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CLINICAL RESEARCH

Reason for Revision Influences Early Patient Outcomes After Aseptic Knee Revision

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Abstract

Background Revision TKA less consistently produces improvements in clinical function and quality of life when compared with primary TKA. The reasons for this difference are unclear.

Questions/purposes We determined differences in patient-reported outcomes and rates of satisfaction between primary and revision TKAs, and determine whether the reason for revision influences patient-reported outcomes after revision TKA.

Methods We retrospectively analyzed prospectively collected patient-reported outcome measures (PROMs) for 24,190 patients (23,393 TKAs; 797 aseptic revision TKAs). We compared patient-reported outcomes using the Oxford Knee Score (OKS), EuroQol (EQ-5D), and patient satisfaction between primary TKA and revision TKA, and for subsets of the revision TKA cohort. The followup data were collected between 6 and 12 months (7 months average) postoperatively.

Results Improvements in the OKS (10) and EQ-5D (0.231) were smaller after revision when compared with primary TKA (OKS, 15; EQ-5D, 0.303). Patients who had revision TKA were less satisfied (66% versus 83%). Revisions for aseptic loosening or lysis were associated with the best patient outcomes (OKS improvement = 11; EQ-5D improvement = 0.232; satisfaction = 72%). Revisions for stiffness had the worst results (OKS improvement = 6; EQ-5D improvement = 0.176; satisfaction = 47%).

Conclusions The early improvements in knee function and general health after revision TKA are only 69% to 76% of those observed for primary TKA. Levels of patient-reported knee function, general health, and satisfaction after revision are varied and related to the reason for revision. Even the best revision group does not approach the levels of function and satisfaction observed after primary TKA at a mean of 7 months postoperatively. Longer-term followup would be required to determine whether conclusions from these early data will need to be modified.

Level of Evidence Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Recent information from the National Joint Registry for England and Wales shows a continued increasing trend in the numbers of primary and revision TKAs performed annually [25]. This trend undoubtedly will continue as we support an increasingly aging population and perform primary surgery on a more demanding younger population [6]. Primary TKA almost uniformly relieves pain, improves knee function, and produces levels of patient satisfaction greater than 80% [2, 17, 21, 24, 26, 28, 32–34]. Revision surgery is less predictable, with lower rates of survival, increased rates of complications, varied patient satisfaction, and an inconsistent ability to restore or improve quality of life [8, 12, 18, 29].

One study comparing primary and revision TKAs reported lower rates of satisfaction after revision surgery (revision = 73%; primary = 86%) [14]. Postoperative general health measures (SF-12 [31]) and knee scores (Hospital for Special Surgery [HSS] [19], Oxford Knee Score [OKS] [7], and WOMAC [3]) are also lower after revision [14–16, 29]. This effect, however, is confounded by the substantially lower preoperative scores observed with revision [14]. If instead we consider the improvements in theses scores from their preoperative baseline, then differences between primary and revision surgery are less consistent [14, 16]. Reported improvements for the WOMAC are greater for primary TKA [14, 16], but equivalent results are seen for the OKS [14] and SF-12 [14, 16]. This is important as the value of an intervention is related to its ability to improve function and quality of life rather than its final end point. In addition, previous analyses of functional outcomes after TKA have been unable to substratify analysis dependent on the reason for revision which might potentially influence outcome [12, 14–16, 18, 23, 27, 29].

We therefore asked (1) whether there is a difference in the preoperative, postoperative, and change in knee-specific and general health scores between primary and revision TKAs; (2) what are the rates of patient satisfaction after primary and revision TKAs; and (3) how the reason for revision influences patient-reported outcome after revision TKA.

Patients and Methods

The study was performed as a retrospective comparative cohort study. Since April 2008 the United Kingdom Department of Health, in conjunction with the National Joint Registry for England and Wales (NJR), has overseen a national program of PROMs collection in patients undergoing National Health Service-funded primary or revision hip or knee arthroplasty. In September 2010 we submitted a combined request for access to PROMS and their corresponding NJR records for patients undergoing primary or revision TKAs. By accessing these datasets in this manner, we were able to link demographic and operative details stored in the NJR database to the PROMS for individual patients. This study was performed using NJR and PROMs data, both of which have their own consent mechanisms. As no additional patient contact was required and no identifiable patient data were used as part of this analysis, the local ethical committee thought it could be performed as a service evaluation without need for formal ethical approval.

