Unicompartmental or total knee replacement

THE 15-YEAR RESULTS OF A PROSPECTIVE RANDOMISED CONTROLLED TRIAL

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Between 1989 and 1992 we had 102 knees suitable for unicompartmental knee replacement (UKR). They were randomised to receive either a St Georg Sled UKR or a Kinematic modular total knee replacement (TKR). The early results demonstrated that the UKR group had less complications and more rapid rehabilitation than the TKR group. At five years there were an equal number of failures in the two groups but the UKR group had more excellent results and a greater range of movement.

The cases were reviewed by a research nurse at 8, 10 and 12 years after operation. We report the outcome at 15 years follow-up. A total of 43 patients (45 knees) died with their prosthetic knees intact. Throughout the review period the Bristol knee scores of the UKR group have been better and at 15 years 15 (71.4%) of the surviving UKRs and 10 (52.6%) of the surviving TKRs had achieved an excellent score. The 15 years survivorship rate based on revision or failure for any reason was 24 (89.8%) for UKR and 19 (78.7%) for TKR. During the 15 years of the review four UKRs and six TKRs failed.

The better early results with UKR are maintained at 15 years with no greater failure rate. The median Bristol knee score of the UKR group was 91.1 at five years and 92 at 15 years, suggesting little functional deterioration in either the prosthesis or the remainder of the joint. These results justify the increased use of UKR.

In the United Kingdom and North America, unicompartmental knee replacement (UKR) has increased in popularity in recent years.¹ Many authors have shown good long-term survivorship following UKR as well as better kinematics²⁻⁴ and function.⁵⁻⁸ However, some surgeons still regard UKR as a temporary procedure^{9,10} and believe that patients over 60 years of age are best treated with a total knee replacement (TKR), since they regard failure as less likely despite the greater magnitude of the procedure. Between 1989 and 1992, a prospective, randomised controlled trial of UKR or TKR in patients suitable for UKR was undertaken in Bristol in an attempt to establish whether UKR has benefits comparable with TKR, and to define whether there is a greater failure rate. The five-year results of this study were published in 1998¹¹ and showed advantages for UKR in respect of speed of rehabilitation, range of movement and the percentage of cases achieving an excellent result. The failure rates were the same. We now report the outcome of this trial after a minimum of 15 years follow-up.

Patients and Methods

Between July 1989 and December 1992, 94 patients (102 knees) agreed to participate in the trial. After obtaining ethical approval the patients were randomised, using random number tables, to undergo either a UKR or a TKR. The patients were well matched for age with a predominance of females and with mainly varus deformity of the knee (Table I). The final decision for inclusion in the trial was made after arthrotomy had been performed and it had been confirmed that the knee fulfilled the appropriate criteria (Table II). In the UKR group, 46 knees had a medial UKR and four a lateral procedure. Bilateral operations were performed on 12 patients, three of whom had a bilateral UKR, five had bilateral TKRs and four had either a UKR or TKR.

The surgery was performed by both senior authors (JN, CA) and a variety of trainees. The prosthesis used was either a St Georg Sled UKR (Waldemar Link, Hamburg, Germany) or a posterior-cruciate-preserving Kinematic Modular TKR (Howmedica, Rutherford, New Jersey). The patella was resurfaced in all the

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Table I. Demographic details of the patients (n = 94) in the two groups

	UKR*	TKR†
Number of knees	52	50
Mean age in yrs (range)	69.6 (53 to 89)	69.8 (47 to 85)
Gender (number of patients)		
Men	18	21
Women	29	26
Pre-operative deformity (number of knees)		
Varus	48	44
Valgus	4	6
Pre-operative Bristol knee score (range)	54.7 (37 to 75)	57.2 (31 to 76)
Pre-operative range of movement (°)	101 (80 to 130)	102 (75 to 120)

* UKR, unicompartmental knee replacement

† TKR, total knee replacement

Table II. Criteria for inclusion of patients in the trial

Unicompartmental tibiofemoral osteoarthritis with 'normal' other compartments
Intact cruciate ligaments
Flexion deformity $\leq 15^\circ$
Varus/valgus deformity $\leq 15^\circ$

TKRs. In both groups all components were fixed using Palacos cement (Schering Plough Ltd, Welwyn Garden City, United Kingdom) with gentamicin.

After review at five years the patients were subsequently reviewed at 8, 10, 12 and 15 years in dedicated clinics by a research nurse and by the senior author (JN) using the Bristol knee score.¹¹ Standard weight-bearing anteroposterior (AP), lateral and skyline radiographs were taken. Radiographs were assessed to monitor the signs of loosening based on the Knee Society roentgenographic evaluation system.¹² There were seven patients in the UKR and two in the TKR group who were too elderly and infirm to attend the clinic and who were assessed by postal questionnaire or in their nursing home by one of the authors (RVP) to determine whether the original implant was still surviving.

The knee replacement was considered to be a failure when the Bristol knee score was < 60 (maximum 100) or when there were radiological signs of loosening, which would suggest the need for a revision procedure.

