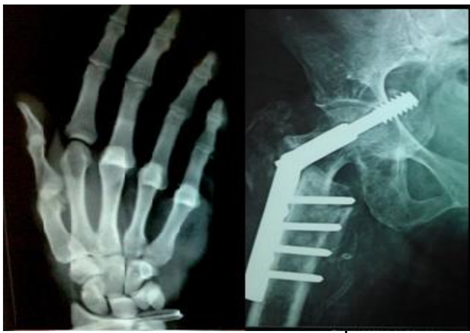

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Incidence and prevalence of total joint replacements due to osteoarthritis in the elderly

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Abstract
Aim: We analyzed risk factors for the occurrence of TJRs due to osteoarthritis and factors associated with late-life prevalence.
Methods: Following the exclusion of inflammatory arthritis and fractures as potential etiologies of TJR, a total of 100 study participants were selected for osteoarthritis research (mean age (SD) 76.4 (5.5), with 58% being female).
Results: During the five-year follow-up, the incidence of at least one joint replacement operation as a result of OA was 1.3% per year, while the prevalence was 11.6%. The prevalence of TJR in old age was positively correlated with BMI, severity of hand OA, female gender, digit length ratio, and spine BMD. Prevalence of prior TJR in the contralateral joint, symptoms at initial visit, and body mass index were risk factors for TJRs in the incidence group. Discriminatory analysis revealed significantly stronger associations for TKR than for THR, with AUC values of 0.71 and 0.84, respectively, for late life prevalence and incidence.
Conclusion: This research demonstrates the significance of the disparate data presented by late life prevalence versus incidence regarding the risk factors for severe osteoarthritis of the hip and knee. Prior description of the observation that prior TJR is a risk factor for subsequent TJR in the contralateral joint is absent. The high power predictions for TKR indicate that the development of a predictive model may be viable, especially if additional predictive variables, such as genetic, biomarker, or imaging data, can be incorporated.

Keywords: Osteoarthritis, joint replacements, incidence and prevalence

Introduction

Worldwide, osteoarthritis of large joints (OA) is a leading cause of discomfort and disability. Multiple joints are impacted by the disease process, and the anatomical condition of a joint as determined by imaging or clinical examination differs significantly from its symptoms and disability [1-3].

Although the precise etiology of OA remains largely unknown, several genetic and environmental factors have been suggested as potential contributors. The affected joints may develop OA due to local factors including trauma, malalignment, dysplasia, and hypermobility [4, 5]. Knee and hip OA are additionally correlated with body mass index (BMI) and strenuous occupation [6, 7]. However, there is also support for the notion that systemic factors contribute to polyarticular involvement, specifically hand OA [7].

In contrast to other chronic diseases, OA lacks definitive endpoint measures that can be utilized in intervention studies. The progression of OA has been characterized as a series of alternating phases of inertia and advancement, underscoring the absence of a linear pattern and considerable variability in clinical indicators. As a result, the progression of OA may endure for decades, interspersed with phases of accelerated advancement that ultimately culminate in joint failure and complete joint replacement [8]. In the most severe manifestations of knee and hip osteoarthritis (OA), total joint replacement surgeries (TJRs) are the preferred treatment approach. Thus, TJRs serve as a surrogate marker for severe OA and a potential endpoint; however, this endpoint is beset by inherent challenges, including access barriers resulting from financial and geographical disparities in the availability of TJR resources and patients' reluctance to undergo such procedures [9, 10].

X-rays and psychometric instruments (e.g., WOMAC) have historically been employed as co-primary endpoints in pivotal drug testing trials. X-rays are insensitive and require two to three years to detect statistically significant differences between treatment groups, whereas the substantial placebo effect that frequently obscures treatment effects compromises psychometric readouts. Although MRI is a more sensitive indicator of change compared to X-ray, their predictive value for TJRs is virtually identical [11, 12].