Data covered operations performed between August 2008 and September 2010. Patient-reported outcomes are completed by the patient preoperatively and again at 6 months postoperatively. Postoperative collection is performed by postal questionnaire which is centrally coordinated by the Department of Health. The time of the postoperative assessment was independently determined by the Department of Health and there are currently no plans for repeated-measures followup at a longer interval after surgery.

Patients were considered eligible for inclusion if they had (1) a date of operation recorded on the NJR database, (2) completed preoperative and postoperative questionnaires, (3) dates of completions for both questionnaires, and (4) a minimum of 6 months followup after surgery. Patients not meeting these criteria were excluded as there either was no mechanism for adequately determining time of followup, no way of establishing improvements in scores owing to missing data, or followup was thought to be too short to allow meaningful comparison.

The study size was determined by the number of patients eligible using these criteria. In total 24,389 patients who had undergone either primary (23,393) or revision (996) TKA were considered. The NJR defines revision as removal or exchange of the femoral component, tibial component, or polyethylene insert. The nature of the PROMS collection meant that preoperative data for two-stage revisions corresponded to their function before the second-stage procedure, not before revision. Additionally, the majority of two-stage revisions was performed for infection, which is known to have a poorer functional outcome [13]. For these reasons, we chose to exclude all two-stage revisions and revisions where infection was recorded as a reason in the NJR database (199 revisions). Therefore, the revision cohort included only single-stage revisions performed for an indication other than infection (n = 797). We included all identified primary TKAs regardless of the reason for primary surgery.

Patient demographics for the primary and revision TKA groups are provided (Table 1). When compared with patients who had primary TKAs, patients who had revision

Table 1. Demographics for the TKA and revision TKA groups

Demographic variable	TKA (N = 23,393)	Revision TKA (N = 797)	p value
Mean age (years)	69.6 (SD, 9.0)	67.8 (SD, 10.0)	< 0.001
Gender (%)			
Female	13,223 (57%)	420 (53%)	0.03
Male	10,170 (44%)	377 (47%)	
ASA (%)			
1	2362 (10%)	65 (8%)	< 0.001
2	17,445 (75%)	562 (71%)	
3	3512 (15%)	170 (21%)	
4	74 (0%)	0 (0%)	
Number of operations performed in the NHS (%)	20,932 (90%)	780 (98%)	< 0.001
Number of operations performed by a consultant surgeon (%)	17,371 (74%)	730 (92%)	< 0.001
Number of patients with three or more major comorbidities (%)	1979 (9%)	71 (9%)	0.66
Mean followup	209 days	209 days	

Major comorbidities = any of cardiac disease, hypertension, stroke, circulatory problems, pulmonary disease, diabetes, renal disease, central nervous system problems, hepatic disease, depression, arthritis, cancer; ASA = American Society of Anesthesiologists; NHS = National Health Service.

TKAs were younger (67.8 versus 69.6 years), a higher proportion were American Society of Anesthesiologists (ASA) Grade 3 or 4 (21% versus 15%), and a greater proportion had surgery performed in the National Health Service (98% versus 90%) by a consultant surgeon (92% versus 74%) as opposed to a training or staff surgeon. Overall mean followup was 7 months (range, 6–12 months) and was similar for the primary and revision groups.

PROMs questionnaires include validated assessments of knee function (OKS) [7]) and general well-being (EQ-5D) [10] in addition to an assessment of patient satisfaction. The OKS contains 12 individual elements assessing knee pain and function that were combined to generate an overall score between 0 (worst) and 48 (best), with lower scores indicating more severe problems. It has been recommended for assessing large TKA databases in a cross-sectional population [9]. Overall health status was measured using the EQ-5D, a standardized measure of health status developed by the EuroQol Group to provide a simple, generic measure of health for clinical and economic appraisal [10]. It provides a simple descriptive profile of five health domains (mobility, self-care, ability to perform usual activities, pain/discomfort, and anxiety/depression), each rated 1 to 3 (Level 1, no problems; Level 2, moderate difficulties; Level 3 severe difficulties). These scores can be combined using population weightings to produce a single index value for health status.

Patient satisfaction was rated using a five-point adjectival scale [30]. Under the heading "satisfaction", patients were asked "How would you describe the results of your operation?", with possible responses of "excellent", "very good", "good", "fair", and "poor". Patients with an excellent, very good, or good response were classified as satisfied and those responding fair or poor as unsatisfied. Although this question has not been formally validated, this type of adjectival scale has good face validity and mirrors the scales used in other assessments of satisfaction after TKA [28].

