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ARTHROPLASTY

Are patient-reported outcomes the same following second-side surgery in primary hip and knee arthroplasty?

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Aims

Up to one in five patients undergoing primary total hip (THA) and knee arthroplasty (TKA) require contralateral surgery. This is frequently performed as a staged procedure. This study aimed to determine if outcomes, as determined by the Oxford Hip Score (OHS) and Knee Score (OKS) differed following second-side surgery.

Methods

Over a five-year period all patients who underwent staged bilateral primary THA or TKA utilizing the same type of implants were studied. Eligible patients had both preoperative and one year Oxford scores and had their second procedure completed within a mean (2 SDs) of the primary surgery. Patient demographics, radiographs, and OHS and OKS were analyzed.

Results

A total of 236 patients met the inclusion criteria, of which 122 were THAs and 114 TKAs. The mean age was 66.5 years (SD 9.4), with a 2:1 female:male ratio. THAs showed similar significant improvements in outcomes following first- and second-side surgery, regardless of sex. In contrast for TKAs, although male patients demonstrated the same pattern as the THAs, female TKAs displayed significantly less improvement in both OKS and its pain component following second-side surgery.

Conclusion

Female patients undergoing second-side TKA showed less improvement in Oxford and pain scores compared to the first-side. This difference in outcome following second-side surgery did not apply to male patients undergoing TKA, or to either sex undergoing THA.

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Keywords: hip, knee, arthroplasty, outcomes, second side, staged bilateral

Introduction

Much of the published literature[1–10] concerning bilateral joint arthroplasty consider simultaneous surgery, as opposed to staged bilateral procedures. Staged bilateral surgery is commonplace in the UK, with 99.5% of bilateral total hip arthroplasty (THA) and 98.7% of bilateral total knee arthroplasty (TKA) being performed as staged procedures.[1] However, there is limited published data with which to inform patients on the expected outcomes.[2,3] The risk of contralateral osteoarthritic disease following THA is quoted at 16% to 30%.[4-9] Staged procedures appear to be preferred in the majority of cases, with reports of a 4:1 ratio versus simultaneous bilateral surgery.[5,10] Simultaneous bilateral surgery has also been shown to convey higher morbidity in terms of venous thromboembolism (VTE), readmission, and blood transfusion, according to a recent systematic review.[2] The same systematic review suggested that patients undergoing staged bilateral TKA might have inferior outcomes when compared to the first operated side.[2] While the reasons for this are multifactorial, a poorer outcome may occur despite the same surgical technique, same implants, absence of a postoperative complication, and satisfactory postoperative radiological appearances.[11]

Perioperative outcomes in terms of length of stay, transfusion, and morbidity are extensively reported outcomes following staged

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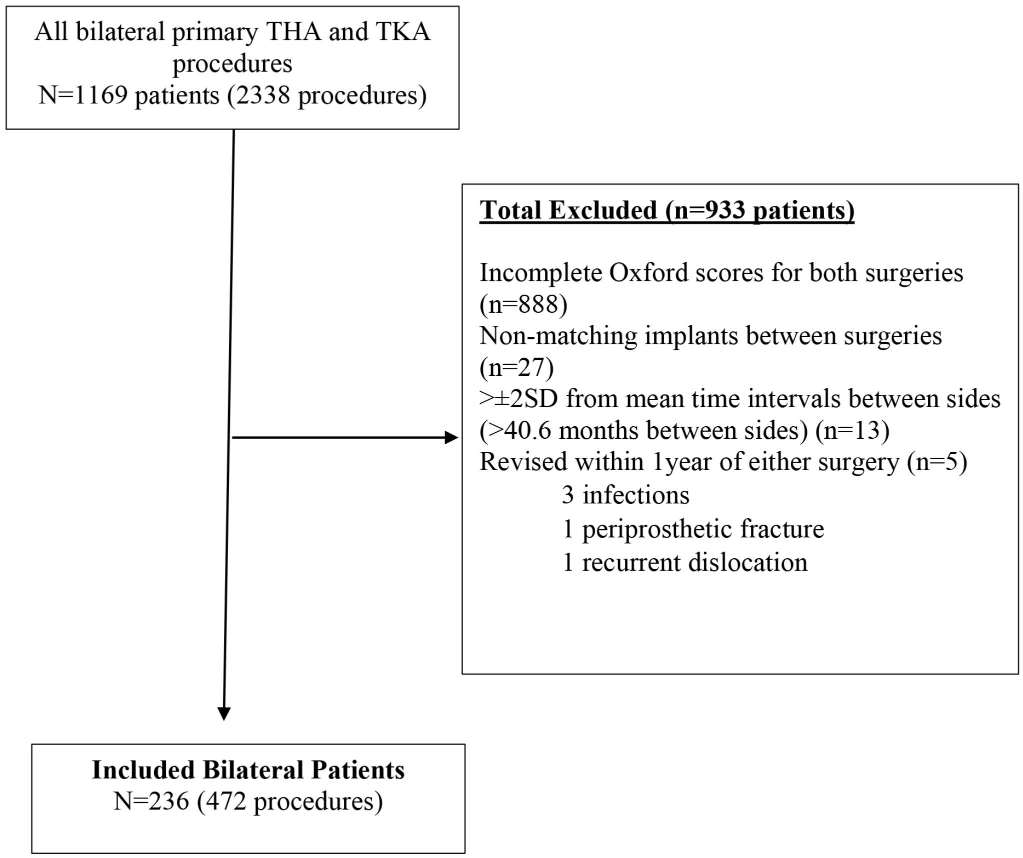


Fig. 1

Flowchart of included patients and reasons for exclusions

bilateral surgery,[12-14] but few have analyzed patient reported outcomes between staged procedures. Therefore, we sought to determine if the outcomes after staged bilateral THA and TKA, as determined by both the Oxford Hip Score (OHS), Oxford Knee Score (OKS), and its pain components, were the same for each side.

