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Early patient outcomes after primary and revision total knee arthroplasty

A PROSPECTIVE STUDY

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There has been speculation as to how the outcome of revision total knee arthroplasty (TKA) compares with that of primary TKA. We have collected data prospectively from patients operated on by one surgeon using one prosthesis in each group. One hundred patients underwent primary TKA and 60 revision TKA. They completed SF-12 and WOMAC questionnaires before and at six and 12 months after operation.

The improvements in the SF-12 physical scores and WOMAC pain, stiffness and function scores in both primary and revision TKA patients were highly statistically significant at six months. There was no statistically significant difference in the size of the improvement in the SF-12 physical and WOMAC pain, stiffness and function scores between the primary and revision patients at six months after surgery. The SF-12 mental scores of patients in both groups showed no statistically significant difference after surgery at the six- and 12-month assessments.

Our findings show that primary and revision TKA lead to a comparable improvement in patient-perceived outcomes of physical variables in both generic and disease-specific health measures at follow-up at one year.

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There has been speculation as to how the outcome of revision total knee arthroplasty (TKA) compares with that of primary TKA. The former is technically demanding and the rates of satisfactory results have not been as high as those after primary TKA, varying between 37% and 89%.[1-30] Many of the series were retrospective, included small numbers of patients and involved numerous surgeons using a variety of prostheses in different hospitals. In this study we have assessed prospectively the outcome of revision and primary TKA performed by a single surgeon, in one hospital, using a single design of implant in each group. The outcome measures which we used were the generic short-form health questionnaire (SF-12)[31] and the disease-specific Western Ontario and McMasters osteoarthritis index (WOMAC).[32,33]

The primary prosthesis was a modular, cruciate-retaining implant. The femoral component was porous-coated and uncemented. The tibial component was cemented and the patella was resurfaced with a cemented polyethylene button. The revision implant used a fluted, canal-filling, cementless stem to obtain a press-fit with augments and/or wedges to address bony deficiency. The stem was 95 mm long in most cases. Occasionally, we used a short tapered stem if the bone stock was good or a 140 mm canal-filling stem if there was major osteolysis. The patella was resurfaced whenever possible. If the bone stock was poor or the patella too thin it was not resurfaced. The housing of both femoral and tibial components was cemented in all cases. The insert used was either posterior-stabilised or varus-valgus-constrained (Fig. 1).

The revision TKAs were performed for failure of the primary Accord implant (Thackray, Leeds, UK) (Fig. 2). The causes of failure included aseptic loosening, wear of polyethylene, meniscal subluxation and instability, malalignment and patellofemoral maltracking.

Patients and Methods

We included in the study all patients undergoing revision TKA between 1997 and 2000 and 100 consecutive patients undergoing primary TKA between 1997 and 1999, in 85 for osteoarthritis and in 15 for rheumatoid arthritis. In the revision group there were 35 women and 25 men with a mean age at surgery of 75 years (57 to 88) and in the primary group 54 women and 46 men with a mean age of 76 years (47 to 90).

All the operations were performed by the senior author (RWP). The prosthesis used in the primary TKA was the

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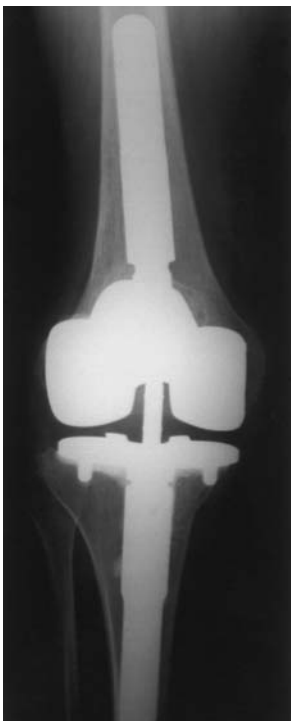