A number of studies have examined risk factors for TJRs, and an effort has been made to develop a predictive model for the incidence of knee osteoarthritis in recent times. A predictive model that can identify individuals at high risk of requiring total joint replacements due to OA would be an extremely useful resource for resource allocation and intervention strategies involving large joint OA [13].

The purpose of this investigation was to determine the prevalence and incidence of total joint replacements in the elderly as a result of osteoarthritis.

Methods

- It is a prospective study of 100 men and women, age 65–95 years.
- Informed consent was obtained from all participants.
- Information regarding hip and knee joint replacements was obtained through anterior scout imaging with computed tomography (CT).
- One hundred participants were eligible for osteoarthritis studies after inflammatory arthritis and joint replacements owing to fractures were excluded (mean age 76.4 (5.5) years; 40 males, 60 females).
- In order to quantify bone mineral density (BMD) in the lumbar spine, quantitative CT (QCT) scans were acquired using a CT Sensation 4 detector scanner manufactured by Siemens Medical Systems in Erlangen, Germany.

BMI, finger length ratio (one case: fourth finger shorter than second finger; two cases: second and fourth fingers of equal length; and three cases: fourth finger longer than second finger) and hand osteoarthritis severity (as determined by high-quality photographs on a scale of zero to four) were additional variables that had been previously linked positively with TJR. Smoking history (0 = never, 1 = former, 2 = current), high-sensitivity C-reactive protein (Hs-CRP), cholesterol, triglycerides, and statin use were additional variables.

Statistics

The association between specific predictor variables and the prevalence and 5-year incidence of THR and TKR was estimated through the utilization of logistic regression models. The SPSS 19 software package was employed to perform the multivariable logistic analysis, while the pROC package of R 3.0 was utilized to calculate the areas under the ROC curves.

Results

Table 1: Prevalence and five-year incidence of total joint replacements due to osteoarthritis

Prevalence at the end of AGES II (n=100)								
	Male				Females			
Age groups	**n**	**TKR (%)**	**THR (%**	**TJR (%)**	**n**	**TKR (%)**	**THR (%**	**TJR (%)**
-69	4	6.1	4.1	10.2	5	5.1	6.6	11.7
70-74	15	5.2	6.4	11.6	23	7.3	6.2	13.4
75-79	11	4.3	6.1	10.4	18	7.0	5.1	12.1
80-84	7	5.0	7.3	12.3	11	5.3	6.5	11.8
85+	3	4.3	6.4	10.7	3	4.4	7.2	12.6
Total (95%CI)	40	5.1	6.6	10.9	60	6.5	5.9	11.9
Incidence during 5 years follow up (n=60)								
	male				females			
Age groups	**n**	**TKR (%)**	**THR (%**	**TJR (%)**	**n**	**TKR (%)**	**THR (%**	**TJR (%)**
-69	2	2.1	2.1	4.2	5	3.1	3.6	6.7
70-74	8	3.2	1.4	4.6	23	5.3	3.3	8.6
75-79	5	2.3	3.1	5.4	18	4.0	4.7	8.7
80-84	4	3.0	2.3	5.3	11	3.3	3.1	6.4
85+	1	1.3	3.4	4.7	3	2.4	2.3	4.7
Total (95% CI)	20	2.1	3.0	5.1	40	3.2	5.4	7.2

100 participants (40 males, mean age 75.5 (5.4) and 60 females, mean age 74.4 (5.5)) were eligible for osteoarthritis studies. Mean BMI for males was 25.9 (3.8) and females 26.3 (4.8). The overall prevalence of those having at least one joint replacement operation due to OA was 11.6% and the overall incidence in the follow up group was 1.3% / year during the five-year follow-up.

Discussion

In this population-based study involving one hundred elderly people, the late-life prevalence of TKRs was strongly correlated with BMI, hand OA severity, and the spine. THRs as a whole exhibited weaker associations, whereas hand OA severity, female gender, BMI, and BMD demonstrated statistically significant positive associations. During a five-year follow-up, incidence revealed an entirely distinct pattern, with prior TKR operations in the contralateral joints, symptoms, and body mass index emerging as highly significant risk factors for TKRs. The combined effect of these risk factors on incident TKR was highly discriminatory, as indicated by the AUC of 0.84. The most significant risk factor for THR was a prior THR that occurred on the opposite side.

