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Patient preferences in knee prostheses

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A total of 344 patients underwent bilateral total knee replacement (TKR) using a different prosthesis on each side. Four knee prostheses were used: anterior and posterior cruciate-retaining (ACL-PCL), posterior cruciate-retaining (PCL), medial or lateral pivot (MLP), and posterior cruciate-substituting (PS).

All patients had good or excellent results. The range of movement, relief from pain, alignment, and stability did not vary among any of the prostheses.

Forty-one of 46 patients (89%) preferred the ACL-PCL to the PS knee and 27 of 35 patients (77%) the MLP knee to the PS knee. Of the patients with an ACL-PCL knee on one side and a MLP on the other, an equal number preferred each type. The MLP knee was preferred to the PCL by 34 (79%) patients. PS and PCL knees were preferred equally. Patients with bilateral TKRs preferred retention of both their cruciate ligaments or substitution with a medial or lateral pivot prosthesis.

Total knee replacement (TKR) using any of the available knee prostheses is a reliable procedure for the relief of pain and to increase function in patients with arthritis. Patients may have preferences as to the type of knee prosthesis which they receive[1] and surgeons certainly have preferences for different designs.

Most differences in knee prostheses revolve around issues of integrity and balance in the cruciate ligaments.[2] Implants which allow preservation of the anterior and posterior cruciate (ACL, PCL) ligaments are the most dependent on soft-tissue balance. The most popular prostheses, however, have been the posterior cruciate-substituting (PS) implant which calls for the excision of both cruciate ligaments and that which retains only the PCL. PS is done either with a central post or a symmetrical deep dished tibial polyethylene insert.[3-6] The PCL implant is usually called a cruciate-retaining prosthesis but in reality the ACL has been sacrificed.

The medial and lateral pivot (MLP) prostheses (Fig. 1) are a new concept.[7] These have an asymmetrical tibial polyethylene component. Anterior and posterior translation is limited in either the medial or lateral compartment. Translation in the other compartment is unrestricted. These implants are therefore ultracongruent in one compartment and not in the other.[7] All of the above prostheses assume that the polyethylene tibial tray and femoral components are fixed.

Fig. 1

Image of the medial pivot total knee prosthesis.

In this study bilateral knee replacements were performed using a different prosthesis on each side. The patients were questioned and examined to determine their preference. A comparison of the results in the same patient eliminated any variability introduced by differences in age, weight, gender, comorbidities, quality of bone, and level of activity.

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Table I. Details of the number of knees, age of patients and function scores

Prosthesis	Number of knees	Mean age (yrs)	Mean pre-operative knee score	Mean pre-operative function score
ACL	201	66	38.6	41.9
MLP	142	67	40.3	46.1
PCL	199	71	47.9	44.7
PS	146	70	45.8	47.8
Total	688			

Table II. Details of patients excluded from follow-up

	Results			
Prosthesis	Poor	Fair	Lost to follow-up	Total excluded
ACL-PCL	4	4	7	15
MLP	1	1	6	8
PCL	3	2	5	10
PS	4	2	6	12
Total	12	9	24	45

Patients and Methods

Beginning in June 1987 all patients who underwent bilateral staged primary TKRs were offered enrolment into this prospective study which was randomised with two exceptions. The MLP prosthesis was not used until 1999. Also, if there was no functional ACL another randomised prosthesis was used. The study protocol was approved by the Institutional Review Board of the author's institution and each patient provided written informed consent. The patients served as their own controls. One surgeon (JWP) performed all the operations.

The inclusion criteria for the study were age 45 to 89 years, English speaking or access to an interpreter and a primary diagnosis of osteoarthritis. The primary exclusion criteria were a history of patellectomy, high tibial osteotomy or previous septic arthritis. In addition, patients with flexion of less than 90°, flexion contracture of 20° or greater, valgus deformity greater than 15°, or varus deformity of greater than 20° were excluded as were those with a unicompartmental, bicompartmental, mobile-bearing, or a fixed or rotating hinge prosthesis.