Methods

Patients. A retrospective review of the Musgrave Park Hospital, Belfast, UK, digital information system was performed to identify all patients who had undergone staged bilateral primary THA and TKA in a single high-volume unit between July 2012 and June 2017. Local institutional audit approval was sought and granted (Belfast Health and Social Care Trust reference number 5897). Initially, 2,338 patients and their implant details were identified. Figure 1 outlines the exclusion reasons and numbers of patients; only primary joint procedures using the same implants were included. Patients without complete data sets for pre- and postoperative outcomes scores, and patients who underwent revision for any reason were excluded. For THA patients, those with prior internal fixation for hip fractures were excluded. To remove those with excessively long intervals between surgeries, only patients undergoing both arthroplasties within the mean (2 standard deviations (SD)) of the entire cohort were included. This interval was 40.6 months, with the theory was that this would keep patients at a similar functional level and level of expectation after both surgeries with appropriate one-year follow-up.

Collected demographic data included sex, age at each surgery, and the length of hospital stay. Patient comorbidity was defined using the American Society for Anaesthesiology (ASA) grading system.

Outcome measures. The change in pre- and postoperative Oxford Hip Score (OHS), Oxford Knee Score (OKS), the delta gain, was calculated to determine the magnitude of change in perceived outcomes. The single pain score (question 1) of the OHS and OKS was used to determine the change in perceived pain for each patient. The minimal clinical important difference (MCID) for the OHS and OKS was defined according to the results by Beard et al.[15] Scores were collected by trained arthroplasty care practitioners within the study unit at clinical review preoperatively and at one year postoperatively.

Radiological analysis. Two post-FRCS authors (AT, JW) performed a blinded, independent review of the preoperative radiographs and recorded the Kellgren and Lawrence (KL) grade[16] for hips and knees. The Sperner grade[17] for patellofemoral osteoarthritis was also

Table I. Comparison of demographics and outcomes between included and excluded patients.

Variable	Audit group (n = 236)	Excluded patients (n = 933)	p-value*
Sex, n (%)			
Female	156 (66.1)	558 (59.8)	0.076
Male	80 (33.9)	375 (40.2)	
ASA grade, n (%)			
1	16 (6.8)	74 (7.9)	0.057
2	198 (83.9)	737 (79.0)	
3	21 (8.9)	122 (13.1)	
4	1 (0.4)	0 (0.0)	
Interval between procedures, mnths, median (IQR)	13.7 (9.5 to 21.3)	11.2 (6.1 to 21.6)	0.002
Age, yrs, median (IQR)	67 (60 to 71)	67 (59 to 73)	0.455
BMI kg/m^2, median (IQR)	30.4 (27 to 34.7)	30.7 (27.5 to 34)	0.627
Length of hospital stay, days, median (IQR)	3 (3 to 5)	4 (3 to 5)	0.002
Preoperative pain, median (IQR)	5 (4 to 5)	5 (4 to 5)	0.188
Preoperative Oxford score, median (IQR)	12 (8.2 to 17)	11 (8 to15)	0.060
One-year postoperative pain, median (IQR)	2 (1 to 3)	2 (1 to 3)	0.563
One-year postoperative Oxford score (range)	38 (30 to 43)	38 (29 to 44)	0.500

*Categorical data anlysed using chi squared test. All other data analyzed using Mann-Whitney U test.
ASA, American Society of Anaesthesiologists; ; IQR, interquartile range.

recorded. Inter-observer agreement using Cohens kappa, and the intra-observer agreements using intraclass correlations (ICC), assuming a single measure, two-way mixed effect model, were calculated. Results were described using Landis and Koch descriptors of strength of agreement.[18]

Statistical analysis. Trends were analyzed using SPSS for Mac v22 (IBM, USA). Continuous data were assessed for normality using the Shapiro Wilk test. For parametric data, a paired samples *t*-test was used, and for non-parametric continuous data, the Kruskal-Wallis test was performed. Ordinal data is reported in percentage terms, and comparisons were made using a chi squared test or Fisher's exact test where appropriate. Parametric data is presented as mean (standard deviation (SD)), while non-parametric data is reported as medians and interquartile ranges (IQRs). For all data, a two-sided p-value < 0.05 was considered statistically significant.

Results

We identified 236 patients, comprising 156 females and 80 males. Comparing the excluded patients to the included cohort, there were no significant differences in demographics and outcomes variables; age, sex, ASA, BMI, pre- and postoperative pain and OHS and OKS (all p > 0.05, categorical data anlyzed using chi squared test, all other data analyzed using Mann-Whitney U test) (Table I).

In the audit cohort, the overall median age was 67 years (IQR 60 to 71). Hips were predominantly Corail Pinnacle (DePuy UK, UK; 68.9%) or Exeter Trident (Stryker, USA; 24.6%), and knees predominantly cementless LCS RP (DePuy, UK; 95.6%). Modal ASA grade was 2 for both hip and knee osteoarthritis (OA). There were no significant differences in ASA or KL distributions between operative sides (p = 0.225 and p = 0.605, respectively, chi squared test). Median time interval between sides was 13.7 months (IQR 9.5 to 21.3). There were no significant differences in one-year Oxford scores between left- and right-sided surgeries for either THA or TKA (all p > 0.05, Mann-Whitney U test).

The modal KL grade was 3 for hips and knees. KL osteoarthritis grades were not significantly different between first and second side surgeries for THAs or TKAs (p = 0.605, chi squared test). Inter-rater KL agreement for first and second sides was "substantial" (Cohens k = 0.768 (95% confidence interval (CI) 0.694 to 0.842) and k = 0.800 (95% CI 0.729 to 0.8871), respectively; both p < 0.01). Intrarater ICC was "moderate to good" (ICC_1 = 0.771 (95% CI 0.573 to 0.884) and ICC_2 = 0.708 (95% CI 0.472 to 0.850).