In the context of clinical practice, the incidence results are unquestionably more pertinent, as they demonstrate an exceptionally high predictive power for TKRs and suggest that overweight, elderly patients who have previously undergone TKR in the contralateral knee are at a heightened risk of requiring TKR procedures. Late-life prevalence provides information that is more pertinent to the burden and etiology of OA over its long-term natural progression. Lohmander LS, *et al*. [7] observed a similar correlation to the well-established association with BMI.

Evidently, a predictive model capable of evaluating the burden of OA and the forthcoming requirement for TJRs would serve as a valuable instrument in determining the allocation of resources to address intervention strategies in significant joint OA. Apold *et al.* [14] and Mnatzaganian *et al.* [15] conducted research on the risk factors associated with TJRs; however, the predictive value of these studies has been limited thus far, frequently attributable to the absence of pertinent variables and soft endpoints. A recent endeavor has been to develop a predictive model for the occurrence of knee osteoarthritis. Kerkhof *et al.* [13] identified gender, age, and BMI as risk factors; however, the inclusion of genetics and biomarkers in the model appeared to be of limited value, whereas radiographic alterations contributed significantly. The existing data could be interpreted as an endeavor to develop a model of this nature.

The high predictive potential of incident TKRs observed in the current investigation provides evidence in support of this possibility. In relation to the late life prevalence TKR group, it is evident that significant factors are absent from the current data. These factors include prior trauma and minor operations, for which no information is available, as well as genetics, which, despite strong heritability associations, have thus far only contributed to relatively minor risk associations [16, 17].

It is conceivable that the identification of individuals who are more likely to require TKRs throughout their lifespan could be enhanced through the application of biomarkers and improved imaging data. Imaging has the potential to make a substantial contribution to the existing predictive model for incidence prediction, likely in conjunction with biomarkers and genetics. There seems to be a significant distance to travel in developing a predictive model for the THRs.

Although the majority of the risk factors incorporated in the present model have been previously documented, the unanticipated significance of previous TJR operations as a risk factor represents an original finding in a population-based study. A prior investigation conducted by Sigurjonsdottir *et al.* [18] identified a positive correlation among hand OA, TKRs, and THRs, suggesting a generalized susceptibility to OA. This suggests that individuals with end-stage OA in one joint have an increased probability of developing the same condition in another joint. McMahon M, *et al.* [19] identified a high incidence of contralateral TKR procedures as a result of radiographic alterations, and Gillam MH [20] has determined, based on the site of the initial TJR, which joints are most susceptible to a second TJR. Multiple studies, including those by Dahaghin S, *et al.* [21] and Metcalfe AJ, *et al.* [22], have documented symmetrical knee OA and polyarticular associations.

As reported by Mnatzaganian M, *et al.* [15], we found no evidence of an inverse relationship between smoking and socioeconomic status and the risk of THRs. The lack of correlations between occupation and education appears to suggest that access barriers to TJRs are minimal or nonexistent, which lends credence to the use of TJRs as an endpoint for severe OA.

One potential limitation of this research is the absence of data regarding incident TJRs among individuals who did not take part in the five-year follow-up period. As a consequence, drawing conclusions about population incidence from these data is restricted. The individuals who participate in the study may be representative of the population at large in terms of health, while severe cases involving early aggressive OA or a history of complicated operations may be underrepresented.

Conclusion

The findings of this study focusing on the elderly highlight the distinctions between risk factors that influence the incidence of TJRs and those that influence their prevalence in old age. Predictive models for the incidence and late-life prevalence of TKRs may be realizable, according to the available data, especially when additional information from genetics, biomarkers, and imaging is incorporated.

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