PREOPERATIVE FACTORS INFLUENCING THE RANGE OF MOVEMENT AFTER TOTAL KNEE ARTHROPLASTY FOR SEVERE OSTEOARTHRITIS

ALEJANDRO LIZAU, LUIS MARCO, ROMAN CEBRIAN

From the Hospital General, Elda, Spain

We report a prospective study, using multivariate analysis, of the factors which influence the range of movement after total knee arthroplasty in 74 patients with 83 arthroplasties at a mean follow-up of 23.6 months (12 to 41). All the patients had a diagnosis of osteoarthritis, a severely disabled knee with a Knee Society system score of less than 60, varus deformity, no previous surgery to the knee, identical prostheses implanted with a similar surgical technique, and no postoperative complications which may have affected the range of movement.

The most important factors which influenced the range of movement after arthroplasty were the preoperative range of flexion and the body-weight of the patient. There was a significant improvement in flexion and reduction of flexion contracture at each successive review up to 12 months after operation. Patients with restricted movement before operation showed a satisfactory gain at final review.

J Bone Joint Surg [Br] 1997;79-B:626-9.

Received 9 September 1996; Accepted after revision 31 January 1997

After total knee arthroplasty (TKA) at least 90° of knee flexion is necessary for the activities of daily living.¹ There have been few prospective studies on the preoperative factors which may influence the range of movement obtained. Our aim was to evaluate these factors.

PATIENTS AND METHODS

Between January 1992 and December 1994 we performed 197 consecutive primary TKAs. For this study we selected patients with a preoperative diagnosis of osteoarthritis, a

severely disabled knee with a Knee Society system score² of less than 60, varus deformity, and no previous knee surgery. All patients had an identical design of prosthesis (Orthomet Plus; Wright Medical Technology Inc, Arlington, Tennessee), which is a posterior-cruciate-retained total condylar implant. Similar surgical techniques were used, with uncemented fixation, no patellar resurfacing, no correction of the collateral ligaments or of the extensor mechanism, and a minimum follow-up of one year. There were no surgical revisions and no postoperative complications which may have influenced the range of movement of the knee.

The relative weight of each patient was defined by desirable weight tables.³ A body-mass index (BMI)⁴ was calculated and obesity defined as an index of more than 28. The patients were grouped according to Insall et al² as: type A, unilateral with the other knee normal or with a successful replacement; type B, unilateral with the other knee symptomatic; and type C, with multiple joint involvement or medical infirmity. The Knee Society clinical rating system² was used to give a functional evaluation. The function of the patellofemoral joint was assessed by a clinical score.³ The range of movement of the knee was measured with a goniometer.⁵

There were 83 knees in 74 patients, 59 in women and 24 in men. The mean follow-up after operation was 23.6 months (12 to 41) (Table I). Unilateral arthroplasties were performed in 65 patients (27 right and 38 left) and bilateral procedures in 9. The relative weight from tables was normal in 28 cases (34%), mildly obese in 44 (53%), moderate in 8 (9%) and severe in 3 (4%). According to the BMI, 63 patients (76%) were obese. The patient category was Insall type A in 21 (25%), type B in 60 (72%) and type C in 2 (3%).

Table I. Details of the 74 patients

	Mean	Range	sd
Age (yr)	68.3	54 to 80	5.6
Height (cm)	154.3	142 to 178	7.0
Weight (kg)	75.4	55 to 107	12.0
Relative weight (%)	125.4	95 to 184	19.5
Body-mass index (BMI)	31.7	24.0 to 47.9	5.0

A. Lizaur, MD, Head, Orthopaedic Surgery Service
L. Marco, MD, Senior Orthopaedic Surgeon
R. Cebrian, MD, Orthopaedic Surgeon
Servicio Cirugia Ortopedica, Hospital General, 03600 Elda, Spain.

Correspondence should be sent to Dr A. Lizaur.