As expected, patients were significantly older at the second surgery, but ASA grade did not differ significantly. Length of stay was significantly shorter overall for second side surgeries for both THA and TKA (Table II).

Mean BMI demonstrated a significant increase for the second side in THA, but not TKA. While statistically significant for THA, this is not likely clinically significant given a mean change of < one point for BMI.[19] However, a critical weight gain of > 5%, as proposed by Riddell et al,[20] was seen in 88/122 (72%) of THA and 78/114 (68%) of TKA patients after first-side surgery. Surgical intervention by THA or TKA demonstrated significant improvements in pain score and Oxford score outcomes for all surgeries (p < 0.001, Wilcoxon rank test), as shown in Figures 2 and 3.

Median interval between procedures was 14 months (IQR 9.5 to 21.3). The time interval between staged TKA procedures was significantly longer than for staged THA (median 16.2 (IQR 11.4 to 22.8) vs 11.7 (IQR 7.8 to 18.2), respectively; p < 0.001, Mann-Whitney U test). Intervals were not significantly different between genders for THA (males 11.2 months (IQR 5.6 to 19.4) vs females 12.5 months (IQR 8.0 to 17.6); p = 0.935, Mann-Whitney U test), nor TKA (males 13.3 months (IQR 11.4 to 21.9) vs females 16.6 months (IQR 11. to 23.5); p = 0.528, Mann-Whitney U test). Furthermore, stratification into time intervals of < six, six to 12, and > 12 months between surgeries demonstrated that only the preoperative Oxford

Table II. Audit cohort patient demographics.

Variable	First side	Second side	p-value*
Age, yrs, median (IQR)	67 (60 to 71)	68 (61 to 72)	< 0.001
ASA grade, n			
1	16	12	0.225
2	198	191	
3	21	33	
4	1	0	
Median (IQR)	2 (2 to 2)	2 (2 to 2)	0.080†
Female THA, n (%)	73 (59.8)	N/A	N/A
Female TKA, n (%)	83 (72.8)	N/A	
BMI, kg/m^2, median (IQR)	30.4 (27.0 to 27.9)	31.3 (27.9 to 35.8)	< 0.001
Length of hospital stay, days, median (IQR)	3 (3 to 5)	3 (2 to 4)	< 0.001
THA, median (IQR)	3 (2 to 5)	3 (2 to 4)	< 0.001
TKA, median (IQR)	4 (3 to 5)	3 (3 to 4)	0.006
TKA			
Female ASA grade 1, n (%)	5 (6.0)	1 (1.2)	0.106
Grade 2, n (%)	71 (85.5)	69 (83.1)	
Grade 3, n (%)	7 (8.4)	13 (15.7)	
Female BMI, kg/m^2, median (IQR)	31.7 (28.4 to 37.9)	33.1 (29.3 to 38.7)	0.616
Female KL grade, median (IQR)	3.0 (3.0 to 4.0)	3.0 (3.0 to 4.0)	0.493
Female length of stay, days, median (IQR)	4.0 (3.0 to 5.0)	3.0 (3.0 to 4.0)	0.194
Male ASA grade 1, n (%)	1 (3.2)	1 (3.2)	1.000
Grade 2, n (%)	25 (80.6)	25 (80.6)	
Grade 3, n (%)	5 (16.1)	5 (16.1)	
Male BMI kg/m^2, median (IQR)	32.8 (29.4 to 37.6)	33.1 (28.1 to 37.0)	0.730
Male KL grade, median (IQR)	3.0 (3.0 to 3.0)	3.0 (3.0 to 3.0)	1.000
Male length of hospital stay, days, median (IQR)	4.0 (3.0 to 6.0)	3.0 (2.0 to 4.0)	0.151
THA			
Female ASA grade 1, n (%)	5 (6.8)	6 (8.2)	0.522
Grade 2, n (%)	52 (84.9)	57 (78.1)	
Grade 3, n (%)	6 (8.2%)	10 (13.7%)	
Female BMI, kg/m^2, median (IQR)	27.7 (24.2 to 30.7)	29.3 (26.6 to 33.4)	0.039
Female OA grade, median (IQR)	3.0 (2.0 to 3.0)	2.0 (2.0 to 3.0)	0.052
Female length of stay, hospital stay, days, median (IQR)	3.0 (3.0 to 5.0)	3.0 (2.0 to 4.0)	0.046
Male ASA grade 1, n (%)	5 (10.2)	4 (8.2)	0.657
Grade 2, n (%)	40 (81.6)	40 (81.6)	
Grade 3, n (%)	3 (6.1)	5 (10.2)	
Grade 4, n (%)	1 (2.)	0 (0.0)	
Male BMI, kg/m^2, median (IQR)	29.6 (27.7 to 33.5)	30.5 (28.1 to 33.5	0.407
Male OA grade, median (IQR)	2.0 (2.0 to 2.0)	2.0 (2.0 to 2.0)	0.786
Male length of stay, days, median (IQR)	3.0 (2.0 to 4.0	3.0 (2.0 to 3.5)	0.215

*Categorical data anlysed using chi squared analysis. All other data analyzed using Mann-Whitney U test.
†Related samples Wilcoxon rank test.
ASA, American Society of Anaesthesiologists; IQR, interquartile range; KL, Kellgren and Lawrence; N/A, not applicable; OA, osteoarthritis; THA, total hip arthroplasty; TKA, total knee arthroplasty.

scores for the second-side TKA was significantly different between groups, with those waiting > 12 months having significantly worse Oxford scores (Supplementary Material table i).

THA. A total of 122 THAs were performed, with 73/122 (59.8%) being in females. Both baseline and postoperative pain scores were similar for male and female patients, but both sexes demonstrated a significant improvement in pain scores for both procedures ($p < 0.001$, Mann-Whitney U test).