Fig. 1a

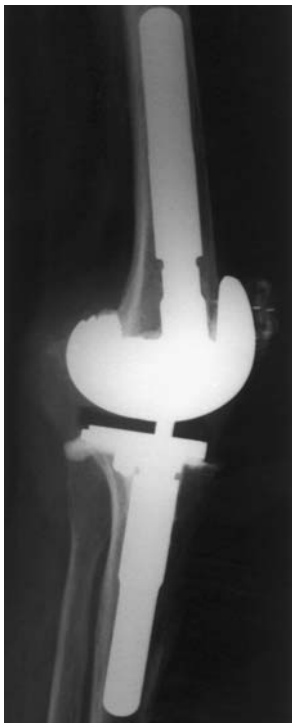

Fig. 1b

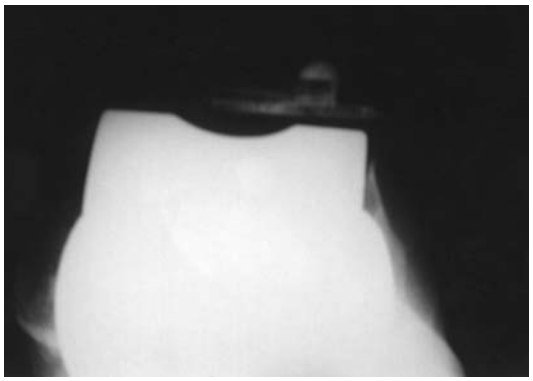

Fig. 1c

Radiographs showing a) anteroposterior, b) lateral and c) skyline views of the Co-Ordinate revision TKA with canal-filling inserts on the femoral and tibial components.

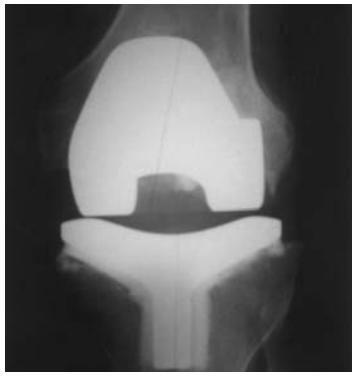

Fig. 2a

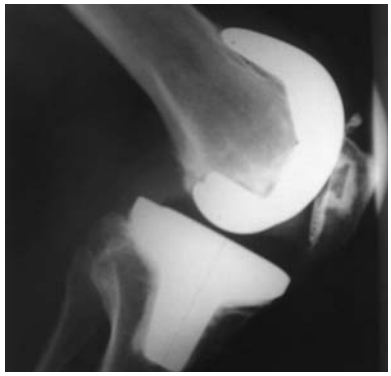

Fig. 2b

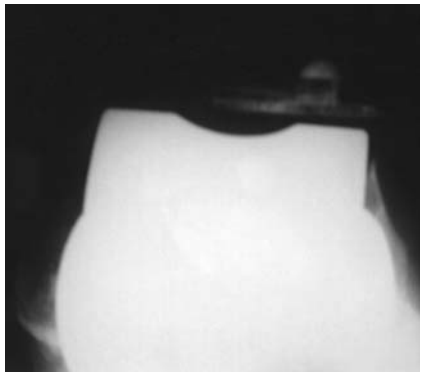

Fig. 2c

Radiographs showing a) anteroposterior (AP), b) lateral and c) skyline views of the Accord TKA. There is a loose, extended femoral component, patellar maltracking and patella baja. Osteolysis is present in the lateral femoral condyle with a 'crescent sign' on the AP view.

Anatomic Modular Knee (AMK-DePuy, Warsaw, Indiana). The Co-Ordinate prosthesis (DePuy) was used for revision surgery until 1999 and the Co-Ordinate Ultra prosthesis (DePuy) thereafter. The latter had screw-on stems as opposed to the taper-fit stems of the Co-Ordinate prosthesis.

All the patients were interviewed and completed the SF-12 and WOMAC questionnaires before and at six and 12 months after operation.

The SF-12 generic health status questionnaire is derived from the SF-36 questionnaire.[31] It is used to assess overall health status and measures two components, physical health (physical component summary scale - PCS) and mental health (mental component summary scale - MCS). It is a reliable and validated outcome measure.

The disease-specific WOMAC questionnaire is also a reliable and validated outcome measure. It was developed to assess outcomes in studies of osteoarthritis of the hip and knee[32,33] and consists of three areas: pain (five items), stiffness (two items) and function (17 items). The total score is obtained by summating the individual scores, but the individual scores allow assessment of changes in the separate variables. The responses were entered into a database. The SF-12 PCS and MCS health summary scales were calculated using the SF-12 interpretation manual[34] and changes in the WOMAC score were determined.

Statistical analysis. We used the SPSS statistical software package (SSPS Inc, Chicago, Illinois). For between-group comparisons (primary *versus* revision TKA) a two-way hierarchical repeated measures analysis of variance (ANOVA) was performed and for within-group comparisons (primary and revision separately) a simple repeated-measures ANOVA. Only if the results of the latter were significant were paired *t*-tests performed to compare pairs of times using a Bonferroni *post-hoc* adjustment to the p value to avoid spurious results. Since the changes in the mean scores from before operation to 6 and to 12 months after operation are of interest, a two-way hierarchical repeated-measures ANOVA was used for between-group comparisons. The within-group comparisons of the change in score either preoperative to 6 months or preoperative to 12 months were evaluated using a paired *t*-test.