©1997 British Editorial Society of Bone and Joint Surgery
0301-620X/97/47242 \$2.00

Table II. Preoperative findings in 83 knees

	Mean	Range	SD
Varus (degrees)	5.3	1 to 18	3.0
Flexion (degrees)	93.4	45 to 130	13.2
Flexion contracture (degrees)	8.8	0 to 45	9.3
Extension lag (degrees)	6.2	0 to 30	7.6
Knee score	16.9	0 to 60	10.9
Function score	30.5	0 to 85	20.1

All patients were examined clinically and radiologically before the operation and at 3, 6, and 12 months and annually thereafter. They had standard physiotherapy before and after operation which included continuous passive motion exercise from six hours after surgery and active exercises after 48 hours.

Statistical analysis. We carried out statistical analysis using the SPSS software package. Categorical variables were analysed by the chi-squared test or Fisher's exact test where appropriate. For comparisons between paired groups we used the Student's *t*-test and the Wilcoxon test, between unpaired groups the Student's *t*-test and the Mann-Whitney U test, and between more than two independent groups the analysis of variance and the Kruskal-Wallis H-test. Correlation between continuous data was tested with the Pearson and Spearman coefficients. To determine the interactions of the other variables with a satisfactory outcome of flexion to 90° or more and extension to 0° we used multiple logistic regression analysis. A *p* value of less than 0.05 was considered significant.

RESULTS

Table II gives the preoperative findings. Patellofemoral function was graded as 0 in two knees, I in six and II in 75 (90%).

The range of flexion before operation was significantly greater in men than in women (*p* = 0.038). There was a significant correlation between the preoperative flexion, the relative weight (*r* = 0.24, *p* = 0.028) and the BMI (*r* = 0.24, *p* = 0.030). There was also a significant relationship between preoperative flexion contracture, the relative weight (*r* = 0.21, *p* = 0.050) and the BMI (*r* = 0.22, *p* = 0.042), but not gender (*p* = 0.81). Both preoperative flexion (*r* = 0.22, *p* = 0.038) and flexion contracture (*r* = -0.66, *p* < 0.001) were significantly associated with the preoperative knee score, but not with the functional score

Table III. Findings at the time of the latest follow-up in 83 knees

	Mean	Range	SD
Time to mobilisation (days)	2.0	1 to 6	1.0
Time to weight-bearing (days)	5.9	1 to 17	3.1
Hospital stay (days)	10.0	2 to 50	6.3
Femorotibial angle (degrees)	4.6	-6 to 15	3.6
Flexion (degrees)	99.6	20 to 130	18.8
External contracture (degrees)	0.6	0 to 10	2.3
Extension lag (degrees)	0.2	0 to 10	0.9
Knee score	83.9	38 to 100	14.8
Function score	89.8	40 to 100	13.0

(*p* = 0.77 and 0.059, respectively) or patellofemoral function (*p* = 0.26 and 0.90).

Table III gives the findings at the time of the latest follow-up. After operation the femorotibial angle was between 6° of varus and 15° of valgus. Fifty-three knees (64%) had a postoperative patellofemoral function of grade 0, 16 (19%) of grade I and 14 (17%) of grade II.

At the latest review a significant correlation was found between flexion, the relative weight (*r* = 0.21, *p* = 0.050) and the BMI (*r* = 0.25, *p* = 0.023), but not between the flexion contracture (loss of extension) and these measurements (*p* = 0.74 and 0.83, respectively). Both the final flexion and the flexion contracture were not significantly associated with age (*p* = 0.48 and 0.66, respectively), gender (0.41 and 0.22), the affected side (0.26 and 0.48), the patient's category (0.08 and 0.31), the time of mobilisation (0.51 and 0.78), the time of weight-bearing (0.90 and 0.84), hospital stay (0.33 and 0.35), the preoperative (0.30 and 0.16) or postoperative femorotibial angle (0.22 and 0.31) or preoperative (0.34 and 0.86) or postoperative patellofemoral function (0.90 and 0.93). The amount of both flexion and flexion contracture was associated with the final knee score (*p* < 0.001). The final knee functional score was associated with the flexion contracture (*r* = -0.22, *p* = 0.040), but not with flexion (*p* = 0.79).