The baseline OHS was significantly worse for the first side (male p = 0.048 and female p = 0.004, Wilcoxon signed rank test), but this failed to meet the MCID threshold of five points (Table III). The OHS improved significantly after surgery irrespective of side and sex. Binary logistic regression demonstrated no difference in in OHS irrespective of side (p = 0.540) or sex (p = 0.337). Figure 1 and Tables III–V summarize the data.

TKA. A total of 114 TKAs were performed, with 83/114 (72.8%) in females. In male patients, first-side preoperative pain and OKS were worse, and all scores demonstrated significant improvement following surgery at one year postoperatively, with no statistical difference in outcomes between sides. Equally, females had significantly worse preoperative OKS for the first-side, despite similar pain scores. OKS and pain scores improved with surgery to either side. However, at one year postoperatively, the second-side reported higher pain scores despite similar functional score as reported by the OKS. Figure 3 and Tables III–V demonstrate the data.

Delta gain and the concept of "improvement". The delta gain threshold was set at five points, as determined by the MCID of the Oxford score. Following THA, 119/122 (97.5%) patients had an improvement greater than the MCID in OHS for first-side surgery, while the second-side had an improvement in OHS in 121/122 (99.2%) patients compared to their preoperative score (p = 0.622, chi squared test).

However, following TKA although all 114 patients (100%) improved with first-side surgery, that dropped to 109/114 (95.6%) with second-side surgery (p = 0.06, chi squared test), i.e. approximately one in 20 patients may perceive no improvement in OKS.

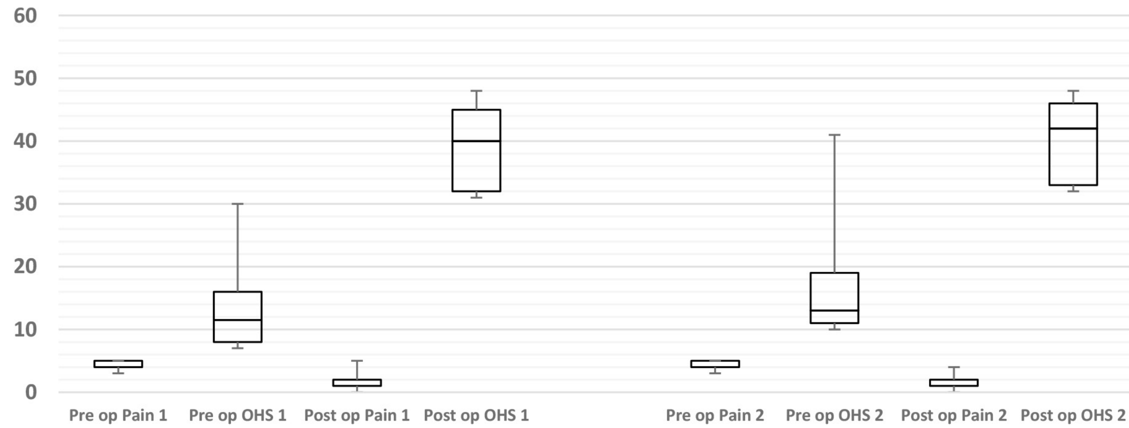


Fig. 2

Changes in pain score and Oxford Hip Score (OHS) pre- and postoperatively following total hip arthroplasty. Pre- and postoperative differences all $p < 0.001$.

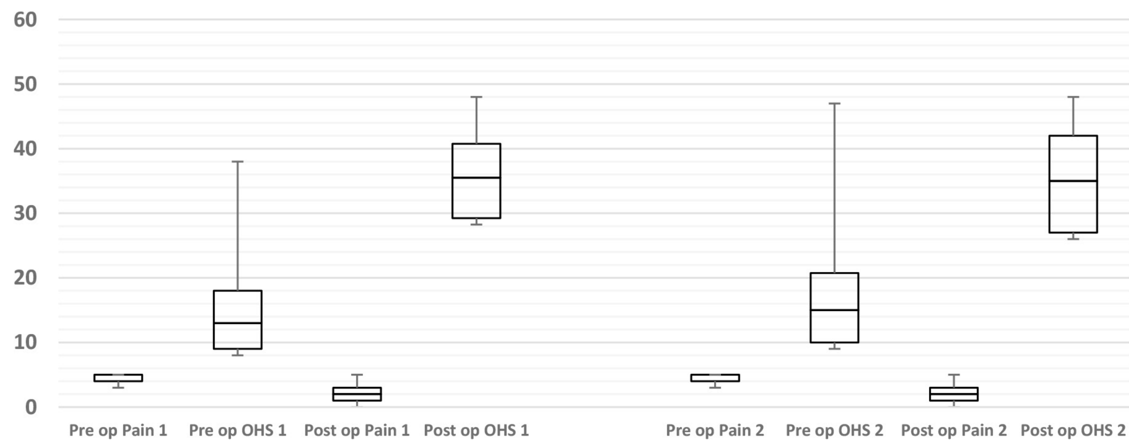


Fig. 3

Changes in pain score and Oxford Hip Score (OHS) pre- and postoperatively following total knee arthroplasty. Pre- and postoperative differences all $p < 0.001$.

For pain data, the effect size was calculated using a distribution-based approach, specifically Cohens d value, and the MCID using both the 0.5 x SD and standard error of the mean (SEM) methods, since there is not one universally accepted method.[21-23] The value of Cohens d = 2.84 (95% CI 2.74 to 2.96), indicating a large effect and therefore significant improvement in patient pain scores. Equally, the MCID using the 0.5 x SD and SEM method was 0.792 and 0.954, respectively. Therefore, a change in pain score of one point was deemed to be clinically important in our patient cohort.

For pain scores, 117/122 (95.9%) patients improve after THA regardless of side ($p = 1.00$, chi ssquared test); however, TKA pain scores were similar in 5.3%, or worse in 0.9% of patients after first side surgery, which increases to 8.8% and 1.8% respectively ($p = 0.438$ and $p = 1.00$, respectively, chi squared test) after the second side surgery. While not statistically significant, first-sided TKA has a risk of similar or worse pain of 6.2%, which increases to 10.6% with second-side TKA. Figures 4 and 5 summarize the data.

