

None of the following: the relative number of orthopedic surgeons or anesthesiologists, population density, average distance of inhabitants of the region to the nearest hospital performing THAs, the average incomes in a region as evaluated by state taxation and morbidity index was associated with the incidence rate of THA for primary OA.

Discussion

The purpose of this study was to evaluate the geographical variation of the incidence of THA for primary OA at a population-based level in Finland, and also determine any potential factors associated with this variation. The incidence varied from 1.9- to 3.0-fold between the highest and lowest incidence groups during the 8-year study period. The high ratio of primary THA for primary OA to primary THA for any reason indicated a high incidence rate of THAs for primary OA. Thus, it seems that in regions where hip surgery was performed on a larger scale, threshold or performing THAs due to primary OA was higher. In some regions the threshold to perform THA in general seems to be higher than in others. In Finland, surgeon decision-making related factors seem to be associated with regional variation of THA rates. In contrast, socio-economic status and morbidity of the patients or long distances for patients to travel for a THA did not appear to play any role.

Validity of data

The main strength of the current study was the access to a nationwide database with previously documented high data validity, allowing a population-based design for this study. The reliability of the Discharge Register for reporting surgical operations is high. As early as the late 1980s at least 95% of operations were recorded in the Discharge Register

[36]. The correlation between Nordic discharge registers and Nordic arthroplasty registers is high [23, 37, 38], (Peltola M, the National Institute for Health and Welfare, personal communication 8.9.2008). It is also notable that the incidence rates we report also include all private hospitals. Thus these data are comprehensive.

One limitation of the current study was that no information on waiting times was available. The data in the Discharge Register in Finland on waiting times are considered incomplete [39]. Long waiting lists and a high rate of surgery can result from a high demand for surgery, which can be influenced by physicians' [40]. Further, we had no information on patients' or physicians' preferences for the surgery, or about local guidelines for clinical decision-making, or the number of specialist nurses available. Subspeciality training of orthopaedic surgeons performing THRs was not taken into account either. It might be that specialized hip arthroplasty surgeons perform more THRs than general orthopedists—their indications might be broader or perhaps more patients self-refer or are referred secondary to those reputed specialists. The method of extreme quotients in estimating variation is susceptible to potential skewing effect of outliers. It does not exclude the variance attributable to outlying random variation [17]. However, in a previous report on data obtained from the Finnish Discharge Register, it was concluded that the method of extreme quotient produces reliable results for THAs [17].

Regional variation in surgery rates was already described during the 1970s and 1980s [11–13]. Procedures performed for clinical conditions with multiple treatment options, such as osteoarthritis, are most commonly subjected to over- or underuse [16]. The ratio for variation in THA was 1.4 between counties in Denmark [14] and 4.7 in a Medicare population in the USA [16]. In England, the rate of THA implantation varied between 25 and 30% [15]. In a previous study on data obtained from the Finnish Hospital Discharge Register, the variation in incidence of THA was threefold [17]. The 1.9- to 3.0-fold difference in incidence of THA in the current study was lower than that reported previously for Finland, but higher than those reported for other European countries.

It has been suggested that the variation in the incidence rate of THAs can be explained by differences in the number of orthopedic surgeons among regions [18]. This has not been verified in other studies [14, 19]. In the current study, variations in relative orthopedic surgeon or anesthesiologist numbers were not associated with THA incidence rates. Among Medicare beneficiaries in the US, the THA rates were inversely proportional to the population density [19]. However, no association between population density and THA rate was found in Denmark or in England [14, 15]. Despite the sparse population in Finland, the population density or the average distance of the inhabitants to the

nearest hospital providing THAs was not associated with any regional variation in the current study. However, the incidence of THA in Helsinki was low. Accordingly, the incidence rate has also been reported to be low in other large cities including London, Copenhagen, Stockholm, Gothenburg, and Malmö [14, 15, 23]. THAs are most often performed on the elderly. Good infrastructure with services and traffic systems may help elderly patients to manage for longer in these very large cities. However, the data in the current study was age adjusted. It is likely that occupational needs are different in urban areas and one can manage for longer without a THA in urban than in rural areas. On the other hand, when the Finnish system does not reward greater surgical productivity directly, it is equally likely that the surgeons in a densely populated area may choose to fill their work day with more routine procedures (arthroscopy), or in fact be busier with urban trauma.

In contrast to our findings, the proportion of patients with primary OA was not associated with the variation in the THA rate in Denmark [14]. It is important to note that no regional variation in the prevalence of clinical hip OA between different parts of Finland has been shown to exist [9, 10]. In Finland there are 20 hospital districts (in our study 21, Helsinki and its greater metropolitan area, Uusimaa, were presented separately) responsible for the management of hip surgery. The effect of the surgeon enthusiasm as an explanation for area variation in arthroplasty [22, 41] may become significant, if there are only a few surgeons responsible for performing THAs.

It has been estimated that the relative need of services has remained quite stable between the municipalities and regions in Finland over the period from 1993 to 2004 [34]. The difference in the need-adjusted expenses ratio between the most- and the least-expensive municipality has been reported to be 2.5-fold [34]. The need-adjusted expenses of specialized care have increased rapidly in the beginning of this century. Therefore, we wanted to evaluate if these increasing expenses were associated with the variation of regional THA incidence. In the current study, the high need-adjusted expenses of specialized care of a district were significantly associated with a high incidence of THAs. More money per capita "than needed" is spent on specialized care in districts where need-adjusted expenses are high. It is likely that some of this money is used to perform a high rate of THAs. When there are numerous small districts investing variable amounts in different forms of care, the risk of high regional variation of treatments would be expected to increase.

A high proportion of patients aged between 18 and 64 years having permanent disability pension because of orthopedic disorders was associated with a lower incidence of THA. It is likely that those with a permanent disability pension also have multiple orthopedic disorders.

Consequently, the willingness to perform a THA on such individuals is lower, than for those with single orthopedic disorders, as the expected benefit from the procedure per se is lower.

Similar to our findings, Dixon et al. [15] found that the number of limiting long-term illnesses and standardized mortality rates in a region providing THAs were not associated with the actual incidence rate of THAs in that region. The weakness of the morbidity-index used in our study is that it was not possible to divide it into parts.

An association between incidence rates of THA and socio-economic status was found in both England and in Finland [17, 28, 42]. In more recent studies, however, this association has not been detected [14, 15]. In the current study, the average incomes in a hospital district were not correlated to THA incidence. However, socio-economic status of the patient has been associated with arthroplasty rates in USA (26,27). We are not aware of any reports of the subject from developing countries, but one might assume that this association in these countries is strong. We think that our results can influence THA rates in developed countries by stating that small units with only a few surgeons performing THAs may be associated with high regional variation. In developing countries and developed countries with large heterogenous population, socio-economic factors are probably of very high importance.

Conclusions

When hip surgery was performed on a larger scale, threshold for performing THAs due to primary OA was higher. Socio-economic status had no apparent effect on THA rate. Surgeon decision-making related factors influence THA rates when there are only a few surgeons responsible for performing THAs in a region.

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