ORIGINAL ARTICLE

Factors associated with a clinically significant improvement in health-related quality of life after total knee arthroplasty

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Abstract

Background The aim was to identify independent preoperative factors associated with changes in health-related quality of life (HRQoL) following total knee arthroplasty (TKA), and whether these could be used as indicators for surgery.

Methods A retrospective study of 3127 TKA patients was undertaken that included 1194 (38.2%) male and 1933 (61.8%) female patients, with a mean age of 70.5 years (standard deviation 9.0). Patient demographics, body mass index and ASA grade, Oxford Knee Score (OKS) and EuroQol 5-dimension (EQ-5D) 3-level, which was used to assess HRQoL, were collected preoperatively and 2 years postoperatively.

Results When adjusting for confounding factors, obesity grade II ($p = 0.002$), ASA grade 3 ($p = 0.002$), and a better preoperative OKS ($p < 0.001$) or EQ-5D score ($p < 0.001$) were associated with a decreased improvement in the HRQoL at 2-years. A preoperative EQ-5D of < 0.8 (95.7% specific, AUC $\geq 67.0\%$) or an OKS of < 36 (97.1% specific, AUC $\geq 58.1\%$) was associated with a clinically significant improvement HRQoL. Patella resurfacing ($n = 1454$, 46.5%) was not independently associated with a clinical or statistically significant improvement in HRQoL. According to preoperative factors, no subgroup of patients benefited more from patella resurfacing according to improvement in their HRQoL.

Conclusion ASA grade 3, grade II obesity, a better preoperative EQ-5D or OKS were independently associated with a lesser improvement in HRQoL. The thresholds identified in the EQ-5D or OKS for a clinically significant improvement in HRQoL may be used as potential indicators for referral for TKA. Patella resurfacing was not independently associated with a clinically important improvement in HRQoL.

Level of evidence Retrospective diagnostic study, Level III.

Keywords Health-related quality of life · Total knee arthroplasty · Outcome · EQ-5D · Resurfacing · Patella

Abbreviations

ASA	American Society of Anaesthesiologists
AUC	Area under the curve
BMI	Body mass index
CI	Confidence interval
COVID-19	Corona virus 2019
EQ-5D	Euro Qol 5 dimension
HRQoL	Health-related quality of life
MCID	Minimal clinical important difference
NICE	National Institute for Clinical Excellence
OKS	Oxford Knee Score
QALY	Quality-adjusted life year
ROC	Receiver operating characteristic
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
TKA	Total knee arthroplasty

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Background

Total knee arthroplasty (TKA) is a cost-effective intervention that is associated with improvement in health-related quality of life (HRQoL) when performed for end-stage arthritis [1]. The increasing length of waiting lists due to the effect of COVID-19 on healthcare services has resulted in more patients enduring reduced HRQoL for longer [2]. This will likely continue to burden healthcare services in the

coming years [3]. The available resources within the healthcare system may need to be targeted at patients that would gain the most from limited financial resources [4]. Previous studies have identified threshold values in the joint-specific Oxford Knee Score (OKS) that offer a meaningful improvement in their knee symptoms [5], are cost effective [6] and are associated with improvements in HRQoL [7]. However, it is not clear whether the OKS is independently associated with improvement in HRQoL, whether other factors should be taken into account, and whether a clinically important change is observed. Should such factors exist they may need to be considered when referring patients for TKA.

There remains no consensus on whether to resurface the patella or not as part of TKA, with practice in the UK being 39% selective, 37% always, and 24% never resurfacing [8]. Data over the last 10 years, however, suggests that the rate of resurfacing has increased in the UK and Australia [9]. Results from recent meta-analyses are conflicting, with some demonstrating lower re-operation rates, less anterior knee pain and better functional scores associated with patella resurfacing [10, 11], whereas others have found no clinical difference in functional scores or anterior knee pain [12, 13]. Despite this inconsistent data, the National Institute for Clinical Excellence supports resurfacing which was demonstrated to be potentially more cost effective due to the lower re-operation rate [14]. This decision was influenced by the results from a single study that demonstrated a non-significant trend towards a greater HRQoL following patella resurfacing, according to the EuroQol 5-dimension (EQ-5D) score [15]. To the authors knowledge, there are no studies assessing the independent effect of patella resurfacing on HRQoL following TKA.

The primary aim of this study was to identify independent preoperative factors associated with changes in postoperative HRQoL following TKA, and whether these could be used as indicators for surgery. The secondary aims were to identify whether patella resurfacing was associated with a greater improvement in HRQoL following TKA or whether there were specific patient groups that may benefit more from resurfacing.