The delta gain was used to quantify the magnitude of change following THA and TKA for each patient. The theory being that lower delta gains would be perceived by the patient to relate to worse outcomes, poor patient satisfaction, and not as having "improved" as much as the first side.

Following THA, both males and females showed similar improvements in both pain scores and OHS, with no statistically significant differences noted between first- and second-side surgeries.

In contrast, following TKA, although males demonstrated similar improvements in pain scores and OKS, with no significant difference in delta gains, female patients demonstrated significantly less improvement in both their pain scores and OKS following second-side TKA compared to the first side. There was also less improvement in OKS compared to male patients, which was significantly different after second-side TKA only. Table V summarizes the data.

For THA, the largest improvements in pain scores and OHS were observed in those with worse radiological OA,

Table III. Pain and Oxford Hip Score changes for total hip arthroplasty by sex.

Variable	Preoperative, median (IQR)	One-year postoperative, median (IQR)	p-value*
Pain score			
Main			
Side 1	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	< 0.001
Side 2	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	< 0.001
p-value side 1 vs side 2*	0.371	0.413	
Female			
Side 1	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	< 0.001
Side2	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	< 0.001
p-value side 1 vs side 2*	0.253	0.616	
Oxford Hip Score			
Male			
Side 1	13 (9 to 16)	41 (34 to 46)	< 0.001
Side 2	14 (10.5 to 19)	42 (35.5 to 45.5)	< 0.001
p-value side 1 vs side 2*	0.048	0.402	
Female			
Side 1	11 (7 to 16.5)	40 (30.5 to 44.5)	< 0.001
Side2	13 (11 to 19.5)	42 (32 to 46.5)	< 0.001
p-value side 1 vs side 2*	0.004	0.065	

*Mann-Whitney U test.
IQR, interquartile range.

as determined by the KL grade. Both outcome parameters demonstrated significant correlations between increasing KL grade and improvements after surgery for both first- and second-side procedures (All p < 0.01, pain analyzed using Spearman Rank coefficient, Oxford score correlation calculated using Pearson correlation coefficient.).

Following TKA, the change in OKS was significantly correlated to KL grade for both sides (R = 0.199 and R 0.257; both p < 0.01, pain analyzed using Spearman Rank coefficient, Oxford score correlation calculated using Pearson correlation coefficien). This was not apparent for the change in pain score, where the value of Spearman rank R did not demonstrate a correlation for first side surgery (R = 0.181; p = 0.054), but did for second-side surgery (R = 0.195; p = 0.038, pain analyzed using Spearman Rank coefficient, Oxford score correlation calculated using Pearson correlation coefficient).

Table VI demonstrates the correlations. Furthermore, TKA delta values were lower than the corresponding delta values following THA for all KL OA grades, regardless of operative side.

Discussion

Our findings suggest the need for counselling female patients undergoing second-side TKA as they demonstrated less improvement in Oxford score than after first-side surgery. Additionally, this difference in outcome following second-side surgery did not apply to male

Table IV. Pain and Oxford Knee Score changes for total knee arthroplasty by sex.

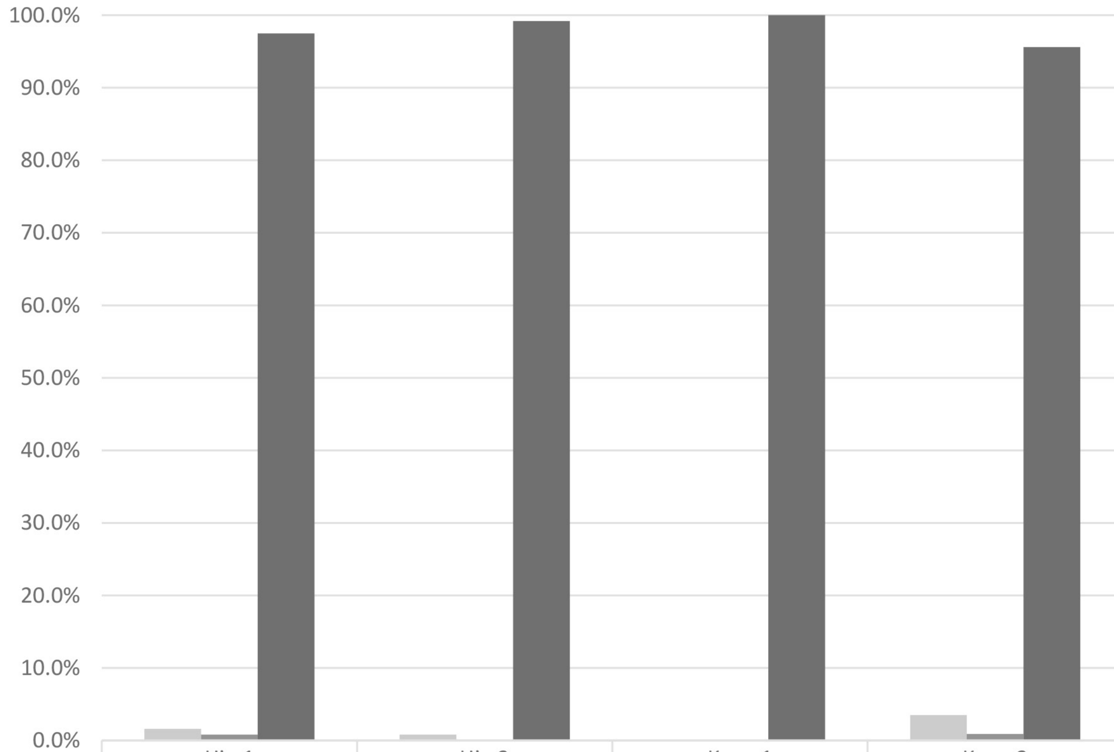
Male	Preoperative, median (IQR)	One-year postoperative, median (IQR)	p-value*
Pain score			
Male			
Side 1	5.0 (5.0 to 5.0)	2.0 (1.0 to 3.0)	< 0.001
Side 2	5.0 (4.0 to 5.0)	2.0 (1.0 to 3.0)	< 0.001
p-value side 1 vs side 2*	0.020	0.670	
Female			
Side 1	5.0 (4.0 to 5.0)	2.0 (1.0 to 3.0)	< 0.001
Side 2	5.0 (4.0 to 5.0)	2.0 (1.0 to 4.0)	< 0.001
p-value side 1 vs side 2*	0.369	0.029	
Oxford Knee Score			
Male			
Side 1	15 (9 to 19)	36 (30 to 42)	< 0.001
Side 2	16 (11 to 21)	41 (32 to 44)	< 0.001
p-value side 1 vs side 2*	0.141	0.43	
Female			
Side 1	13 (9 to 17)	35 (28 to 39)	< 0.001
Side 2	15 (10 to 20)	35 (25 to 41)	< 0.001
p-value side 1 vs side 2*	0.001	0.459	