For the revision TKA group we were interested in the effects of the reason for revision on patient outcomes. Information for this variable is available in the NJR database. To overcome the problem of multiple reasons for revision on the NJR data collection form, we used a hierarchical strategy for determining the primary reason for revision. This mirrored the hierarchy used by the Australian Arthroplasty register [1] but was modified to accommodate the additional reasons for revision available on the NJR forms.

We determined differences in continuous data (OKS, EQ-5D) between the primary and revision TKA groups using independent t-tests. The method of Fieller [11] was used to quantify the proportional differences between these two groups for the OKS and EQ-5D. Differences in satisfaction between primary and revision TKAs were determined using chi-square and Fisher's exact tests. For the analysis of reason for revision, one-way ANOVA was used to assess differences in continuous variables (OKS, EQ-5D), and the chi-square test was used to determine differences in categorical variables (satisfaction).

Post hoc power calculation based on the distributions of each of the outcome variables and their associated clinically relevant differences (OKS, 3 points; EQ-5D index, 0.1 points; satisfaction/success, 10%) showed that, with the numbers available, we would have greater than 98% power for each variable to detect a difference at the 5% level ($p < 0.05$) for the comparison of primary and revision TKAs. Statistical analyses were done using SPSS version 17 (SPSS Inc, IBM Corporation, Armonk, NY, USA) and Minitab version 15 (Minitab Ltd, Coventry, UK).

Results

The mean preoperative, postoperative, and overall changes in scores were greater for the primary group when compared with the revision group for the OKS and EQ-5D. The mean improvement in the OKS was greater ($p < 0.001$) after primary surgery than after revision surgery (15 versus 10, respectively). The relative improvement in OKS for revision TKA therefore was 69% (95% CI, 64%–74%) of the improvement observed for primary TKA. The mean postoperative OKS was greater ($p < 0.001$) after primary surgery than after revision surgery (34 versus 27, respectively). The proportion of patients not reporting improvements in the OKS was less ($p < 0.001$) after primary surgery than after revision surgery (7% versus 17%, respectively) (Table 2). The mean improvement in the EQ-5D was greater ($p < 0.001$) after primary surgery than after revision surgery (0.303 versus 0.231, respectively). The relative improvement in the EQ-5D for revision TKA therefore was 76% (95% CI, 71%–81%) of the improvement observed for primary TKA. The mean postoperative EQ-5D was greater ($p < 0.001$) after primary surgery than after revision surgery (0.710 versus 0.541, respectively). The proportion of patients not reporting improvements in the EQ-5D was less ($p < 0.001$) after primary surgery than after revision surgery (21% versus 34%, respectively) (Table 2). Both groups had improvements in each of the five EQ-5D domains postoperatively; however, the improvements were more noticeable in the primary TKA group, with a greater proportion of patients in Level 1 after surgery (Table 3).

A greater proportion ($p < 0.001$) of patients described the results of their operation as excellent after primary TKA (5124 of 22,960 respondents [22%]) when compared with revision TKA (102 of 786 respondents [13%]). The proportion of patients with poor results was greater ($p < 0.001$) for the revision group (revision, 82 of 786 respondents [10%]; primary, 856 of 22,960 respondents [4%]) (Fig. 1). Overall 83% of patients who had primary TKAs were satisfied compared with 66% of patients who had revision TKAs.

The reason for revision influenced the OKS, EQ-5D, and satisfaction rate. The highest postoperative scores were seen in patients who had revision TKA for either aseptic loosening or lysis (OKS, 28; EQ-5D, 0.560). Even in this group, however, the improvements in the OKS and EQ-5D, postoperative OKS and EQ-5D, and the rate of satisfaction were lower ($p < 0.001$) than the equivalent scores after primary TKA (Table 4). The worst OKS and EQ-5D score were seen in revisions performed for stiffness. In this group the improvement in OKS (6) and the postoperative OKS (21) were worse than the corresponding values for revisions performed for aseptic loosening (OKS improvement, 11; postoperative OKS, 28; $p < 0.001$). Satisfaction rates also were lower ($p < 0.001$) between these two groups (aseptic loosening and lysis, 72%; stiffness, 47%)

Discussion

Knee-specific functional scores and general health outcomes are worse after revision TKA when compared with primary TKA [14, 15, 29]. It may be that this disparity is related to the poorer preoperative functional status