Methods

A retrospective study was undertaken using data from an established arthroplasty database held at the study centre. Over a 42-month period (01/06/2012 to 31/12/2015) 5857 patients underwent primary, unilateral TKA. Data from 25 surgeons using different implants and techniques (cruciate retaining and posterior stabilised) were included. Patients with a history of post-traumatic osteoarthritis or prior high tibial osteotomy were excluded. The theatre database was used to identify whether patients had undergone resurfacing or not.

Patient demographics, body mass index (BMI) and American Society of Anaesthesiologists (ASA) grade were recorded preoperatively. Patients' radiographs were reviewed to assign implant design type which was dived in to cruciate retaining (CR) or posterior stabilised (PS). The EuroQoL five-dimension (EQ-5D) [16] general health questionnaire and OKS [17] were recorded preoperatively and two years post-operatively. The EQ-5D assesses dimensions including mobility, self-care, usual activities, pain/discomfort and anxiety/depression [16]. The 3L version of the EQ-5D questionnaire was used, with the responses to the five dimensions being recorded on three levels of severity. The EQ-5D index is calculated on a UK-specific scale of -0.594 to 1, where 1 represents perfect health, and a score less than zero represents a health state worse than death [18]. The minimal clinically important difference (MCID) for EQ-5D is 0.08 [19]. The OKS is a validated, joint-specific, patient-reported outcome measure. It consists of 12, equally weighted questions assessed on a Likert scale with values from 0 to 4. A summative score is then calculated where 48 is the best possible score (least symptomatic) and 0 is the worst possible score (most symptomatic). Questions 3, 5, 7 and 12 of the OKS were thought to be associated with patellofemoral joint function and, therefore, were specifically selected for the assessment of the secondary outcome:

Q3. Have you had any trouble getting in and out of the car or using public transport because of your knee? (With or without a stick).
Q5. After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your knee?
Q7. Could you kneel down and get up again afterwards?
Q12. Could you walk down a flight of stairs?

Statistical analyses were performed using Statistical Package for Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Paired and unpaired Student's t tests were used to compare linear variables between groups. Dichotomous variables were assessed using a Chi-square test or a Fishers exact test if less than 5 in one of the groups. Pearson's correlation was used to assess the relationship between linear variables. Multivariate linear regression analysis was used to identify independent predictors associated with change in the EQ-5D score at 2 years. Receiver operating characteristic (ROC) curve analysis was used to assess the reliability of the preoperative threshold values in the EQ-5D and OKS that were predictive of a clinically significant improvement in HRQoL according to the postoperative EQ-5D score (equal to or greater than the MCID). The area under the ROC curve (AUC) ranges from 0.5 (no accuracy) to 1.0 (test identifies all patients that had a clinical improvement in their HRQoL).

Values > 0.6 are thought to represent sufficient diagnostic accuracy but > 0.7 are good [20]. A *p* value of < 0.05 was defined as significant.

There was no additional patient contact and as such this project was performed as a service evaluation without the need for formal ethical approval. The project was registered with the institution's audit department and was conducted in accordance with the Declaration of Helsinki and the guidelines for good clinical practice [21].

Results

There were 3127 TKA performed during the study period with complete pre- and postoperative data that met the inclusion criteria. There were 1194 (38.2%) male patients and 1933 (61.8%) female patients, with a mean age of 71.5 (SD 8.5, range 32–94) years. Mean BMI was 30.8 (SD 5.4, range 13–54). The mean preoperative EQ-5D was 0.450 (SD 0.307) and at 2 years postoperatively this increased to a mean of 0.764 (SD 0.255); the 0.315 points improvement was significant (95% confidence interval (CI) 0.303 to

0.327, $p < 0.0001$ paired *t* test). There were 1673 (53.5%) patients undergoing TKA without patella resurfacing and 1454 (46.5%) patients that also received patella resurfacing.

Primary outcome: independent factors associated with improvement in HRQoL

Male sex, older age, less severe preoperative OKS or EQ-5D scores were associated with a lesser improvement in the 2-year EQ-5D score on unadjusted analysis (Table 1). When adjusting for confounding factors obesity grade II, ASA grade III, CR TKA, and a better preoperative OKS and EQ-5D score were independantly associated with a statistically significant worse improvement in the EQ-5D score at 2 years (Table 2). Obesity grade II, ASA grade III, and CR TKA were associated with an improvement in EQ-5D that was less than the MCID and therefore may not be clinically relevant. However, the OKS and EQ-5D score were both clinically statistically significant. For example, if patient A had a preoperative OKS that was 11 points worse, or an EQ-5D score that was 0.584 points worse than patient B, they would have a clinically and significantly greater

Table 1 Unadjusted preoperative factors associated with change in the 2-year postoperative EQ-5D