A survivorship analysis was performed using the Kaplan-Meier system with 95% confidence intervals for all knees in both groups. A log rank test was used to identify any significant difference in survival between the groups. Values of $p \leq 0.05$ were regarded as significant. Comparison between variables such as the Bristol knee score, movement scores and functional scores was carried out using a Mann-Whitney U test and a chi-squared test. For analysis we used SPSS Version 14.0 (SPSS Inc., Chicago, Illinois).

Results

By the 15-year review 23 patients (24 UKRs) had died in the UKR group, of whom 20 had a unilateral procedure, one a bilateral and two had a UKR and TKR. In the TKR group, 20 patients (21 TKRs) had died, of whom 17 had a unilateral replacement, one a bilateral and two had a UKR and TKR (Table III). There were 11 (ten patients) of the original group of UKRs and six (four patients) of the TKRs which did not undergo a full clinical and radiological assessment in the hospital, largely because of old age and frailty. However, five of them completed postal questionnaires, eight were seen in their nursing home and two had confirmation of the prosthesis remaining *in situ* from their general practice notes. One patient with a UKR and two patients with a TKR were lost to follow-up. The mean post-operative varus alignment was 2° (2° to 14°).

Failures. We defined failure as either a revision operation or a Bristol knee score < 60 . Four UKRs had failed, three of which were revised (Table III). In two there was progression of arthritis without any signs of loosening (Fig. 1). One underwent revision ten years after the primary procedure and in the other, surgery was deferred because of comorbidities. The third patient with a failed UKR was revised because of recurrent haemarthroses 57 months after the primary procedure. In the fourth patient the tibial component was revised because of aseptic loosening 60 months after the initial operation. This patient remained asymptomatic at the 15-year follow-up.

There were six patients (six TKRs) in the TKR group whose prosthesis failed. Of these, four (four TKRs) under-

Table III. Distribution of unicompartmental (UKR) and total knee replacements (TKR) at five and 15 years

	UKR	TKR
Five years	52	50
Deceased	5	4
Lost to follow-up	1	1
Follow-up available	46	45
15 years		
Deceased	24	21
Failed	4	6
Revised	3	4
Failure (not revised)	1	2
Surviving	24	23
Scored	21	19
Known alive with intact knees	2	2
Lost to follow-up (could not be traced)	1	2

Table IV. Reasons for revision

Reason for revision	UKR*	TKR†
Progression of arthritis	2	4
Polyethylene wear	0	1
Recurrent haemarthroses	1	0
Peri-prosthetic fracture	0	1

* UKR, unicompartmental knee replacement

† TKR, total knee replacement

Table V. Types of revision procedure

Type of revision procedure	UKR*	TKR†
Change of polyethylene only	1	1
Posterior-stabilised TKRs‡	2	1§
TC3 TKR**	0	1§
Hinged TKR prosthesis††	0	1
Failed but not revised	1	2

* UKR, unicompartmental knee replacement

† TKR, total knee replacement

‡ Howmedica, Rutherford, New Jersey

§ thickness of polyethylene inserted during revision surgery ranged from 10 mm to 25 mm

§ stems and augments were used in these TKR revisions

** DePuy Orthopaedics Inc., Warsaw, Indiana

†† Waldemar Link, GmbH & Co. KG, Hamburg, Germany

went revision while in two (two TKRs) operation was not performed because of age and other co-morbidities. The reasons for revision are shown in Table IV. The revisions were performed at five, ten, 11 and 13 years after the primary TKR. Implants used during the revision procedures are shown in Table V.

Outcome. A full clinical and radiological assessment was performed for 13 UKRs (nine patients) and 17 TKRs (13 patients). There were 15 UKRs (71.4%) and ten TKRs (52.6%) with an excellent outcome (Table VI). The median Bristol knee score of the UKR group was 92 (32 to 100) and for the TKR group 87.5 (48 to 98, Mann-Whitney U test;

$p = 0.99$), with the median pain scores being 40 and 35 (15 to 90), respectively. In addition, 21 (78%) of the UKRs in 17 patients had $\geq 120^\circ$ of flexion compared with 19 (38%) in seven patients in the TKR group (Mann-Whitney U test; $p = 0.08$). All the patients underwent the functional assessment of everyday activities. The median Bristol knee scores for the UKR and TKR groups were 21 of 27 and 20 of 27, respectively. The survivorship of the implant in both groups, with revision or a Bristol knee score < 60 as the endpoint (Fig. 2) was 89.8% (95% confidence interval (CI) 74.3 to 100) in the UKR group and 78.7% (95% CI 56.2 to 100) in the TKR group. There was no significant difference in survival between the groups (log-rank test; $p = 0.51$).

Discussion

Numerous studies have shown good results after both UKR and TKR.¹¹⁻¹⁸ Although there has generally been a higher failure rate among unicompartmental groups, UKRs tend to have marginally better function.¹⁹⁻²¹ They are usually performed in patients with less severe disease, who have better ultimate function, but who wear their joints more rapidly. In order to avoid this potential bias, randomisation is needed. To our knowledge ours is the first such study because all patients had been deemed suitable pre-operatively for UKR.