Table 2. Comparison of preoperative, postoperative, and changes in scores

Patient-reported outcome measure	TKA	Revision TKA	p value
Oxford Knee score			
Mean preoperative	18.9 (95% CI, 18.8–19.0)	16.2 (95% CI, 15.6–16.8)	< 0.001
Mean change	15.1 (95% CI, 15.0–15.3)	10.4 (95% CI, 9.7–11.1)	< 0.001
Mean postoperative	34.0 (95% CI, 33.9–34.2)	26.6 (95% CI, 25.8–27.4)	< 0.001
% no improvement	7%	17%	< 0.001
EQ-5D index			
Mean preoperative	0.407 (95% CI, 0.403–0.411)	0.310 (95% CI, 0.286–0.334)	< 0.001
Mean change	0.303 (95% CI, 0.298–0.307)	0.231 (95% CI, 0.205–0.258)	< 0.001
Mean postoperative	0.710 (95% CI, 0.707–0.714)	0.541 (95% CI, 0.518–0.565)	< 0.001
% no improvement	21%	34%	< 0.001

Table 3. EuroQol domains and percentage change preoperative to postoperative for the TKA and revision TKA groups

EQ-5D dimension	TKA			Revision TKA		
	Preoperative	Postoperative	Net change	Preoperative	Postoperative	Net change
Mobility						
Level 1	6.0	47.6	+41.6	3.9	22.9	+19.0
Level 2	93.8	52.2	−41.6	95.3	76.9	−18.4
Level 3	0.2	0.1	−0.1	0.8	0.1	−0.7
Self-care						
Level 1	69.4	78.7	+9.3	57.5	62.1	+4.6
Level 2	30.0	20.8	−9.2	41.2	37.1	−4.1
Level 3	0.6	0.6	0.0	1.3	0.8	−0.5
Usual activities						
Level 1	8.7	42.5	+33.8	5.8	20.5	+14.7
Level 2	78.0	52.7	−25.3	73.3	66.8	−6.5
Level 3	13.3	4.8	−8.5	20.9	12.7	−8.2
Pain/discomfort						
Level 1	0.9	32.6	+31.7	1.4	15.4	+14.0
Level 2	59.7	61.5	+1.8	48.2	68.1	+19.9
Level 3	39.4	5.9	−33.5	50.3	16.5	−33.8
Anxiety/depression						
Level 1	63.0	76.7	+13.7	52.5	60.5	+8.0
Level 2	33.5	21.1	−12.4	40.4	33.4	−7.0
Level 3	3.5	2.2	−1.3	7.1	6.2	−0.9

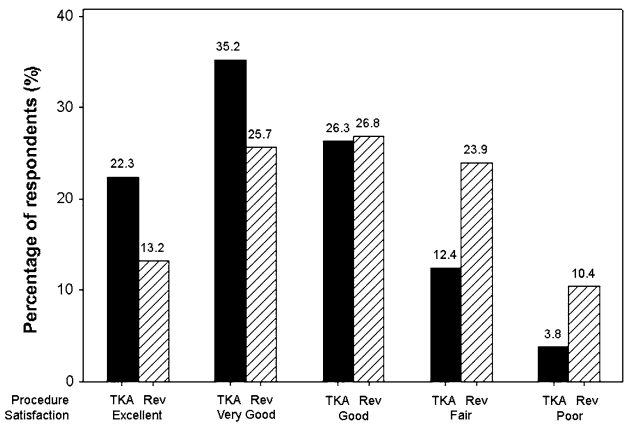

Fig. 1 Postoperative patient satisfaction was higher after primary TKA compared with revision (Rev) TKA.

observed for revision TKAs [14, 16] in combination with the larger operation and greater surgical insult they experience. Improvements in knee-specific and general health scores in studies directly comparing these two groups appear to be equivalent for numerous assessment modalities [14, 16]. Previous studies have failed to reliably assess the influence of potentially important factors such as reason for revision on knee scores and general health measures after revision TKA [12, 14–16, 18, 27, 29]. We therefore asked three specific questions: (1) Is there a difference in the preoperative to postoperative changes in knee-specific and general health scores between primary and revision TKAs? (2) What are the rates of patient satisfaction after primary and revision TKAs? (3) How does the reason for revision influence the patient-reported outcome after revision TKA?