Demographic	Descriptive	Mean Change or Correlation	EQ-5D 95% CI		*p* value*
			Lower	Upper	
Patella resurfacing	No	Reference			
	Yes	−0.010	−0.034	0.013	0.393
Gender (M/F)	Male	Reference			
	Female	0.053	0.029	0.077	**< 0.001**
Mean age *		−0.060	−0.001	−0.118	**0.001****
BMI	Under	0.038	−0.323	0.400	0.999***
	Normal	Reference			
	Over	0.012	−0.346	0.371	0.999***
	Obese 1	0.002	−0.356	0.361	0.999***
	Obese 2	0.021	−0.340	0.382	0.999***
	Obese 3	−0.031	−0.395	0.331	0.999***
ASA grade	1	Reference			
	2	−0.014	−0.069	0.041	0.917***
	3	0.010	−0.056	0.077	0.979***
	4	−0.087	−0.517	0.343	0.954***
TKA design	CR	Reference			
	PS	−0.007	−0.017	0.030	0.571*
Oxford Score*	Full	−0.376	0.306	0.442	**< 0.001****
	Q3	−0.221	0.145	0.295	**< 0.001****
	Q5	−0.297	0.223	0.367	**< 0.001****
	Q7	−0.161	0.083	0.237	**< 0.001****
	Q12	−0.256	0.181	0.328	**< 0.001****
EQ-5D*		−0.684	0.640	0.724	**< 0.001****

Statistically significant p values are in bold (p<0.05)

*Unpaired Students *t* test unless otherwise stated, **Pearson's correlation, ***ANOVA

Table 2 Multivariable linear regression analysis to identify preoperative independent predictors of 2-year ($R^2 = 0.14$) postoperative EQ-5D

Demographic	Descriptive	Mean change	EQ-5D 95% CI		P value
			Lower	Upper	
Patella resurfacing	No	Reference			
	Yes	−0.005	−0.022	0.012	0.493
Gender (M/F)	Male	Reference			
	Female	0.002	−0.017	0.020	0.859
Mean age *		0.000	−0.002	0.001	0.393
BMI	Under	0.046	−0.132	0.224	0.615
	Normal	Reference			
	Over	0.027	−0.003	0.057	0.083
	Obese 1	−0.002	−0.032	0.028	0.899
	Obese 2	−0.042	−0.080	−0.005	**0.027**
	Obese 3	−0.026	−0.069	0.018	0.248
TKA design	CR	Reference			
	PS	0.022	0.003	0.040	**0.024**
ASA grade	1	Reference			
	2	−0.014	−0.045	0.017	0.383
	3	−0.060	−0.098	−0.022	**0.002**
	4	0.045	−0.189	0.280	0.706
Oxford score*	Full	0.007	0.005	0.010	**< 0.001**
	Q3	0.010	−0.003	0.024	0.134
	Q5	−0.015	−0.029	−0.002	**0.028**
	Q7	−0.005	−0.016	0.007	0.453
	Q12	0.002	−0.011	0.016	0.749
EQ-5D*		0.137	0.099	0.175	**< 0.001**

Statistically significant p values are in bold (p<0.05)

*Mean change for each year or point change in age or preoperative score, respectively

improvement in their 2 year EQ-5D score (Table 2). There were significant correlations for EQ-5D between preoperative and 2 years ($r = -0.684$, $p < 0.001$), and for OKS between preoperative and 2 years ($r = -0.376$, $p < 0.001$) (Figs. 1 and 2). A preoperative EQ-5D of < 0.8 or an OKS of < 36 was associated with a clinically significant important improvement (being greater than the MCID) in the 2-year EQ-5D score (Figs. 1 and 2). The preoperative EQ-5D of < 0.8 was 95.7% specific, and an OKS of < 36 was 97.1% specific of a clinically significant improvement in the EQ-5D score at 2-years postoperatively. The EQ-5D was a more reliable predictor (AUC 67.0% 95% CI 64.9 to 69.0 at 2 years) than the OKS (AUC 58.1%, 95% CI 55.9 to 60.3 at 2 years) (Fig. 3). Overall, 73% of patients had a clinically significant improvement in their HRQoL at 2 years ($n = 2284$).