*Mann-Whitney U test.

Table V. Delta gain by sex following total hip arthroplasty and total knee arthroplasty second-side surgeries.

Variable	Delta 1	Delta 2	p-value*
Pain score			
THA, median (IQR)			
Male	3 (2.5 to 4)	3 (2 to 4)	0.125
Female	3 (2.75 to 4)	3 (2 to 4)	0.255
p-value female vs male*	0.653	0.855	
TKA, median (IQR)			
Male	3 (2 to 4)	2 (1 to 3)	0.132
Female	2 (1.75 to 3)	2 (1 to 3)	0.020
p-value female vs male*	0.222	0.338	
Oxford Score			
THA, mean (SD)			
Male	25.4 (9.7)	24.1 (9.4)	0.460
Female	24.7 (11.7)	23.3 (10.2)	0.373
p-value female vs male*	0.965	0.896	
TKA, mean (SD)			
Male	21.3 (8.1)	21.8 (8.3)	0.652
Female	20.2 (9.1)	16.5 (10.3)	0.001
p-value female vs male*	0.547	0.031	

*Change in pain score reported as median (IQR) analyzed by Mann Whitney U test for non-parametric data, and change in Oxford Knee Scores by mean (SD) analyzed using paired *t*-test as parametric data.
IQR, interquartile range; SD, standard deviation; THA, total hip arthroplasty; TKA, total knee arthroplasty.



	Hip 1	Hip 2	Knee 1	Knee 2
Worse	1.6%	0.8%	0.0%	3.50%
Same	0.8%	0.0%	0.0%	0.90%
Better	97.5%	99.2%	100.0%	95.60%

Fig. 4

Percentage of patients with worse, same, or better Oxford scores following first- and second-side total hip arthroplasty or total knee arthroplasty.

patients undergoing TKA or to either sex undergoing THA. These trends have been reported in other studies as summarized in the literature review (Supplementary Material table ii).

Large registry studies have shown simultaneous bilateral hip and knee arthroplasty to be both clinically and cost-effective and without an increased mortality.[1,4] Staged bilateral arthroplasty is also safe and efficacious, and is performed at a 4:1 ratio over simultaneous surgery.[2,10]

While crude measures such as mortality, perioperative complications, and hospital admission data have a solid evidence base, the patient-reported outcomes of staged bilateral surgery is less prevalent. Malahais et al[2] highlighted a variety of outcome measures are reported following THA and TKA, and study homogeneity is lacking, limiting any meaningful meta-analysis. While they demonstrated variable outcomes at varying time intervals for staged surgery, they did report inferior outcomes for second-side surgery.

Hip. Hofstede et al[24] has shown no high quality evidence for prognostic factors after THA, but patients with worse preoperative pain and worse radiological OA grades demonstrated better postoperative outcomes. However, registry studies confirm no difference in postoperative outcomes following staged bilateral surgery, regardless of the time interval.[12,25,26]

Evidence regarding differences in functional outcomes and possible contributing factors is lacking, in terms of quantity and quality, in the literature.

The results demonstrate improvements in pain and function for both THA and TKA, regardless of the time interval between procedures and whether it was first or second side surgery in the majority of patients. However, Poulsides et al[27] reported that up to 70% of TKA and 80% of THA patients have higher expectations for second side surgery. Furthermore, Haanstra et al[28] suggests that further studies determining patient expectations for surgery, and how this may affect patient reported outcomes, are required.

Knee. Sesan et al[29] reported that patients following TKA were less likely to proceed to second-side surgery if they were aged > 70 years, and had worse postoperative functional scores compared to their preoperative scores. The same author also highlighted the “psychology” in arthroplasty, with worse outcomes reported in those patients with depression, and that second-side refusal was reported to be 28% to 36%. Indeed, the lack of psychological