This study has some limitations. First, we used data from the national PROMs project and thus were constrained by its design. Almost 90% of PROMs are completed between 6 and 8 months after surgery, so there is no scope for extending the minimum followup without losing virtually all the data. The database constraint meant we could not adjust the length of followup and the type of data collected. We have attempted to limit the effects of limited followup by restricting our analysis to only patients with a minimum of 6 months followup and all comparisons were performed between groups with equivalent median lengths of followup. Owing to the timing of followup, further improvements occurring later during postoperative recovery could not be appreciated. Additional improvements after primary TKA beyond 6 months are likely to be small as function is reaching a plateau by this time [20]. Reaching a functional plateau after revision TKA takes longer owing to the extent of the surgery and the time required for recovery. For revision TKA this plateau phase may not be reached until at least year after surgery [23]. The data presented here, however, have the advantage of using standardized prospective collection methods

Table 4. PROMs for the revision TKA group dependent on reason for revision

Patient demographics and PROMs	Malalignment	Loosening/lysis	Component wear	Dislocation/instability	Stiffness	Unexplained pain	Other/no reason stated
Number	94	367	34	81	33	84	104
Mean age (years)	68.6	69.3	67.8	66.0	63.9	65.5	65.9
Gender (M:F)	44:50	190:177	13:21	29:52	19:14	43:41	39:65
Oxford Knee Score							
Mean preoperative	15.4 (95% CI 13.7–17.0)	16.5 (95% CI 15.7–17.3)	14.6 (95% CI 12.4–16.9)	17.0 (95% CI 14.9–19.0)	15.5 (95% CI 12.9–18.2)	16.8 (95% CI 15.0–18.5)	15.6 (95% CI 14.1–17.0)
Mean change	11.3 (95% CI 9.4–13.1)	11.3 (95% CI 10.2–12.4)	11.6 (95% CI 8.1–15.2)	7.2 (95% CI 4.9–9.5)	5.6 (95% CI 2.0–9.1)	9.6 (95% CI 7.4–11.7)	10.5 (95% CI 8.5–12.6)
Mean postoperative	26.7 (95% CI 24.3–29.0)	27.8 (95% CI 26.6–28.9)	26.3 (95% CI 22.5–30.0)	24.2 (95% CI 22.0–26.5)	21.1 (95% CI 16.8–25.4)	26.4 (95% CI 23.5–29.3)	26.1 (95% CI 23.9–28.3)
% no improvement	11%	16%	21%	24%	28%	15%	19%
EQ-5D							
Mean preoperative	0.255 (95% CI 0.187–0.323)	0.328 (95% CI 0.292–0.363)	0.329 (95% CI 0.216–0.442)	0.329 (95% CI 0.256–0.403)	0.303 (95% CI 0.173–0.432)	0.310 (95% CI 0.232–0.387)	0.277 (95% CI 0.213–0.341)
Mean change	0.293 (95% CI 0.221–0.365)	0.232 (95% CI 0.192–0.271)	0.203 (95% CI 0.069–0.337)	0.208 (95% CI. 0.129–0.287)	0.176 (95% CI 0.015–0.338)	0.172 (95% CI. 0.091–0.252)	0.263 (95% CI 0.191–0.334)
Mean postoperative	0.548 (95% CI 0.479–0.617)	0.560 (95% CI 0.526–0.593)	0.533 (95% CI 0.439–0.627)	0.537 (95% CI 0.467–0.608)	0.479 (95% CI 0.334–0.624)	0.481 (95% CI 0.395–0.568)	0.540 (95% CI 0.478–0.601)
% no improvement	33%	33%	33%	40%	44%	35%	34%
Satisfied (%)	64%	72%	73%	60%	47%	58%	59%

PROMs = patient-reported outcome measures.

including preoperative and postoperative data. Second, the PROMs project is still in its infancy, having commenced in April 2008, and has, until now, been designed to be a sample analysis of the total primary and revision TKAs. Owing to the number of primary and revision TKAs performed annually in England and Wales, there are still a substantial number of PROMS suitable for analysis showing the power of PROM collection linked to a national registry. Third, the revision population is heterogeneous in that they have revision surgery for various reasons. We tried to account for this by excluding revision TKAs performed for infection or two-stage revisions. In addition we presented a substratification of this group with analysis dependent on the reason for revision to highlight differences related to this factor. Fourth, although the patients who had primary and revision TKAs were not directly comparable cohorts owing to differing patient demographics and the nature of the underlying disorder, there is value in comparing the outcomes between these two groups to help surgeons quantify the expected outcome relative to a well-established procedure. Fifth, we could not obtain specific information about some variables that might have influenced functional recovery outcome. These included information regarding whether the revision was major (change of all components) or minor (change of polyethylene only) and whether these revisions were first, second, third, etc, revisions.