Secondary outcome: HRQoL associated with patella resurfacing

There was a greater rate of patella resurfacing in: female patients (odds ratio (OR) 1.55, 95% CI 1.34 to 1.79,

$p < 0.001$), and patients with a worse response to questions 7 ($p = 0.020$) or 12 ($p = 0.020$) of the OKS (Table 3). Both groups had a clinically and statistically significant improvement in the EQ-5D score at 2 years following surgery; however, there was no clinically or statistically significant difference between the two groups at 2 years or for change in the score (Table 4). When adjusting for confounding factors between the two groups, patella resurfacing was not associated with a clinically or statistically significant improvement in the EQ-5D score at 2 years (change in EQ-5D -0.005, 95% CI -0.022 to 0.012) when compared to those not undergoing resurfacing (Table 2). When assessing the change in EQ-5D scores at 2 years for those patients undergoing patella resurfacing and those who did not, according to preoperative factors, there were no clinically or statistically significant differences (Tables 5).
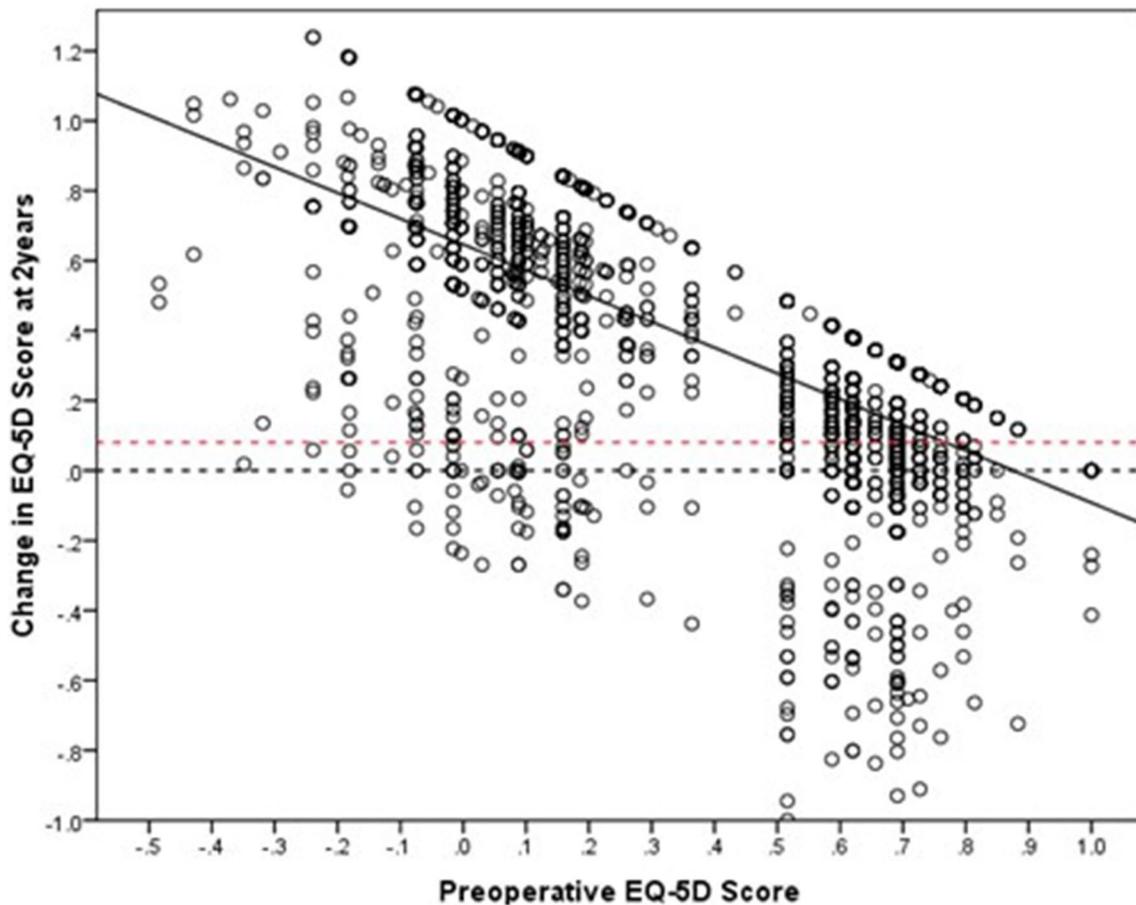
Fig. 1 Scatter plot for the association between preoperative EQ-5D and change in the score at two years following TKA. The solid black line represents the linear line of best fit, and the dashed black and red lines indicate no change in the EQ-5D and an improvement equal to the MCID in the EQ-5D, respectively

Discussion

This study has shown that ASA grade 3, grade II obesity, CR TKA, and a greater (less symptomatic) preoperative OKS or EQ-5D score were independently associated with a lower improvement in HRQoL 2 years following TKA; however, ASA grade, obesity and CR TKA may not be clinically significant. The threshold values identified in the preoperative EQ-5D and OKS that were predictive of a clinically important improvement in HRQoL offered high specificity, but the EQ-5D was a more reliable discriminator than the OKS. Patella resurfacing was not independently associated with a clinical or statistically significant improvement in HRQoL, and there was no group of patients identified that benefitted from patella resurfacing, according to improvement in their HRQoL.