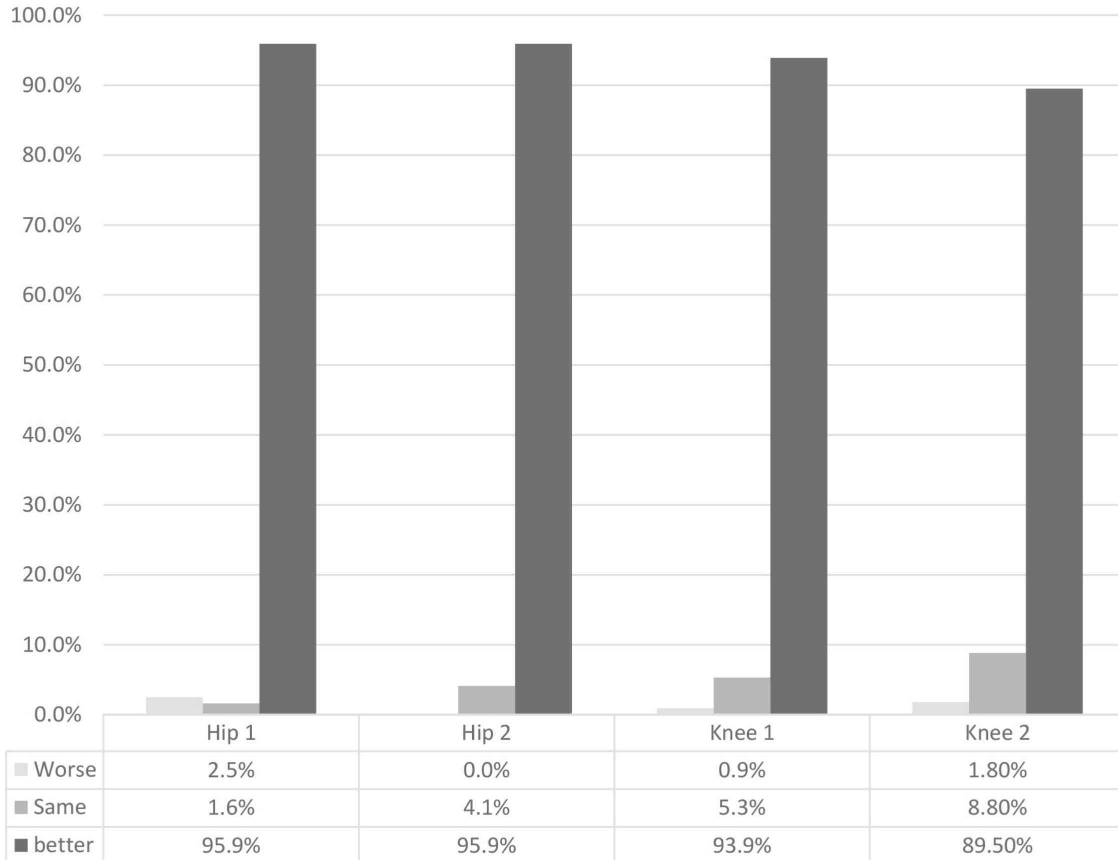


Fig. 5

Percentage of patients with worse, same, or better pain scores following first- and second-side total hip arthroplasty or total knee arthroplasty.

metrics across studies makes pain perception difficult to adjust for. Interestingly, we found that the interval between staged TKA was greater than for staged THA.

A common theme in all of these studies is that careful consideration should be given to patients with less preoperative pain and better functional scores before embarking on a staged second-side procedure, and careful counselling on postoperative expectations and outcomes should be provided. Our results suggest that female TKA patients in contrast to their male counterparts have less improvement in both pain and OKS after second side surgery. Females have been shown to report high postoperative pain scores after TKA.[30] Our results are similar and statistically significant, but we cannot state if this is clinically significant as we did not capture patient "satisfaction" per se. However, poorer outcomes regarding second-side TKA surgery are reported in the literature.[3,11,31,32]

This may be explained by several hypotheses regarding patient psychology, pain perception and their effect on patient-reported outcome measures (PROMs). Studies have suggested females often have worse preoperative scores because they are often primary care givers, subjugating their own health for others.[33,34] There is evidence that poorer preoperative scores lead to relatively poorer post operative scores. Belford et al[35] reported that biopsychosocial factors impact on PROMs after TKA, particularly a depressive illness and neuroticism, which is in agreement with other studies.[29,35-37]

Kim et al[38] suggested "pain sensitization" following second-side surgery may impact upon outcome scores. Ghandi et al[39] suggested that what individual patients perceive to be "effective analgaesia" can impact on one-year outcome scores. Additionally, Poultsides et al[40] demonstrated that patient expectations change between second-side procedure, and this direction of change is not uniform, with 70% of TKA patients having similar or higher expectations of the second side. This patient perceived higher expectation may not be met, which ultimately skews any reported outcome, for a variety of biopsychosocial reasons that the current study cannot answer with the data presented.

In the current study, BMI tended to increase in two-thirds of patients between staged surgery, more so following THA than TKA. Weight gain after THA and TKA has been previously reported,[20,41-44] and while significant weight gain can increase the risk of subsequent arthroplasty surgery, this has not been shown to affect clinical outcomes.[45-49] Performing arthroplasty with a view to enabling patients to lose weight is not justified and

Table VI. Comparison of pain and oxford scores for each side following total hip arthroplasty and total knee arthroplasty, with correlations for the change in score by KL grade