The amount of flexion at the latest follow-up was significantly associated with the preoperative range of flexion (*p* = 0.002), but not with preoperative flexion contracture (*p* = 0.59). Final flexion of more than 90° was found in 91.3% of knees with a minimum of 90° of flexion before operation, but in only 71.4% of those with an initial flexion of less than 90° (*p* = 0.040). No significant correlation was found between the amount of flexion contracture at the latest follow-up and that before operation (*p* = 0.93) or with

Table IV. Changes in the range of movement (mean ± SD) after operation

Follow-up (mth)	Number of knees	Flexion (degrees)	<i>p</i> value*	Flexion contracture (degrees)	<i>p</i> value*
3	83	85.6 ± 16.9	0.001	4.5 ± 7.7	0.001
6	83	93.1 ± 19.3	0.001	1.7 ± 3.8	0.001
12	83	97.0 ± 17.3	0.003	0.9 ± 3.2	0.006
24	54	100.4 ± 21.6	0.052	0.6 ± 1.9	0.159
>24	33	99.6 ± 18.8	0.182	0.6 ± 2.3	0.322

* between successive follow-ups

Table V. Mean (SD) range of movement (degrees; range) at the latest follow-up compared with before operation

	Preoperative flexion		Preoperative flexion contracture	
	<90°	>90°	0°	>0°
Final flexion	88.0 ± 27.0 (20 to 120)	103.1 ± 15.8 (45 to 130)	97.4 ± 19.1 (45 to 130)	101.9 ± 19.0 (20 to 130)
Final flexion contracture	0.6 ± 2.6 (0 to 10)	0.6 ± 9.7 (0 to 10)	0.68 ± 2.5 (0 to 10)	0.6 ± 2.2 (0 to 10)

preoperative flexion ($p = 0.30$). Using logistic regression analysis we found that only the BMI ($r = -0.30$, $p = -0.030$) and the preoperative flexion ($r = -0.42$, $p = 0.020$) had a significant effect on the final range of flexion.

Table IV gives the changes in postoperative movement with time. There was a significant difference for both flexion ($p = 0.0016$) and flexion contracture ($p < 0.001$) at the time of the latest follow-up compared with before operation. There was a significant increase in flexion and a decrease in flexion contracture at each successive review up to 12 months but not between then and two years, or more.

The range of movement at the latest follow-up compared with that before operation is shown in Table V. There was a significant increase in flexion and decrease in flexion contracture in both knees which had had a preoperative flexion of less than 90° and in those of more than 90° ($p < 0.001$).

DISCUSSION

The mean preoperative range of movement was 84.6° with flexion of 93.4° and a flexion contracture of 8.8°. At the latest follow-up these were 99°, 99.6° and 0.6°, results which are similar to those reported in other studies.⁶⁻⁸

We found significant increases in flexion and decreases in flexion contracture at each successive postoperative review up to 12 months. This has been shown in other studies with longer follow-up. Rorabeck et al⁷ found no significant difference in the range of movement between one and four years after operation, Insall et al⁹ between one and five years, Shoji et al¹⁰ up to nine years, and Malkani et al⁶ up to ten years. Schurman, Parker and Ornstein¹¹ concluded that studies of factors influencing the range of movement should not require follow-up for more than one year.

In our patients, all of whom had osteoarthritis, we have found an increase in flexion and a decrease in flexion contracture both in the first postoperative year and at the latest follow-up. Several authors¹¹⁻¹³ have reported no differences in postoperative movement between rheumatoid and osteoarthritic knees, while others^{5,14} described worse results in osteoarthritis with a range of flexion at one year worse than before the operation.

In our patients those with poor flexion before operation improved more than those with better movement, as has been observed by others.^{11,12,15} Yoshino et al¹³ noted that knees with a good range of movement before operation had a similar range of movement after this, and vice versa,

whereas Harvey et al⁵ observed that less mobile knees gained movement, but the more mobile lost mobility. Ritter and Stringer¹⁴ found that patients with preoperative flexion of less than 75° had little improvement at one year.

We found that the degree of flexion contracture did not influence that found after, but stiffer knees gained more movement than lax joints. Aglietti et al¹⁶ in a study of 20 stiff knees found a significant decrease in flexion contracture from 28° to 7°, and increase in flexion from 60° to 85° at seven years, and Mullen¹⁷ in 13 ankylosed knees noted a decrease in flexion contracture from 16° to zero and in flexion from 48° to 103°.