This study has shown that most patients undergoing TKA had a clinically significant improvement in their HRQoL, which is a novel finding. However, patients with a BMI of less than 35 and those with a worse preoperative EQ-5D or OKS were more likely to have a greater improvement in their HRQoL postoperatively. This is consistent with the results of Baker et al. [22], who also found the preoperative EQ-5D and OKS to be predictive of HRQoL using 6-month data from the National Joint Registry, although they did not adjust for the confounding factor of BMI/obesity. The recent effect of the COVID-19 pandemic on the orthopaedic waiting lists has resulted in more patients enduring a lower HRQoL than observed prior to the pandemic while waiting for surgery [2]. Therefore, according to the results of the current study, a greater proportion of patients will have a clinically significant benefit from TKA. However, it has been shown that patients with a worse preoperative HRQoL may not achieve the same final HRQoL as other patients [18]. This suggests that if HRQoL diminished preoperatively a patient may not enjoy the same postoperative level of HRQoL that they may have done prior to their deterioration, i.e. they may have a greater improvement but do not achieve the same final HRQoL they may have done.
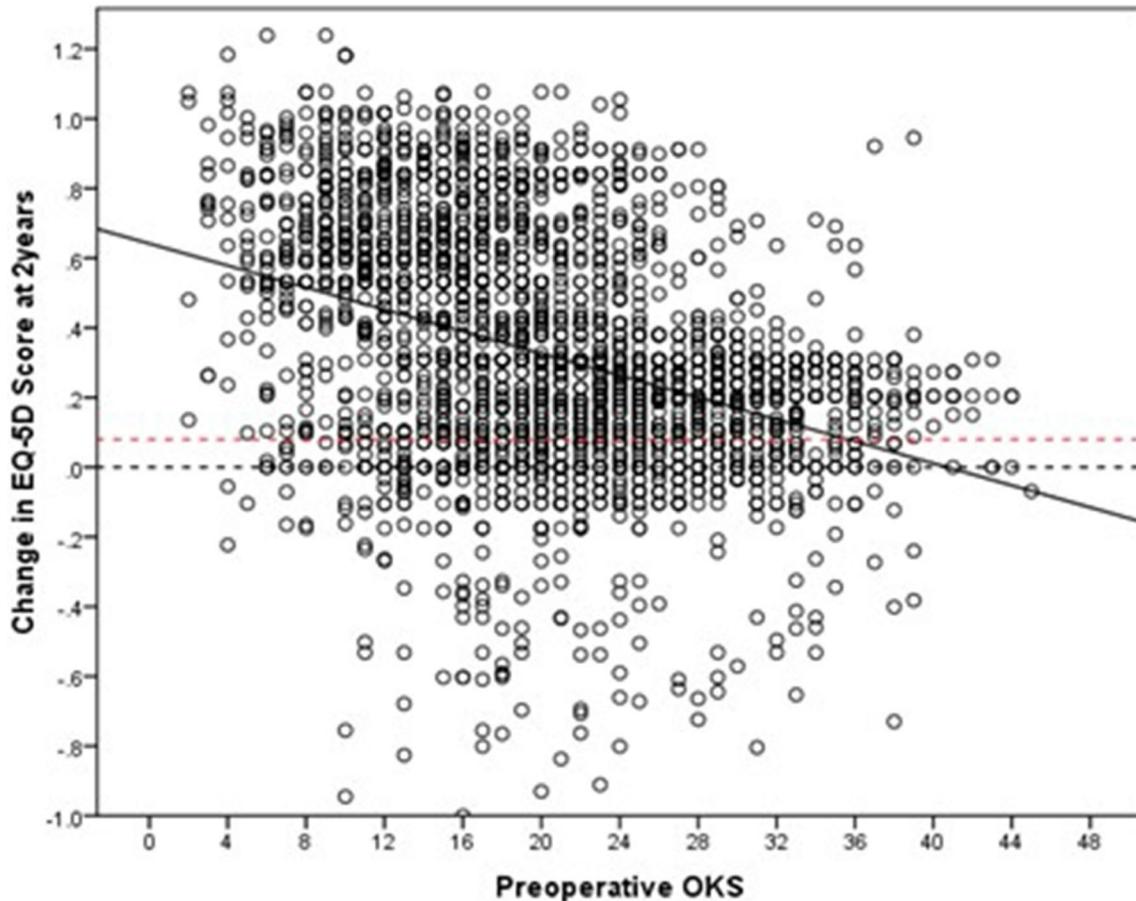
Fig. 2 Scatter plot for the association between preoperative OKS and change in the EQ-5D score at two years following TKA. The solid black line represents the linear line of best fit, and the dashed black and red lines indicate no change in the EQ-5D and an improvement equal to the MCID in the EQ-5D, respectively