Preliminary analysis of the data showed that the mean scores and changes in scores over time had a normal distribution. A p value < 0.05 was taken to be significant.

Results

WOMAC scores. Table I gives the mean scores and the mean changes in scores with 95% confidence intervals. There was no significant difference in the preoperative score between the two groups using an unpaired *t*-test (pain, p = 0.697; stiffness, p = 0.978; function, p = 0.779).

Two-way hierarchical repeated-measures ANOVA of the mean scores showed that they were significantly different over time in both groups (p < 0.001). When applied to the change in score there was no significant difference in the magnitude of the changes in pain, stiffness and function scores between the preoperative and 6-month and between the preoperative and 12-month assessments (ANOVA F values for pain change = 0.029, p = 0.864; for stiffness change = 1.543, p = 0.216; for function change = 0.764, p = 0.383). Comparison between the two groups showed that the revision patients had significantly higher pain and

Table I. Mean scores with mean changes in score, 95% confidence intervals and *post-hoc* adjusted Bonferroni *t*-test results of pairs of times after simple repeated-measures ANOVA

	Primary		Revision	
	Mean (95% CI)	**p value***	**Mean (95% CI)**	**p value***
Pain				
Preop	16.3 (15.7 to 16.8)		16.2 (15.3 to 17.2)	
6 mths	7.8 (7.1 to 8.6)		9.2 (8.2 to 10.2)	
12 mths	6.7 (6.1 to 7.4)		10.2 (9.2 to 11.1)	
Change preop to 6 mths	-8.5 (-9.4 to -7.4)	< 0.001	-7.0 (-8.2 to -5.9)	< 0.001
Change 6 to 12 mths	-1.1 (-2.1 to -0.2)	0.026	1.0 (-0.3 to 2.2)	0.117
Change preop to 12 mths	-9.6 (-10.4 to -8.7)	< 0.001	-6.0 (-7.5 to -4.6)	< 0.001
Stiffness				
Preop	6.4 (6.0 to 6.7)		6.5 (5.9 to 7.0)	
6 mths	4.0 (3.7 to 4.4)		4.6 (4.2 to 5.0)	
12 mths	3.6 (3.3 to 3.9)		4.5 (4.1 to 4.9)	
Change preop to 6 mths	-2.4 (-2.8 to -1.9)	<0.001	-1.9 (-2.6 to -1.2)	< 0.001
Change 6 to 12 mths	-0.4 (-0.9 to 0.1)	0.139	-0.1 (-0.7 to 0.5)	0.69
Change preop to 12 mths	-2.8 (-3.3 to -2.2)	< 0.001	-2.0 (-2.7 to -1.3)	< 0.001
Function				
Preop	53.7 (51.4 to 56.0)		53.2 (49.8 to 56.5)	
6 mths	29.9 (27.2 to 32.7)		34.0 (30.9 to 37.1)	
12 mths	24.7 (22.6 to 26.8)		37.0 (33.8 to 40.3)	
Change preop to 6 mths	-23.8 (-26.7 to -20.7)	< 0.001	-19.2 (-23.6 to -14.7)	< 0.001
Change 6 to 12 mths	-5.2 (-8.5 to -2.0)	0.002	3.0 (-0.9 to 6.8)	0.124
Change preop to 12 mths	-29.0 (-31.9 to -26.0)	< 0.001	-16.2 (-21.5 to -10.8)	< 0.001
PCS				
Preop	34.3 (32.5 to 36.1)		29.7 (27.5 to 31.9)	
6 mths	40.8 (39.0 to 42.6)		36.7 (33.9 to 39.4)	
12 mths	41.1 (38.6 to 43.7)		34.9 (31.8 to 37.9)	
Change preop to 6 mths	6.5 (4.5 to 8.6)	<0.001	7.0 (3.6 to 10.3)	0.001
Change 6 to 12 mths	0.3 (-2.8 to 3.5)	0.838	-1.8 (-5.3 to 1.7)	0.313
Change preop to 12 mths	6.8 (3.8 to 9.9)	< 0.001	5.2 (1.4 to 8.9)	0.009
MCS				
Preop	52.2 (49.9 to 54.6)		52.7 (49.7 to 55.7)	
6 mths	52.1 (50.1 to 54.0)		54.4 (52.0 to 56.7)	
12 mths	53.3 (51.4 to 55.2)		52.8 (50.3 to 55.4)	
Change preop to 6 mths	-0.1 (-3.2 to 2.8)		1.7 (-2.5 to 5.8)	
Change 6 to 12 mths	1.2 (-1.4 to 3.8)		-1.6 (-5.3 to 2.2)	
Change preop to 12 mths	1.1 (-1.9 to 4.1)		0.1 (-3.3 to 3.3)	