KL grade		Side 1 Oxford Hip Score Pain, median (IQR)			Side 1 total Oxford Hip Score, median (IQR)				Side 2 pain score, median (IQR)			Side 2 total pain score, median (IQR)		
	N (%)	Preoperative	One-year	Delta	Preoperative	One-year	Delta	N (%)	Preoperative	One-year	Delta	Preoperative	One-year	Delta
THA														
1	1 (0.8)	4.0	3.0	1.0	20.0	28.0 (28.0 to 28.0)	8.0 (8.0 to 8.0)	0 (0.0)						
2	50 (41.7)	5.0 (4.0 to 5.0)	1.5 (1.0 to 3.0)	3.0 (2.0 to 4.0)	12.0 (8.0 to 18.0)	38.0 (26.8 to 43.3)	24.5 (11.8 to 31.0)	60 (50.0)	5.0 (4.0 to 5.0)	2.0 (1.0 to 3.0)	3.0 (2.0 to 3.0)	14.5 (11.0 to 20.8)	38.0 (29.0 to 44.8)	21.0 (14.5 to 28.0)
3	51 (42.5)	5.0 (5.0 to 5.0)	1.0 (1.0 to 2.0)	4.0 (3.0 to 4.0)	11.0 (8.0 to 16.0)	41.0 (32.0 to 46.0)	30.0 (21.0 to 34.0)	45 (37.5)	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	3.0 (3.0 to 4.0)	15.0 (11.0 to 19.5)	43.0 (38.0 to 45.0)	23.0 (20.0 to 31.0)
4	18 (15.0)	5.0 (4.0 to 5.0)	1.0 (1.0 to 2.0)	4.0 (3.0 to 4.0)	11.5 (7.5 to 15.0)	43.0 (38.5 to 47.0)	31.0 (25.8 to 34.0)	15 (12.5)	5.0 (4.0 to 5.0)	1.0 (1.0 to 1.0)	4.0 (2.0 to 4.0)	11.0 (6.0 to 13.0)	46.0 (38.0 to 48.0)	34.0 (24.0 to 37.0)
Correlation (KL vs delta)				R = 0.300 p = 0.001			R = 0.270 p = 0.003				R = 0.250 p = 0.006			R = 0.318 p < 0.001
TKA														
1	3 (2.6)	5.0 (5.0 to 5.0)	3.0 (1.0 to 3.0)	2.0 (2.0 to 2.0)	16.0 (13.0 to 16.0)	37.0 (34.0 to 37.0)	22.0 (18.0 to 22.0)	2 (1.8)	5.0 (5.0 to 5.0)	3.0 (2.0 to 3.0)	2.0 (1.0 to 2.0)	12.0 (8.0 to 12.0)	39.0 (35.0 to 39.0)	27.0 (27.0 to 27.0)
2	27 (23.7)	5.0 (4.0 to 5.0)	3.0 (2.0 to 4.0)	2.0 (1.0 to 3.0)	13.0 (8.0 to 20.0)	32.0 (26.0 to 36.0)	15.0 (8.0 to 25.0)	30 (26.3)	5.0 (4.0 to 5.0)	3.0 (1.0 to 4.0)	1.0 (0 to 3.0)	15.0 (11.0 to 21.3)	29.0 (19.8 to 39.0)	9.0 (3.8 to 21.0)
3	75 (65.8)	5.0 (4.0 to 5.0)	2.0 (1.0 to 3.0)	3.0 (2.0 to 4.0)	13.0 (9.0 to 17.0)	36.0 (31.0 to 41.0)	21.0 (16.0 to 30.0)	73 (49.3)	5.0 (4.0 to 5.0)	2.0 (1.0 to 3.0)	2.0 (1.0 to 3.0)	15.0 (10.0 to 21.0)	37.0 (30.5 to 43.0)	22.0 (14.0 to 26.0)
4	9 (7.9)	5.0 (4.5 to 5.0)	2.0 (1.0 to 4.0)	3.0 (1.0 to 4.0)	10.0 (5.0 to 12.5)	35.0 (17.5 to 42.5)	20.0 (8.0 to 33.0)	9 (7.9)	5.0 (4.0 to 5.0)	3.0 (1.0 to 4.0)	2.0 (1.0 to 3.0)	12.0 (8.0 to 19.0)	37.0 (25.5 to 42.5)	22.0 (10.0 to 29.5)
Correlation (KL vs delta)				R = 0.181 p = 0.054			R = 0.199 p = 0.034				R = 0.195 p = 0.038			R = 0.257 p = 0.006

*Pain analyzed using Spearman Rank coefficient. Oxford score correlation calculated using Pearson correlation coefficient.
IQR, interquartile range; KL, Kellgren and Lawrence; THA, total hip arthroplasty; TKA, total knee arthroplasty.

patients should be advised that their weight commonly increases after THA and TKA.[50]

The limitations to the current study are its single centre, retrospective design. The high number of exclusions for patients that did not have a completed Oxford score at all time points impacted on the study size. We do not believe this constitutes selection bias, but reflects the integrity of the data presented. Despite these small numbers, there was no difference in baseline characteristics between the studied cohort and the excluded patients, which we feel indicates that our study group is representative of the whole. Some will question the usefulness of using a single scoring system; however, the Oxford score is a robust, accepted, and validated scoring system.[51,52] Multiple outcome scores are reported in the literature (Supplementary Material table ii[53–63]), with significant heterogenicity, and limit the ability to compare studies. We chose not to use the visual analogue scale (VAS), as this only provides a point estimate of function within the last 24 hours, is subjective and highly variable, and can be impacted by concurrent analgaesic use, or lack thereof.[64] Furthermore, with the lack of a benchmark for pain, one cannot provide exact criterion validity, and VAS use in comparing long-term orthopaedic outcomes is poor.[65] There is no rationale for choosing one set of descriptors over another,[64] nor the statistical method for analysis.[66] However, the VAS has been shown to correlate highly with a five-point scale, as is used on the Oxford scoring.[64,67] Therefore, we feel this is an appropriate method of determining pain scores. Studies are beginning to determine patient "satisfaction" as an outcome.[68] We did not capture this information, which may have provided some additional clinically relevant information which we could have correlated to scores to determine if the statistical and clinical significance matched.

The strengths of our study include our adjustment for any bias, since our unit uses a standardized surgical and anaesthetic technique, proven implant designs, and a consistent perioperative management regime. The information provided by the current study is an interesting observation, which is line with other studies in the reported literature, but further studies analyzing PROM scores, patient psychology, and patient-reported satisfaction are required.

THA gives satisfactory outcomes, regardless of sex, in the staged surgery setting. Female patients undergoing second-side TKA show less improvement in Oxford scores and its pain component compared to after first-side TKA. This difference in outcome following second-side surgery does not apply to male patients undergoing TKA or to either sex undergoing THA.

Take home message

- Total hip arthroplasty (THA) gives satisfactory outcomes, regardless of sex, in the staged surgery setting.
- Female patients undergoing second-side total knee arthroplasty (TKA) show less improvement in Oxford scores and its pain component compared to after first side TKA.
- This does not apply to male TKA patients, nor THA patients, regardless of sex.

Supplementary material

Tables showing summary of patient-reported outcome scores between total knee arthroplasty (TKA) and total hip arthroplasty (THA) stratified by interval between surgical procedures, and studies in the literature with trends in patients undergoing TKA and THA.

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