Numerous authors have suggested cut-off values in the preoperative OKS that are associated with improvement in HRQoL [7], a meaningful improvement in knee symptoms [5], and cost effectiveness of TKA [4, 5]. Eibich et al. [7], using data from the National Joint Registry, identified that a preoperative OKS of ≤44 was associated with an improvement in HRQoL, according to the EQ-5D, at 6 months following TKA. This threshold is lower than that observed in the current study (OKS < 36), which may in part be explained by the differing threshold definitions used. The current study used a clinically significant improvement threshold in the EQ-5D (> 0.08), but Eibich et al. [7] used any improvement as their threshold definition. Price et al. [5] used an upper preoperative OKS threshold value of ≤41 to identify as many patients as possible that would have a clinically meaningful improvement in their knee symptoms. Again, the current study suggested a lower (worse) preoperative OKS of < 36 to be predictive of a clinically significant improvement in HRQoL. Using this same threshold of < 36 point in the OKS, according to the results of Price

et al. [5], 50% of their patients would achieve a meaningful improvement in knee symptoms but, conversely, this would also exclude 50% of patients that could benefit from TKA. Therefore, using the threshold for the OKS suggested in the current study may not be optimal, whereas the preoperative EQ-5D may be a better alternative, being a more reliable predictor compared to the OKS with an AUC approaching 70% [20]. The authors are not aware of any previous study identifying a threshold in the EQ-5D that is predictive of HRQoL following TKA. Furthermore, a patient's perception of their HRQoL may be more important than their knee symptoms postoperatively, depending on their expectations [23].

The EQ-5D score can also be used as part of cost-utility analysis to assess the cost effectiveness of TKA [1, 4]. Patients with a worse preoperative EQ-5D have been shown to gain the greatest quality-adjusted life years (QALY) following TKA and have a lower cost per QALY [1, 4]. Dakin et al. [6] demonstrated that patients with a preoperative OKS of < 40 had a cost per QALY of < £7000, whereas
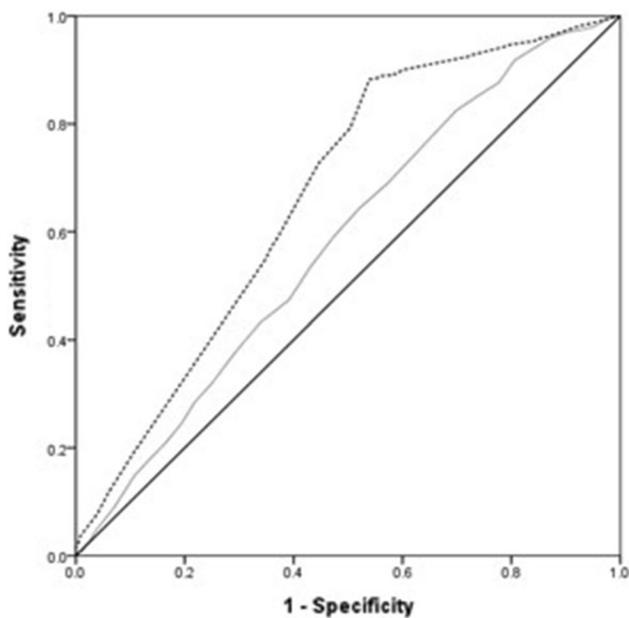
Fig. 3 Receiver operative characteristic curves for achievement of a clinically significant improvement in health-related quality of life following TKA according to the preoperative EQ-5D (dashed line) and OKS (grey line) at two years (colour figure online)

patients with an OKS of ≤ 43 the cost per QALY increased to $< £20,000$. Jenkins et al. [1] also demonstrated that an OKS of > 36 was not associated with a QALY gain following TKA, which is the same as the current study for the clinically significant improvement in HRQoL. Healthcare systems in the coming years may need to prioritise resources [4], and those patients with a preoperative EQ-5D of < 0.8 and or OKS of < 36 may offer the best value for money and may enjoy clinically significant benefit from TKA. However, patients with higher preoperative functional scores still achieve an improvement in their joint-specific function and HRQoL.

An original aspect of the current study was to demonstrate that patella resurfacing was not associated with an independent effect on HRQoL following TKA. Recent NICE guidelines suggest that patella resurfacing is a cost-effective intervention [14], but this was based on a non-significant difference in cost and QALYs gained between those patients that did and did not undergo patella resurfacing from the KAT trial [15]. The current study affirms the non-significant results of KAT study, with no independent benefit being observed in the EQ-5D score following resurfacing. An alternative benefit of resurfacing may be the prevention of revision surgery for secondary patella resurfacing, which is estimated to be one in 189 primary TKA performed in the

Table 3 Patient demographics and preoperative functional scores according to group

Demographic	Descriptive	Patella Resurfacing		*p* value*
		No (*n* = 1673)	Yes (*n* = 1454)	
Gender (M/F) (*n*, % of group)	Male	718 (42.9)	476 (32.7)	
	Female	955 (57.1)	978 (67.3)	**< 0.001**
Mean Age (years: mean, SD)	71.4 (8.5)	71.6 (8.6)	0.515**	
BMI (kg/m^2: mean, SD)	Under	5 (0.3)	2 (0.1)	0.457***
	Normal	177 (10.6)	155 (10.7)	
	Over	554 (33.1)	503 (34.6)	0.777
	Obese 1	624 (37.3)	534 (36.7)	0.862
	Obese 2	204 (12.2)	147 (10.1)	0.206
	Obese 3	109 (6.5)	112 (7.7)	0.357
	Missing	0 (0)	1 (0.1)	0.468***
ASA Grade	1	154 (9.2)	116 (8.0)	
	2	1274 (76.2)	1135 (78.1)	0.195
	3	243 (14.5)	201 (13.8)	0.549
	4	2 (0.1)	2 (0.1)	0.999***
Preoperative Functional measures (mean, SD)				
Oxford Score	**Full**	20.8 (8.0)	20.6 (7.9)	0.599**
	Q3	2.11 (0.86)	2.11 (0.85)	0.974**
	Q5	1.85 (0.89)	1.81 (0.86)	0.217**
	Q7	0.91 (0.92)	0.84 (0.92)	**0.020****
	Q12	1.93 (0.93)	1.86 (0.88)	**0.020****
EQ5D		0.446 (0.308)	0.452 (0.306)	0.583**

Statistically significant p values are in bold (p<0.05)

*Chi-square test unless otherwise stated **Students *t* test ***Fisher's exact test

Table 4 Postoperative outcome measures and the difference relative to preoperative EQ-5D scores according to group

| Functional measure | Patella resurfacing | | | | Difference | 95% CI | | p value* |
| | No | | Yes | | | | | |
	Mean	SD	Mean	SD		Lower	Upper	
Postoperative EQ-5D	0.764	0.241	0.763	0.250	0.001	−0.017	0.019	0.890
Difference	0.320	0.331	0.309	0.332	0.010	−0.013	0.034	0.393
95% CI	0.304 to 0.336		0.292 to 0.327					
p-value**	<0.001		<0.001					

* t test

**Paired t test

Table 5 Change in the EQ-5D score at 2 year for patients undergoing patella resurfacing and for those that did not according to patient demographics and preoperative functional scores

| Demographic | Descriptive | n = | Patella resurfacing | | Difference | 95% CI | | p value* |
			No	Yes		Lower	Upper	
Gender	Male	703 vs 460	0.294 (0.300)	0.286 (0.306)	0.010	−0.028	0.049	0.604
	Female	936 vs 950	0.345 (0.336)	0.325 (0.330)	0.019	−0.011	0.050	0.205
Mean age	<60	139 vs 118	0.315 (0.375)	0.337 (0.352)	0.022	−0.068	0.111	0.638
	60 to 70	538 vs 445	0.342 (0.328)	0.343 (0.347)	0.002	−0.041	0.044	0.936
	>70	966 vs 845	0.308 (0.325)	0.288 (0.320)	0.020	−0.009	0.050	0.180
BMI (kg/m² : mean, SD)	Under	5 vs 2**						
	Normal	172 vs 146	0.288 (0.334)	0.283 (0.335)	0.005	−0.069	0.079	0.891
	Over	541 vs 490	0.315 (0.307)	0.308 (0.305)	0.007	−0.031	0.044	0.721
	Obese 1	615 vs 519	0.330 (0.339)	0.312 (0.343)	0.018	−0.022	0.058	0.367
	Obese 2	203 vs 143	0.313 (0.353)	0.288 (0.375)	0.026	−0.052	0.104	0.514
	Obese 3	107 vs 107	0.348 (0.357)	0.364 (0.335)	0.015	−0.078	0.109	0.744
ASA grade	1	153 vs 114	0.297 (0.323)	0.317 (0.276)	0.020	−0.054	0.094	0.603
	2	1249 vs 1097	0.309 (0.332)	0.309 (0.332)	0.019	−0.008	0.046	0.159
	3	239 vs 195	0.287 (0.332)	0.306 (0.368)	0.019	−0.047	0.085	0.578
	4	2 vs 2**						
Oxford score	<21	813 vs 700	0.427 (0.360)	0.420 (0.360)	0.007	−0.030	0.044	0.702
	≥21	830 vs 708	0.214 (0.260)	0.200 (0.253)	0.014	−0.011	0.040	0.274
Q3	2 to 4	1273 vs 1101	0.272 (0.305)	0.271 (0.309)	0.001	−0.024	0.026	0.942
	0 and 1	370 vs 307	0.484 (0.363)	0.448 (0.375)	0.037	−0.019	0.093	0.195
Q5	2 to 4	1011 vs 845	0.235 (0.298)	0.235 (0.286)	0.000	−0.027	0.027	0.997
	0 and 1	632 vs 563	0.455 (0.336)	0.421 (0.364)	0.034	−0.006	0.074	0.093
Q7	2 to 4	406 vs 314	0.227 (0.260)	0.213 (0.254)	0.013	−0.025	0.051	0.487
	0 and 1	1237 vs 1094	0.350 (0.346)	0.337 (0.347)	0.013	−0.015	0.041	0.359
Q12	2 to 4	1094 vs 909	0.257 (0.292)	0.246 (0.294)	0.011	−0.015	0.037	0.400
	0 and 1	549 vs 499	0.443 (0.368)	0.424 (0.366)	0.020	−0.025	0.064	0.390
EQ5D	**<0.5**	624 vs 511	0.614 (0.272)	0.616 (0.287)	0.003	−0.030	0.035	0.872
	≥ 0.5	1019 vs 897	0.139 (0.214)	0.134 (0.206)	0.005	−0.014	0.024	0.596

Statistically significant p values are in bold (p<0.05)

*Unpaired Students t test ** test not performed due to limited patient numbers

UK [24]. However, to spend £33,075 (£175 multiplied by $n = 189$ if it is assumed the cost of resurfacing is £175 [25]) to prevent one revision with an associated cost of £9655 [26], may not be a cost-effective intervention. Furthermore, this does not acknowledge re-operation for extensor mechanism problems.

The independent effect of BMI on HRQoL following TKA was another original finding. Patients with grade II obesity had a significantly lower HRQoL postoperatively, and a trend towards significance for grade III obesity was observed. This is a modifiable risk factor associated with a poorer outcome and, if addressed preoperatively, may result in a greater improvement in HRQoL for patients following TKA. Conversely, in view of the increasing time spent on waiting lists, avoidance of weight gain may be advocated to potentially improve postoperative HRQoL. The OPPORTUNITY study is currently assessing the benefits of weight loss and the potential of improved HRQoL prior to TKA and postoperatively, which may affirm the findings of the current study [27]. Using the EQ-5D data from the current study, a reduction from BMI grade II to I would be associated with a 0.093 gain in postoperative EQ-5D, and therefore, an intervention with a cost less than £1860 would be cost-effective with a cost per QALY of less than £20,000 as recommended by NICE [28].

This was a retrospective study and only associations can be made, but this is one of the largest datasets used to assess HRQoL following TKA and patella resurfacing. The MCID used to define a clinically significant outcome was defined for a cohort of patients undergoing total hip replacement and may not be applicable to TKA [19, 29]; however, there is currently no defined MCID following TKA. The OKS [30] and EQ-5D [31] both have acknowledged ceiling effects following TKA and this may have influenced the change in score, and therefore, the real postoperative HRQoL gain may be higher than presented. The SF-36 is an alternative measure of HRQoL, has a limited ceiling effect for most of the eight dimensions assessed, and may be a better tool to measure HRQoL change than the EQ-5D [32]. Finally, associated perioperative complications were not considered, and these may be the reason why those with a higher BMI or ASA grade had a lower HRQoL gain postoperatively, as they may be more likely to suffer complications due to their comorbidity.

Conclusions

The thresholds identified in the preoperative OKS or EQ-5D for a clinically significant improvement in HRQoL may be used as indicators for referral for TKA; however, the EQ-5D threshold may be more reliable. Weight loss targeted at patients with grade II, and probably grade III, obesity may be associated with greater improvements in HRQoL postoperatively and should be advocated. However, these factors did not limit a clinically significant improvement in HRQoL following TKA being achieved.

Data availability Patient-level data are not available due to patient confidentiality.

Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethics approval and consent to participate This project was approved by the local Quality improvement team. It fulfilled the Health Regulatory Authority requirements for service evaluation and as such did not require formal ethical approval. The project has been signed off by the SWLEOC team for data release and publication.

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