We found that postoperative patient-reported knee-specific and general health scores and their associated improvements from baseline were greater after primary TKA when compared with revision TKA. Revision TKA has been shown to produce improvements in knee function using various assessment modalities including the OKS, KSS, and WOMAC [8, 12, 14–16, 18]. The findings from this study are comparable to results of the New Zealand registry where reported 6-month postoperative OKS scores were 37.2 and 29.4 after primary and revision TKAs, respectively [27], and with an OKS of 35.0 reported 1 year after primary TKA by a previous NJR study [2]. Postoperative knee scores assessed using the HSS score (good to excellent results, primary 92% versus revision 81%) [15], WOMAC (primary 80.2 versus revision 69.1) [14], and OKS (converted to 0-100 range, primary 78.3 versus revision 68.4) [14] are consistently better for primary TKA when compared with revision TKA. Similarly postoperative SF-12 scores are reportedly better after primary TKA (primary 83.5 versus revision 71.6) [14, 16]. However, evidence relating to differences between primary and revision with respect to the changes from baseline for these assessment tools is lacking. Direct comparisons of primary and revision TKAs showed the improvements for the SF-12 [14, 16] and OKS [14] were equivalent and the scores for the overall WOMAC and its pain and function components were only marginally better after primary TKA [14, 16]. Our study shows the improvements from baseline are smaller for patients undergoing revision procedures regardless of assessment modality.

Rates of satisfaction after primary TKA range from 81% to 86% [2, 5, 14, 28]. Satisfaction after revision TKA has been reported between 73% and 88% [14, 18]. The satisfaction rate for primary TKA (83%) in our study therefore is comparable, whereas the rate after revision surgery of 66% is lower than in previous reports [14, 18]. This may be a reflection of the shorter duration of followup and differing methods of collection for these data. Patients rated the outcome of their surgery as poor in 4% of primary TKAs and 10% of revision TKAs. This indicates that although the overall rates of satisfaction differed, the proportion of patients reporting the poorest results was small for both groups.

Revisions performed for aseptic loosening and lysis were associated with the greatest postoperative OKS and EQ-5D scores and the highest rates of satisfaction. Revisions for malalignment and component wear produced comparable outcomes when compared with aseptic loosening and lysis. The improvements in scores for revisions performed for dislocation or instability, unexplained pain, and stiffness typically were smaller with the worst OKS, EQ-5D scores, and satisfaction rates seen in the group with stiffness. The reason why revision for stiffness performs poorly may be related to poorer postoperative ROM and function. Owing to the type of data collected we could not explore this hypothesis in further detail. There are currently no direct comparative studies assessing the effects of revision reason on functional outcome and satisfaction, with studies combining results from aseptic revisions without substratifying those performed for aseptic loosening against other reasons. In one of the few studies to examine revisions performed for aseptic loosening, Bertin et al. [4] found 91% of 53 patients who had revisions reported relief of pain and 80% could walk for more than 30 minutes. A study of revisions performed for stiffness showed low postoperative Knee Society scores and only modest improvements in scores at a mean of 43 months after surgery (postoperative Knee Society pain score, 46.9 (improvement, 31.9); postoperative Knee Society function score, 58.4 (improvement, 18.4)) [22]. These findings indicate that surgeons should expect different improvements and final functional scores depending on the reason for revision and that even in the best aseptic loosening and lysis groups the expected results are lower than those observed after primary TKA.

Our data suggest that improvements in knee function and general health after revision TKA are only 69% to 76% of those observed for primary TKA and that these outcomes are considerably worse in specific groups depending on the reason for revision. On average all patients who had

revision surgery improved from baseline regardless of the reason for revision although revisions for stiffness and unexplained pain produced the smallest improvements. This information is useful as it allows surgeons to counsel patients regarding expected improvements and final functional outcomes after revision TKA relative to the levels achieved after primary TKA. It also provides surgeons with information regarding how these outcomes change in the context of the reason for revision. This information will be especially useful in making clinical decisions regarding revision TKAs for stiffness or unexplained pain.

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