**post-hoc* Bonferroni *t*-test

function scores ($p < 0.001$) but not stiffness scores ($p = 0.168$). The improvements in the pain, stiffness and function scores over time were statistically significant in both groups (ANOVA F values for primary pain = 545.6, stiffness = 112.9, function = 376.8, $p < 0.001$; for revision pain = 69.8, stiffness = 35.7, function = 36.7, $p < 0.001$).

In the primary group, only pain and function scores improved significantly between 6 and 12 months ($p = 0.026$ and $p = 0.002$, respectively). There was no significant improvement in any of the scores in the revision group between 6 and 12 months. The changes in pain and function scores in the primary group were significantly greater than those in the revision group between 6 and 12 months (pain $F = 20.160$, $p = 0.009$ and function $F = 20.714$, $p < 0.001$).

Comparison of the magnitude of the changes in scores from the preoperative to the 6-month assessment, using unpaired *t*-tests, revealed no significant differences between the two groups (pain $p = 0.056$, stiffness $p = 0.208$, function $p = 0.079$). Comparison of the changes in scores within the two groups using paired *t*-tests showed that the magnitude of change in pain, stiffness and function scores was greater in the preoperative to 6-month period than in the 6- to 12-month period (Table II).

SF-12 scores

PCS. Table I gives the mean scores and the mean changes in scores with 95% confidence intervals. Two-way hierarchical repeated-measures ANOVA of the scores showed that they were significantly different over time in both groups ($p < 0.001$) but not between groups ($p = 0.618$). The preoperative PCS score was significantly higher in the primary group than in the revision group using an unpaired *t*-test ($p = 0.012$). In both groups there were statistically significant improvements in the PCS score with time on analysis by a simple repeated-measures ANOVA (primary $F = 19.6$, $p < 0.001$, revision $F = 7.4$, $p = 0.008$). Bonferroni *post-hoc* adjusted *t*-tests on pairs of times showed significant changes between the preoperative and 6-month assessment (primary $p < 0.001$, revision $p < 0.001$) and the preoperative and 12-month assessment (primary $p < 0.001$, revision $p < 0.001$). There was no significant change in score in either group between 6 and 12 months (primary $p = 0.838$, revision $p = 0.313$).

Two-way hierarchical repeated-measures ANOVA of the changes in score between the preoperative and 6-month and preoperative and 12-month assessments for the between-group comparisons showed that there was no significant difference in the size of the changes in the PCS score between primary and revision patients ($F = 0.467$, $p = 0.495$) or between the preoperative and 6-month and preoperative and 12-month assessments ($F = 0.354$, $p = 0.553$). Comparison of the size of the changes in score from the preoperative to 6-month assessment, using unpaired *t*-tests, showed no significant differences between the two groups of patients ($p = 0.817$).

Comparison of the changes in scores within the two groups using paired *t*-tests showed that the size of the change in score is greater in the preoperative to 6-month period than in the 6- to 12-month period (primary $p = 0.006$ and revision $p = 0.004$) (Table II).

MCS. Analysis of the MCS scores using a two-way hierarchical repeated-measures ANOVA showed no significant difference between the two groups ($p = 0.489$) or with time ($p = 0.79$).

Table II. Results of paired *t*-test for comparison of changes of score within groups between the preoperative and 6-month assessment and the 6- and 12-month assessment with mean differences in change between the time periods, 95% confidence intervals and t values

	Primary	Revision
Pain change		
t value	8.9	8.4
p value	< 0.001	< 0.001
Mean difference	-7.4	-8.0
95% CI	-8.9 to -5.7	-9.9 to -6.1
Stiffness change		
t value	5.1	-3.3
p value	< 0.001	0.002
Mean difference	-2.0	-1.8
95% CI	-2.8 to -1.2	-2.9 to -0.7
Function change		
t value	-6.6	-6.9
p value	< 0.001	< 0.001
Mean difference	-18.6	-22.2
95% CI	-23.9 to -12.9	-28.5 to -15.8
PCS change		
t value	2.8	3.0
p value	0.006	0.004
Mean difference	6.2	8.8
95% CI	1.8 to 10.5	2.9 to 14.5
MCS change		
t value	-0.6	0.9
p value	0.556	0.370
Mean difference	-1.3	3.3
95% CI	-6.1 to 3.3	-3.9 to 10.4