After 15 years follow-up we did not see a higher failure rate in our UKR group. Only three of these patients and four in the TKR group had undergone revision. One further patient in the UKR group and two in the TKR group were recorded as failures because of significant pain. Since this trial started both prostheses have been modified so one might expect improved results with more modern techniques and prosthetic design.

Several series²²⁻²⁵ have reported that UKRs fail because of progression of arthritis in other compartments; this accounted for two of the UKR failures in our study. However, others^{24,26} have shown a slow rate of progression of osteoarthritis, especially following medial UKR, provided the deformity is not overcorrected. In our study the mean post-operative varus alignment was 2° . Generally, progression of arthritis will result in pain before revision of the knee. This was not evident in our patients as the median pain score remained 40 of 40, although some had mild asymptomatic progression (Fig. 3). Throughout the 15-year period of the study the Bristol knee scores for the UKR group remained better than for those with a TKR (Fig. 4). Bremner-Smith, Ewings and Weale²⁷ have shown a fall in Bristol knee scores in a normal ageing population. This has not been seen in our patients. In our series those with lower scores were more likely to undergo revision or die, while those with higher scores tended to survive.

One accepted advantage of UKR has been a greater range of movement. Unfortunately the Bristol knee score, along with other scoring systems introduced in the 1980s, only records a maximum flexion of 120° ; flexion beyond that was then considered impossible to achieve. The early

Table VI. Outcome of unicompartmental (UKR) and total knee replacement (TKR) at 15 years

Outcome	Bristol knee score	UKR (n = 21) (number, %)	TKR (n = 19) (number, %)
Excellent	91 to 100	15 (71.4)	10 (52.6)
Good	81 to 90	1 (4.8)	3 (15.8)
Fair	71 to 80	1 (4.8)	1 (5.2)
Poor	61 to 70	4 (19.0)	5 (26.4)

Fig. 1

A unicompartmental knee replacement with associated progression of arthritis at 15 years. Minimally symptomatic, the implant was satisfactory.

Fig. 2a **Fig. 2b** **Fig. 2c**

Kaplan-Meier survival analysis of a) unicompartmental knee replacement (UKR), b) total knee replacement (TKR) and c) a comparison of UKR with TKR.

results¹¹ from this study demonstrate that a higher percentage of UKRs achieved 120° of flexion, compared with TKR. This was maintained at 15 years follow-up when one might have expected changes in the remainder of the joint to impact adversely and reduce the range of movement.

It has now been recognised^{26,28} that the lateral compartment is anatomically and biomechanically different to the medial and it would have been better to have excluded lateral compartment disease. Nevertheless a fixed bearing UKR will still produce satisfactory long-term results,²⁹ so the four knees with a UKR and the six with a TKR for lateral disease are not likely to affect the overall outcome.

Inevitably, failure will occur and options for revision need to be considered. In both groups, one revision was merely a change of polyethylene insert which was easier in the modular TKR than the cemented all-polyethylene St Georg Sled tibial component. However, the UKRs which underwent conversion to a TKR each received a standard prosthesis whereas two of the three TKRs required a revision design (Table V). Following revision the Bristol knee score was significantly improved to 91 and 87, respectively, in these patients from the UKR and TKR groups.

Our survivorship analysis provides a comparison between UKR and TKR. The survival rate of 89.8% for UKR and 78.7% for TKR is comparable with the rates in other studies,²⁰ with only three of our patients being lost to follow-up. Gill and Josh³⁰ showed survival of TKR to be 92.6% at 17 years with younger patients faring worse than older ones. We did not see this in our cohort of patients.

Undoubtedly, the outcome of both UKR and TKR has improved in the last 15 years and many series have published results, which are better than ours.^{17,18,21-23,30-32}

However, this study has demonstrated that, in a randomised group of patients with unicompartmental disease, the results for UKR are as good as those for TKR and show no greater tendency to fail for at least 15 years.

Fig. 3

Anteroposterior and lateral radiographs showing 15-year follow-up of a unicompartmental knee replacement with no signs of loosening and only minimal evidence of polyethylene wear or progression of arthritis.

Fig. 4

Bristol knee scores for unicompartmental and (UKR) total knee replacements (TKR) pre-operatively and at eight months, two years, five years, ten and 15 years after operation.

The Australian joint registry³³ has shown that the risk of revision for UKR is affected by age, an effect which differs between men and women, while the cumulative percentage revised decreases with increasing age. Of those patients aged under 55 years at the time of their primary procedure, the cumulative percentage revised was 13.3% compared with 5.6% for patients aged over 75 years. This was also dependent upon the type of prosthesis and type of bearing used, and was similar to an earlier study by Pandit et al,³¹ although their patients were aged 65 years or over and the bearings used were fixed. These results may not apply to younger patients but confirm that the lesser procedure of UKR can be performed in this age group with a higher expectation of rapid recovery, excellent function and long-lasting result.

Supplementary material

A further opinion by Mr R. Allum is available with the electronic version of this article on our website at www.jbjs.org.uk

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