Patients requiring bilateral knee replacement received one type of prosthesis in one knee and another type in the other. The four types of prosthesis used were as follows: 1) the ACL-PCL prosthesis (Biopro Inc, Port Huron, Michigan and Wright Medical Technology, Arlington, Tennessee); 2) the MLP prosthesis (Encore Orthopaedics, Austin, Texas and Wright Medical Technology); 3) the PCL prosthesis (Biomet, Warsaw, Indiana; Biopro; Depuy, Warsaw, Indiana; Howmedica, Rutherford, New Jersey; Wright Medical and Zimmer, Warsaw, Indiana) and 4) the PS prosthesis (Biomet, Depuy, Howmedica, Wright Medical and Zimmer).

In all patients, implantation of the prosthesis involved cementing the components and resurfacing the patella with a polyethylene button. The same technique was used for each TKR including the balancing of ligaments, the use of guides, and the handling and exposure of tissues. Each patient received the same post-operative care.

A total of 389 patients received bilateral TKRs. The mean follow-up was seven years (2 to 14). The mean interval between TKRs was two years (0.5 to 6). The 344 patients available for analysis were primarily women (241/344; 70%) and they had a mean age of 68 years (45 to 89) (Table I). The mean pre-operative Knee Society[8] clinical score was 43.

Clinical and radiological follow-up studies were done at six weeks, three months and one year after the operations and yearly thereafter. All the clinical data were recorded by physicians not involved in the care of the patient and who had no knowledge of the type of prosthesis used. Follow-up ratings according to the Knee Society score[8] were obtained for all patients. Patients were excluded if they had follow-up of less than two years of if they had a fair or poor result in one of their knees (Table II). All the patients in this study therefore had an excellent or good result.

Statistical analysis. The Kruskal-Wallis non-parametric test was used and the statistical power estimation gave values from 0.86 to 0.99. All the intergroup comparisons had significant power to detect a large size effect. A four-point difference was detected by the analysis used and may be clinically important.

Results

Radiologically, all the implants appeared to be soundly fixed. There were no progressive radiolucent lines at the cement-bone or prosthesis-cement interfaces. Post-operative alignment was between 0° and 7° of valgus. All the patients had a tibial polyethylene thickness of between 10 and 14 mm.

Table III. Results of knee replacement in all groups

Prosthesis	Mean range of movement (°)	Mean follow-up (yrs)	Mean post-operative knee score	Mean knee function score
ACL	119	8.3	92.6	76.7
PCL	119	9.2	89.8	71.3
MLP	121	4.0	93.2	75.2
PS	111	6.6	91.7	74.1

Table IV. Patient preferences (%) regarding their knee replacement when asked 'Which is your better knee overall?'

	ACL	MLP	PCL	PS	Can't tell
ACL *vs* PCL	*73*	-	*19*	-	*8*
ACL *vs* MLP	*48*	-	*48*	-	*3*
ACL *vs* PS	*89*	-	-	*4.3*	*6.5*
MLP *vs* PCL	-	*79*	*11*	-	*11*
MLP *vs* PS	-	*77*	-	*9*	*14*
PCL *vs* PS	-	-	*43*	*43*	*13*

Fig. 2

An anteroposterior radiograph of a 46-year-old woman six years after the insertion of an ACL-PCL prosthesis in her left knee and a medial pivot prosthesis in her right knee.

The mean total post-operative Knee Society clinical score was 91.8 (Table III).[8] The mean range of movement (117.5°) did not vary significantly between type of knee prosthesis used (Table III), neither was there a significant difference in the mean pain score, knee score or functional score between the types of knee prosthesis. There was no difference in preference for the right over the left knee.

There were 201 patients in three groups which received the ACL-PCL implant: ACL-PCL *vs* PCL implant (91 patients), ACL *vs* PS implant (46 patients) and ACL-PCL *vs* MLP implant (64 patients). In the ACL-PCL *vs* PCL group seven patients did not express a preference, 17 (18.7%) felt the PCL implant was better and 67 (73.6%) that the ACL-PCL was better (Table IV). Two of 46 (4.3%) patients preferred the PS to the ACL-PCL implant and three (6.5%) could not tell the difference.

There were 142 patients in the comparison group which received the MLP implant: the MLP *vs* ACL-PCL group (63 patients), the MLP *vs* the PS group (35 patients) and the MLP *vs* the PCL group (44 patients). Three of the 35 patients preferred the PS knee to the MLP knee (Table IV). Five of 44 patients preferred the PCL to the MLP knee. Five patients each could not tell the difference between the MLP and PS or PCL. Of those with the MLP on one side and the ACL-PCL on the other, an equal number preferred each type (Fig. 2). Two of the 63 patients could not tell the difference between their knees.