Some believe that the final extension does not differ significantly from that obtained at operation and that improvement should be gained at the time of surgery by soft-tissue release or increased bone resection. We found that flexion contracture continued to decrease up to one year after operation, and Tanzer and Miller¹⁸ reported similar results. Schurman et al¹¹ noted that the knee extension improved for up to one year but that significant gain had occurred between the time of operation and discharge from hospital. All their patients, however, had to attain a minimum of 75° of flexion before discharge.

We have found no difference between monoarticular and biarticular arthritis.¹¹ We agree with Ritter and Stringer¹⁴ that the age and gender of the patient have no influence on postoperative movement. Other authors have found that other factors such as prosthesis design,^{12,16} previous tibial osteotomy,^{19,20} collateral ligament release,²¹ preoperative condition of the cruciate ligaments¹⁰ or patellar replacement⁵ have no influence on the outcome. Shoji et al¹⁰ noted that the most influential factor for good postoperative flexion was intense physiotherapy while Nielsen, Rechnagel and Nielsen²² found no help from the use of continuous passive motion. We found that the body-weight of the patient had a significant influence on both the preoperative and the final flexion, but Stern³ noted no influence of the body-weight on the functional results after TKA.

Conclusions. The preoperative range of movement and the body-weight were the most influential factors determining flexion after operation. There was a continued gain in flexion and loss of flexion contracture up to one year. Patients with the stiffest knees had the greatest improvement in movement.

We wish to acknowledge the assistance of Dr Marco Lopez Cerda, Professor of Statistics at the University of Alicante, with the analysis of the results.

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.

REFERENCES

1. Insall J, Scott WN, Ranawat CS. The total condylar knee prosthesis: a report of two hundred and twenty cases. *J Bone Joint Surg [Am]* 1979;61-A:173-80.
2. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. *Clin Orthop* 1989;248:13-4.
3. Stern SH, Insall JN. Total knee arthroplasty in obese patients. *J Bone Joint Surg [Am]* 1990;72-A:1400-4.
4. Kristensen O, Nafei A, Kjaersgaard-Andersen P, Hvid I, Jensen J. Long-term results of total condylar knee arthroplasty in rheumatoid arthritis. *J Bone Joint Surg [Br]* 1992;74-B:803-6.
5. Harvey IA, Barry K, Kirby SPJ, Johnson M, Elloy MA. Factors affecting the range of movement of total knee arthroplasty. *J Bone Joint Surg [Br]* 1993;75-B:950-5.
6. Malkani AL, Rand JA, Bryan RS, Wallrichs SL. Total knee arthroplasty with the Kinematic Condylar prosthesis: a ten-year follow-up study. *J Bone Joint Surg [Am]* 1995;77-A:423-31.
7. Rorabeck CH, Bourne RB, Lewis PL, Nott L. The Miller-Galante knee prosthesis for the treatment of osteoarthritis: a comparison of the results of partial fixation with cement and fixation without any cement. *J Bone Joint Surg [Am]* 1993;75-A:402-8.
8. Stockley I, Douglas DL, Elson RA. Bicondylar St Geor sledge knee arthroplasty. *Clin Orthop* 1990;255:228-34.
9. Insall JN, Hood RW, Flawn LB, Sullivan DJ. The total condylar knee prosthesis in gonarthrosis: a five to nine-year follow-up of the first one hundred consecutive replacements. *J Bone Joint Surg [Am]* 1983;65-A:619-28.
10. Shoji H, Solomonow M, Yoshino S, D'Ambrosia R, Dabezies E. Factors affecting postoperative flexion in total knee arthroplasty. *Orthopedics* 1990;13:643-9.
11. Schurman DJ, Parker JN, Ornstein D. Total condylar knee replacement: a study of factors influencing range of motion as late as two years after arthroplasty. *J Bone Joint Surg [Am]* 1985;67-A:1006-14.
12. Tew M, Forster IW, Wallace WA. Effect of total knee arthroplasty on maximal flexion. *Clin Orthop* 1989;247:168-74.
13. Yoshino S, Shoji H, Komagamine M. