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HIP ARTHROPLASTY

Are people following hip and knee arthroplasty at greater risk of experiencing a fall and fracture? Data from the Osteoarthritis Initiative

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Abstract
Introduction Falls are a major challenge for older people and are a significant source of mortality and morbidity. There has been uncertainty as to whether people with total hip (THA) or knee (TKA) arthroplasty have a greater risk of falls and associated fractures. This analysis was to explore this question with a large community dataset.
Materials and methods Data from all people enroled onto the US Osteoarthritis Initiative programme who had undergone a THA ($n = 104$) or TKA ($n = 165$), within a 12-month period, were compared to those who had not undergone an arthroplasty ($n = 4631$). Data were collected on: the number of participants who reported a fall within a 12-month period; the frequency of falls in this period; and whether a fracture was sustained during this period. Odd ratios were calculated for the probability of experiencing a fall or fracture between the groups.
Results There was no statistical difference in falls between people following THA (OR 0.90; 95 % CI 0.58–1.41) or TKA (OR 0.95; 0.67–1.35) compared to a non-arthroplasty cohort. Whilst there was no statistical difference in fracture risk between people following TKA compared to non-arthroplasty individuals (OR 1.25; 95 % CI 0.57–2.70), those who underwent THA had a 65 % lower chance of experiencing a fracture in the initial 12 post-operative months compared to the non-THA cohort (OR 0.35; 95 % CI 0.19–0.65; $p < 0.01$).
Conclusions There appears a lower chance of experiencing a fracture for people following THA compared to those who have not.

Keywords Lower limb · Joint replacement · Osteoarthritis · Community-dwelling · Trauma · Rehabilitation

Introduction

Falls and their subsequent injuries are a major cause of morbidity and mortality in older people [1]. It has been estimated that the prevalence of falls in people aged 65 years and over is 30 % in community-dwelling individuals, and in 50 % of those aged 85 years and older [2]. Falls-related injuries can range from minimal soft tissue injury to more serious life and limb threatening injuries such as fractures, head injuries and chest or abdominal contusion [3].

Hip and knee arthroplasty are two of the most common orthopaedic procedures worldwide and are the treatment of choice for end-stage symptomatic osteoarthritis [4]. The number of people undergoing primary total hip (THA) and knee (TKA) arthroplasty is expected to increase in number

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from 95,877 to 118,666 by 2035 [5]. The mean age for such procedures ranges from 68 to 70 years. Both pre- and early post-operatively, such people may have reduced muscle strength, endurance, balance and joint range of motion as a consequence of their degenerative or recovering arthroplasty joint, in addition to other symptomatic degenerative joints which present in a high proportion of the osteoarthritis population [6, 7]. Previous cohorts have demonstrated that people with hip or knee osteoarthritis, the most frequent indication for TKA or THA [4], have greater falls and fracture risk compared to the general (non-osteoarthritis) population [8, 9]. Therefore, these are major physical risk factors attributed to increased risks of experiencing a fall [10].

Previously it has been unclear whether patients who have undergone THA or TKA are at higher risk of falling. Matsumoto et al. [11] reported that in their age- and gender-matched cohort of 81 patients, who underwent TKA, the incidence of falls was 38 % in the first year post-operatively, compared to 24 % in non-TKA cohort. These results were lower than previous cohorts of 43 % [12], but similar to Ikuotomo et al's [13] THA cohort of 36 %, and higher than that reported by Swinkels and Allain [14] and Swinkels et al. [15] at 23 and 24 %, respectively. Furthermore, previous cohorts have demonstrated a higher risk of hip fracture in people who undergo a TKA in the first 12 months, reported at 54 and 57 % increased risk of hip fracture in Lalmohamed et al. [16] and Prieto-Alhambra et al. [17], respectively. In contrast, previous literature has demonstrated a significant improvement in gait and balance in those who have undergone THA and TKA to address these key physical risk factors to falling [18–20].

However, it remains unclear whether there is a difference in falls rates and subsequent fractures for people who undergo THA or TKA based on a large cohort of individuals. It also remains uncertain whether specific subgroups within the arthroplasty population are at particular risk of falls and falls-related fracture. It would therefore be valuable to examine for differences between sufficiently powerful matched cohorts of people who have compared to have not undergone arthroplasty within 12 months post-operatively. Through this, it will be possible to determine firstly whether people following THA and TKA are at lesser or greater risk of falls post-operatively; secondly, whether this risk changes in the initial post-operative period; and thirdly whether certain individuals are at greater risk than others. This will be valuable as it may lead to a more strategic approach to rehabilitating people post-arthroplasty, thereby improving the recovery of this population which is growing in number. Accordingly the purpose of this analysis was to explore the risk factors associated with falls and subsequent fracture for those people with and without THA or TKA.

Materials and methods

Data used in the preparation of this article were obtained from the Osteoarthritis Initiative (OAI) database, which is available for public access at http://www.oai.ucsf.edu/. The OAI is a large-scale, multi-centre (four sites across the USA), longitudinal cohort study aimed to investigate the role of biomarkers in the development and progression of lower limb osteoarthritis.

Baseline data were collected between February 2004 and May 2006, and then longitudinally collected at 12, 24, 30, 36, 48, 60, 72 and 84 months follow-up intervals. Data collected included: individual's demographic characteristics, previous and current medical history including medical morbidities, lifestyle and physical activity assessed using the Physical Activity Scale for the Elderly (PASE) [21]. This is a 12-question tool which evaluates the frequency and duration of leisure activity (e.g., sports, jogging, swimming, strengthening and endurance exercise), household activity and work-related activity during a previous seven-day period. For this analysis we collated data on: the number of participants who reported a fall within a 12-month period; the frequency of falls in this period; whether a fracture was sustained during this period; and the type of fracture (when recorded).

The whole OAI cohort was included in this analysis. Specifically, to answer this research question, we identified all individuals who had had a THA or TKA within the first 12 post-operative months, and compared outcomes to those who had not undergone an arthroplasty. Through this it was possible to attribute the outcomes of these individuals within the first 12 months of undergoing a THA or TKA.

Data analysis

Descriptive statistics were initially used to analyse the trends and patterns in categorical and continuous data. The normality of the dataset was analysed using the Shapiro–Wilks test.

The aim of the analysis was to determine whether there was a difference in incidence of falls, with or without a consequential fracture, between people who had undergone a THA or TKA within their first 12 post-operative months, compared to those who had not. To determine this we compared the arthroplasty groups to non-arthroplasty groups using a Mann–Whitney U test to assess mean cumulative falls, and a Chi square test to assess the occurrence of a fall and the occurrence of a fracture within the first 12 post-operative months.

Secondly, we aimed to determine what factors may be associated with the occurrence of a fall and/or fracture within people who had undergone a THA or TKA within

the first 12 post-operative months. To determine this, a univariate analysis was initially undertaken with the dependent variables: occurrence of a fall and occurrence of a fracture within the study period. The independent variables identified through previous research as potential explanatory factors included: age, gender, ethnicity, marital status, employment status, previous THA (in the TKA cohort), previous TKA (in the THA cohort), diagnosis of hip osteoarthritis, diagnosis of knee osteoarthritis, and use of bisphosphonates in past 12 months. Based on these, all variables identified as significant at $p < 0.01$ on univariate analysis were entered into a multivariate logistical regression model. All logistical regression data were expressed as odd ratios (OR) with 95 % confidence intervals (CI) and p values. Statistical significance was denoted at $p > 0.05$ on multivariate analysis and OR interpretation. The Wald statistic was used to assess statistical significance in each regression model. All analyses were undertaken using STATA version 12.0 (STATACorp LP, Texas, USA).

Results

A study flowchart is presented as Fig. 1. In total, data on falls and participant characteristics were available for 104 people who had undergone THA and 165 who had undergone TKA. Consequently, it was possible to compare the THA cohort to 4692 non-THA participants and 4631 individuals to the TKA cohort. The demographic characteristics of the cohorts are presented in Table 1. As this demonstrates, the characteristics of each comparable group were broadly similar; the exceptions being for the THA cohort, where the mean age of the THA cohort was 4 years older. There was a slightly higher proportion of people diagnosed with concomitant knee osteoarthritis in the THA cohort (15 %) compared to the non-THA cohort (10 %), and the non-THA group had a higher PASE score (mean = 151) compared to the THA group (mean = 142). In the TKA analysis, the groups were largely similar; with the exception being that the TKA group demonstrated a slightly greater proportion of people with concomitant hip osteoarthritis (9 %), compared to the non-TKA group (4 %). The proportion of people prescribed bisphosphonates was broadly similar throughout the four groups (Table 1).

Total hip arthroplasty

There was no statistically significant difference between the chances of experiencing a fall in the initial 12 months post-THA compared to non-THA cohort from the dataset (Table 2). The chances of experiencing a fall were 10 % less in the THA cohort compared to the non-THA cohort in the 12 months assessed (OR 0.90; 95 % CI 0.58–1.41). However, this did not reach statistical significance ($p = 0.66$). There was no significant difference between the two groups for mean cumulative falls in the 12 months assessed (mean: 0.57 vs 0.49; $p = 0.27$). However, there was a difference in fracture risk. Those who underwent a THA had a 65 % lower chance of experiencing a fracture

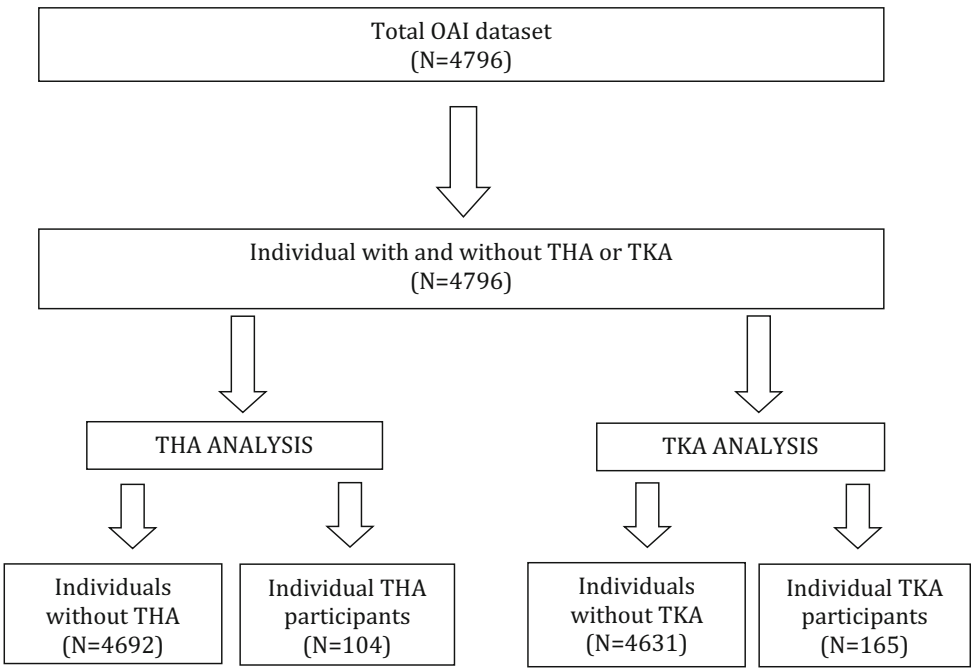

Fig. 1 Flowchart illustrating the subject selection based on a priori eligibility criteria

Table 1 Demographic characteristics

	Non-THA	THA	Non-TKA	TKA
N	4692	104	4631	165
Gender (m/f; %)	1949/2743 (41.5/58.5)	43/61 (41.3/58.7)	1923/2708 (41.5/58.5)	69/96 (41.8/58.2)
Mean age in years (SD)	66.8 (9.0)	71.1 (9.2)	66.9 (9.0)	67.6 (9.1)
Race (*n*; %)				
1: Other non-white	1: 81 (1.7)	1: 1 (1.0)	1: 81 (1.8)	1: 0 (0.0)
2: White or caucasian	2: 3704 (79.0)	2: 86 (82.7)	2: 3651 (78.9)	2: 139 (84.8)
3: Black or African American	3: 859 (18.3)	3: 15 (14.4)	3: 850 (18.4)	3: 24 (14.5)
4: Asian	4: 43 (1.0)	4: 2 (1.9)	4: 44 (0.9)	4: 1 (0.7)
Marital status (*n*; %)				
1: Married	1: 3252 (71.9)	1: 60 (67.4)	1: 2325 (64.8)	1: 87 (68.0)
2: Widowed	2: 411 (9.1)	2: 8 (9.0)	2: 404 (11.3)	2: 15 (11.7)
3: Divorced	3: 498 (11.0)	3: 9 (10.1)	3: 493 (13.7)	3: 14 (10.9)
4: Separated	4: 47 (1.0)	4: 0 (0.0)	4: 45 (1.3)	4: 2 (1.6)
5: Never married	5: 317 (7.0)	5: 12 (13.5)	5: 319 (8.9)	5: 10 (7.8)
Employed (Y; %)	2247 (47.9)	45 (43.3)	2209 (47.7)	81 (49.1)
Number of THA (Y; %)	0 (0.0)	104 (100.0)	17 (0.4)	2 (1.2)
Number of TKA (Y; %)	25 (0.5)	2 (1.9)	0 (0.0)	165 (100.0)
Number of hip OA diagnosed (Y; %)	135 (2.9)	42 (40.4)	163 (3.5)	14 (8.5)
Number of knee OA diagnosed (Y; %)	441 (9.5)	15 (14.4)	471 (10.2)	67 (40.6)
Bisphosphonates prescribed (Y; %)	592 (12.6)	16 (15.4)	608 (13.1)	31 (18.8)
Mean PASE score (SD)	151.1 (82.5)	141.5 (80.9)	146.3 (82.7)	149.2 (75.4)
Type of bisphosphonate prescribed (*n*; %)				
0: None	0: 3779 (86.5)	0: 90 (86.5)	0: 3877 (86.5)	0: 134 (81.2)
1: Alendronate	1: 419 (9.6)	1: 11 (10.6)	1: 431 (9.6)	1: 22 (13.4)
2: Risedronate	2: 113 (2.6)	2: 2 (1.9)	2: 114 (2.5)	2: 7 (4.2)
3: Alendronate and risedronate	3: 49 (1.1)	3: 1 (1.0)	3: 49 (1.1)	3: 2 (1.2)
4: Other	4: 10 (0.2)	4: 0 (0.0)	4: 9 (0.3)	4: 0 (0.0)

f female, *m* male, *N* number, *OA* osteoarthritis, *PASE* Physical Activity Scale for the Elderly, *SD* standard deviation, *THA* total hip arthroplasty, *TKA* total knee arthroplasty, *Y* yes

Table 2 Difference between arthroplasty and non-arthroplasty groups for falls and fracture outcomes over 12-month follow-up

	Arthroplasty group	Non-arthroplasty group	Odd ratio (95 % CI)
THA	104	4692	
Fall in past 12 months (Y; %)	26 (25.0)	1265 (27.0)	0.90 (0.58–1.41; 0.66)
Fracture in the past 12 months (Y; %)	146 (13.5)	12 (0.9)	0.35 (0.19–0.65; <0.001)
Mean cumulative falls in past 12 months (SD)	0.57 (0.86)	0.49 (0.85)	$p = 0.27$ (−0.10–0.26)*
TKA	165	4631	
Fall in past 12 months (Y; %)	43 (26.1)	1254 (27.1)	0.95 (0.67–1.35; 0.77)
Fracture in past 12 months (Y; %)	7 (4.2)	159 (3.4)	1.25 (0.57–2.70; 0.58)
Mean cumulative falls in past 12 months (SD)	0.40 (0.78)	0.48 (0.84)	$p = 0.99$ (−2.48 to 2.64)*

CI confidence intervals, *OA* osteoarthritis, *SD* standard deviation, *THA* total hip arthroplasty, *TKA* total knee arthroplasty, *Y* yes

* Student's *t* test (95 % CI)

in the initial 12 post-operative months compared to the non-THA cohort (OR 0.35; 95 % CI 0.19–0.65; $p < 0.01$).

The results of the univariate analysis are illustrated in Table 3. This demonstrates that age (OR 0.99; 95 % CI 0.98–1.00), gender (OR 1.28; 95 % CI 1.03–1.58), bisphosphonate use (OR 1.23; 95 % CI 1.03–1.58), having not undergone a previous TKA (OR 0.35; 95 % CI 1.04–1.20) and a physician-diagnosis of knee osteoarthritis (OR 1.51;

Table 3 Univariate analysis: factors associated with falls and fractures in people who have undergone THA or TKA during the first 12 post-operative months (OR and 95 % CI: *p* value)

	Age	Gender	Bisphosphonate use	Marital status	Employment	THA	TKA	Hip OA	Knee OA	Race
THA										
Fall in past 12 months	**0.99 (0.98, 1.00) 0.07**	**0.87 (0.74, 1.02) 0.08**	**1.28 (1.03, 1.58) 0.02**	1.00 (0.94, 1.01) 0.96	1.07 (0.89, 1.27) 0.48	–	**0.35 (1.04, 1.20) 0.09**	1.00 (0.79, 1.26) 0.24	**1.51 (1.06, 2.14) 0.02**	0.94 (0.78, 1.13) 0.52
Fracture in past 12 months	1.00 (0.99, 1.03) 0.46	1.05 (0.72, 1.54) 0.79	**2.41 (1.59, 3.67) <0.01**	0.98 (0.84, 1.14) 0.75	1.00 (0.65, 1.52) 0.99	–	0.00 (0.00, 0.00) 1.00	1.36 (0.82, 2.25) 0.24	1.28 (0.59, 2.78) 0.54	0.74 (0.46, 1.0) 0.22
TKA										
Fall in past 12 months	1.00 (0.99, 1.00) 0.84	**0.89 (0.76, 1.00) 0.15**	**1.23 (1.03, 1.58) 0.03**	1.01 (0.95, 1.07) 0.81	0.86 (0.56, 1.30) 0.47	1.62 (0.64, 4.08) 0.31	–	**1.34 (0.93, 1.94) 0.12**	0.96 (0.76, 1.21) 0.72	1.05 (0.87, 1.27) 0.59
Fracture in past 12 months	1.00 (0.98, 1.02) 0.84	0.89 (0.61, 1.30) 0.54	**2.01 (1.45, 3.37) <0.01**	**1.13 (0.99, 1.30) 0.08**	**0.86 (0.56, 1.30) 0.08**	**3.06 (0.68, 13.79) 0.15**	–	1.10 (0.48, 2.55) 0.82	1.26 (0.74, 2.14) 0.39	0.96 (0.62, 1.49) 0.86

Bold refers to factors which were significant on univariate analysis to $p<0.10$

CI confidence intervals, *OA* osteoarthritis, *OR* odd ratio, *THA* total hip arthroplasty, *TKA* total knee arthroplasty

95 % CI 1.06–2.14) were potentially significant predictors of falls in the initial 12 post-operative THA months. However, on multivariate analysis only having not undergone a previous TKA was identified as a statistically significant predictor, reducing the chances of experiencing a fall in the initial 12 post-THA months by 85 % (OR 0.15; 95 % CI 0.04–0.53; Supplementary File 1).

Only bisphosphonate use was identified as a significant predictor of fracture in the past 12 months from the THA cohort, where people who took bisphosphonates were at a nearly two and a half times greater chance of experiencing a fracture within the first 12 months post-THA (OR 2.41; 95 % CI 1.59–3.67; Table 3).

Total knee arthroplasty

There was no statistically significant difference in the chances of someone experiencing a fall or fracture following TKA compared to the non-TKA cohort (Table 2). The chances of experiencing a fall in the first 12 months post-TKA were 5 % lower than in the non-TKA cohort (OR 0.95; 0.67–1.35; $p = 0.77$). However, whilst there was a 25 % greater chance of experiencing a fracture in the TKA cohort compared to non-TKA cohort in the initial 12 months post-TKA (OR 1.25; 95 % CI 0.57–2.70), this was not a statistically significant relationship. The cumulative number of falls experienced in the assessed 12-month period was not statistically significantly different between the TKA and non-TKA cohorts (mean: 0.40 falls vs 0.48 falls; $p = 0.99$).

Table 3 illustrates the univariate analysis results from the TKA cohort. This demonstrated that predictors such as gender (OR 0.86; 95 % CI 0.76–1.00), bisphosphonate use (OR 1.23; 95 % CI 1.03–1.58) and a physician-diagnosis of hip osteoarthritis (OR 1.34; 95 % CI 0.93–0.94) were significant predictors of experiencing a fall within the 12-month assessment period. However, only bisphosphonate use remained a significant predictor on multivariate analysis (OR 1.25; 95 % CI 1.00–1.56; Supplementary Table 1), where those who took bisphosphonates demonstrated a 25 % greater chance of experiencing a fall in the first post-operative year.

Bisphosphonate use (OR 2.01; 95 % CI 01.45–3.37), marital status (OR 1.13; 95 % CI 0.99–1.30), current employment (OR 0.86; 95 % CI 0.56–1.30) and having not undergone a previous THA (OR 0.86; 95 % CI 0.76–1.00) were significant predictors of experiencing a fracture within 12 months of a TKA on univariate analysis. However, on multivariate analysis, only bisphosphonate use remained a significant predictor, where people following TKA who took bisphosphonates were over twice as likely to have a fracture within 12 months post-operative, compared to those who did not (OR 2.24; 95 % CI 1.45–3.49; Supplementary Table 1).

Discussion

There was no direct evidence supporting the hypothesis that people who undergo TKA are at any greater or lesser risk of falls or fractures during their first 12 post-operative months. Whilst there was no direct evidence that people who undergo TKA are at any different risk of experiencing a fall in their first 12 post-operative months, THA did confer a reduced risk of fracture in this period, with a 65 % lower chance of experiencing a fracture following THR, compared to non-arthroplasty cohort. Bisphosphonate prescription was identified as a significant predictor of fracture and falls risk for people following THA or TKA; however, it remains unclear whether this is a cause or consequence of such adverse events within the assessing 12-month intervals. Having undergone TKA was also identified as a significant predictor of reducing the chances of experiencing a fall in the initial 12 months post-THA.

Ikutomo et al. [13] previously reported an increased occurrence of falls in the initial 12 months after TKA; however, these analyses had not compared falls in THA and TKA against a similar non-arthroplasty cohort. Matsumoto et al. [11] did compare their findings to age and gender-matched cohorts, reporting a significantly higher incidence of falls in people post-arthroplasty ($p = 0.04$). However, they did not control for the duration since operation, which has been identified as a significant predictor of falls [13]. Nonetheless, both the current data and previous literature have emphasised that the prevalence of falls is considerable in this population, being estimated in up to 48 % of patients in the first post-operative year [22]. This reiterates that both the arthroplasty and non-arthroplasty populations in general should be considered populations that would potentially benefit from falls rehabilitation if this is indicated in specific individuals with a history of this adverse event.

Age and gender were reported as predictors of falls or fracture in the univariate analyses. Previously Lalmohamed et al. [16] reported an association between TKA and increased hip fracture; however, this was not reproduced in this cohort, with contrary findings reported in this dataset. This may be attributed to the difference in ages where the mean age of the TKA cohort in our dataset was 68 years, compared to the increased age reported in Lalmohamed et al.'s [16] cohort who were 70 years and older. The findings of similar fracture rates between THA and TKA cohorts and age and gender-matched cohorts reported in Prieto-Alhambra et al. [17, 23] but only at 3-year follow-up, though similar data from the UK General Practice Research Dataset reported by the same team concluded that risk was greater in the THA cohort up to 5 years post-operatively. These results may be attributed to lower age group in our analysis, or the non-significant findings may be related to the smaller individuals samples and type II statistical error, which our THA and TKA cohorts may have represented compared to Prieto-Alhambra et al's [17, 23] 14,133 THA and 20,033 TKAs.

Only the prescription of bisphosphonates was identified as a consistent predictor of falls or fracture risk in this analysis in the multivariate analyses, although this should be interpreted with caution. Given the longitudinal, annual assessment approach adopted by the OAI programme, it was not possible to distinguish whether bisphosphonate use commenced before or after falls and fracture events occurred. Given that it is recommended national and international guidance that people at risk of falls with subsequent insufficiency fractures should be routinely prescribed some form of bisphosphonate [24, 25], it would appear a sensible hypothesis that the analysed falls and fracture population were prescribed these medications following their initial fall. Thus, this finding is measurement artefact rather than indicating a causal relationship between bisphosphonate use and fracture and falls. This is supported by the literature which has not reported such a previous association [24], whilst also emphasising that these medications are indicated for people at risk of fractures related to falls to mitigate this potentially fatal event [26]. The finding that there is a relationship between falls, fracture and bisphosphonates is therefore an encouraging finding, as it suggests that those who are at most need of such pharmacological agents, are prescribed these medications.

The findings of this study suggest that there is little difference in fracture or falls risk between those who have and those who have not undergone THA or TKA. Given that people following joint arthroplasty pre-operatively have greater pain, loss of joint range of motion and increased disability, which has been shown to increase falls risk [27, 28], joint arthroplasty and the subsequent rehabilitation and recovery undertaken by this population, may mitigate these previously reported trends. The results therefore suggest that in respect to falls, the current rehabilitation provided to cohorts such as the US OAI dataset is sufficient and further falls management strategies should therefore only be routinely employed for those exceptional cases who are at greatest risk. The minimal difference in falls and fracture risk between people who have undergone a THA and TKA is notable from this dataset. Whilst a good recovery following THR has been widely considered to be high in this population [29], between 20 and 30 % of people following TKA still present with residual pain, loss of motion and functional difficulties at 12 and 24 post-operative months [30, 31]. Since these are all recognised risk factors to falls, the minimal difference between the cohorts is an interesting finding which may or may not be representable of the wider population.

This analysis presented with five notable limitations. Firstly, the OAI dataset did not collect information related to the type of falls and possible contributing factors to falls. Therefore, it remains unclear whether the falls experienced between people following THA or TKA were in relation to physical activity and being more physically active or to more sedentary activities. This would be valuable as it could help identify where best to support this population to reduce future falls risk. Secondly, the OAI dataset reported falls and fracture events which occurred in a 12 months period. It was not possible to distinguish between the number and type of falls which occurred within the initial post-operative period (i.e. 6–12 weeks post-surgery) compared to the remaining follow-up period. Given that previous literature has suggested that rehabilitation and recovery may take up to 6 months for people following THA or TKA [32, 33], it would have been valuable to have analysed by recovery period, to explore the potential importance of this. Thirdly, there was limited data available through the dataset on the location and type of fracture experienced by the cohort; this was due to a high number of missing data-points. Such an analysis would have provided an indication as to whether the types of fractures experienced by the cohort differed, and may be a useful addition for future research on this post-surgical population. Fourthly, we included data from all potentially eligible individuals rather than basing the sample size on an a priori power calculation. The number was therefore self-determined by the size of the OAI dataset. Finally, the OAI database is a cohort of individuals from North America who have volunteered to a research project. Whilst this provides valuable data, this cohort may be considered a self-selecting sample of healthier and more educated or affluent individuals compared to the full spectrum of clinical practice, and may therefore limit generalisability to the wider population from different economic, social and cultural backgrounds worldwide.

Conclusions

Whilst people following TKA or THA have no greater risk of falls or fracture events in the initial 12 post-operative months compared to people who have not undergone THA or TKA, there appears a lower chance of experiencing a fracture for people following THA compared to those who have not.

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Compliance with ethical standards

Conflict of interest None.

Patient consent Obtained.

Ethics approval Committee on Human Research, University of California, San Francisco (IRB approval number 10-00532 Approved 10th March 2015).

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