Discussion

Revision TKA is a technically difficult procedure. Exposure can be difficult because of stiffness and adhesions. In addition, there is often instability due to ligamentous laxity and the bone stock may be poor. The results of revision surgery have not matched those of primary TKA.[1-30] Our aim in this prospective study was to evaluate the results of revision TKA performed by one surgeon, using one prosthesis and compare them with those in a group of primary TKA patients operated on by the same surgeon using one prosthesis during the same time period. The revision TKAs were performed for failure of the primary Accord implant which was locally popular but not successful in terms of design and survivorship.

There have been many studies which have determined the effectiveness of TKA in reducing pain and deformity and improving function.[35-41] Most have assessed outcomes using standardised knee scoring systems such as the Hospital for Special Surgery (HSS) score or The

Knee Society score (KSS).[38,41-47] These have not been validated and are surgeon-specific. They have poor internal reliability and small effect sizes and are therefore not good for assessing outcomes in TKA.[48] This casts doubt on the validity of the results of these studies. Several papers have specifically considered the outcomes in elderly patients.[42,49,50]

The outcome measures which we have used (SF-12 and WOMAC) are reliable and validated scoring systems.[31-33,48] To our knowledge, no study has been published which has prospectively assessed patient-perceived outcomes after revision TKA and compared them with primary TKA.

Anderson et al[51] showed a significant correlation between the SF-36 score, the WOMAC pain and function scores and patient satisfaction. Those patients with better WOMAC function scores also had higher SF-36 physical scores, indicating a relationship between improved knee function and improved overall function. The HSS score did not correlate with patient satisfaction. Neither the HSS nor the KSS scores showed any correlation with the WOMAC pain score, the SF-36 bodily pain score or patient satisfaction.

Our findings show no significant difference in the preoperative WOMAC scores between the two groups. The revision patients, however, had worse preoperative PCS scores than the primary patients. This may be due to the fact that they already had had surgery on their knees using an unsuccessful implant.

We have also shown that the improvements in SF-12 PCS and WOMAC pain, stiffness and function scores in primary and revision TKA are highly statistically significant at the six-month assessment. There was no statistically significant difference in the size of the mean improvement from the preoperative to the six-month assessment between the primary and revision patients in SF-12 PCS scores and WOMAC pain, stiffness and function scores. This indicates that in terms of patient-perceived outcome measures, revision TKA leads to as great an improvement as does primary TKA. Both groups of patients showed a statistically significant improvement in WOMAC pain, stiffness and function scores and SF-12 PCS scores between the preoperative and 12-month assessments. There was no significant change in SF-12 MCS scores in either group over this period of time.

There was no significant change in SF-12 PCS scores in either group between 6 and 12 months. This indicated that the patients had reached an 'end-stage' in recovery of generic physical health status at six months. However, in the WOMAC pain and function areas, the primary patients continue to improve up to 12 months, whereas the revision patients did not improve significantly between the 6- and 12-month assessments.

The perception among knee surgeons is that a TKA will continue to improve up to 12 months after surgery. We have shown that this is true of the primary patients in terms of pain and function but not of revision patients. There is, however, continued improvement in stiffness scores in the revision patients, but this was not statistically significant. This is not the case in terms of the SF-12 generic health measure, as both groups attain maximum improvements at six months after surgery. This may be because the WOMAC outcome measure is designed to be maximally sensitive in patients with knee symptoms as a result of osteoarthritis, whereas the SF-12 is intended to address a wide range of health problems and is therefore less specific.[52] The mental scores of patients in both groups showed no statistically significant improvement after the operation. Also, there was no statistically significant difference in the mental scores before and after operation between the primary and revision groups. Thus, the commonly held perception that mental state and sense of well-being are improved after TKA is not true. This may be because patients' poor preoperative mental state reflects their type of personality rather than their physical problems. We aim to perform further research into this area by attempting to identify a correlation between high preoperative SF-12 mental scores and high postoperative SF-12 physical scores.

We conclude that revision TKA leads to a comparable improvement in both generic health outcome measures and disease-specific outcome measures as does primary TKA.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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