There were 64 patients in the comparison group which received a PCL prosthesis on one side and a PS on the other. An equal number preferred each prosthesis but 9 (14%) could not tell the difference between their knees.

Patients gave the following reasons for their preference for one knee over the other: 1) felt more normal; 2) was stronger on stairs; 3) felt more stable; 4) have fewer 'clunks', 'pops' or clicks; 5) did not know.

Discussion

It is clear from this study that patients often have a preference for one prosthesis over another, but the reasons are not obvious. Differences in proprioception, subjective sense of stability, sagittal plane kinematics, or in the femoral radius of curvature are among the possibilities. In simplest terms, knee prostheses may be divided into anatomical or functional designs. ACL-PCL and some PCL prostheses try to simulate normal anatomy while PS, MLP and many PCL knees aim for improved function without retaining or re-creating normal anatomy and are therefore functional designs.

The purpose of this study was to provide information only on patients' preference. No attempt was made to make conclusions about loosening or wear of the implant or other variables. It is certainly possible for a patient to prefer a knee which may fail earlier than another design. More congruent knees such as the medial and lateral pivot prostheses could reduce polyethylene contact stresses and increase the longevity of the implant, but the information on follow-up of this implant is too limited to comment on ultimate rates of failure.

The post-operative knee scores in this study were higher than those usually reported because the fair and poor results were excluded. This was necessary so that a poor result on one side would not be compared with a good result on the other.

Clinical results with various techniques of handling of the PCL have shown no clear advantage for retaining the PCL or substituting it with a PS prosthesis.[2-5] The results of both techniques are excellent in most series. This was true even in bilateral paired series. Despite the enthusiasm of innovators such as Cloutier[9] and Townley,[10] the ACL-PCL

knee has been studied much less often, but the results are excellent or good in most cases.

In osteoarthritis a viable ACL is not always present.[9] Also, the retained tibial eminence may break off so that extreme attention to detail when inserting the tibial prosthesis is required. The advantage of the ACL-PCL implant is improved performance which has been documented by studies on gait analyses during walking and climbing.[11,12] Only patients with retained cruciate ligaments have nearly normal kinematics.[12,13]

In vivo fluoroscopic analysis has emerged as a valuable technique for evaluating knee prostheses.[13-15] With this technique it was found that ACL-PCL knees, like normal knees, had limited anterior and posterior translation but did remain posterior to the mid-sagittal plane in all positions.[13,14] The tibial component of the PCL prosthesis was significantly posterior with respect to the femur in extension, demonstrated anterior translation with flexion and had exaggerated medial condylar translation on deep knee flexion.

Posterior stabilised knees remained stable in the mid-sagittal area through the positions in which the central post was engaged.[13,14] The PCL-retaining knees had the most abnormal kinematics.[14]

In vivo fluoroscopic analysis of the medial pivot prosthesis has shown that the medial femoral condyle remains fully constrained and posterior translation occurs in the lateral compartment as called for by the design.[7] The same is true for lateral pivot knees.[15] In this design the tibial polyethylene in the lateral compartment is ultracongruent and constrains anteroposterior movement with unconstrained rotatory translation allowed in the medial compartment. The knee rotates around a lateral pivot point.[15]

Patients may prefer ACL-PCL prostheses because of superior proprioception. However, just as many prefer the MLP prosthesis which provides a single radius of femoral curvature. Quadriceps power is enhanced, especially in early flexion, by promoting early roll out of the femur. Greater leverage for the extensor mechanism is maintained by preventing anterior slide and shortening of the quadriceps lever arm.[16] This may also improve patellofemoral mechanics by engaging the patella earlier in flexion. Difficulties with patellofemoral articulation has been suggested as a drawback of the PS prosthesis.[17]

Since all the current knee prostheses perform well, paired bilateral studies may be the best way to determine the subtle differences which a patient may experience. The conclusion of this study is that patients with bilateral procedures are more likely to prefer retention of their ACL and PCL or substitution with the medial or lateral pivot prosthesis.

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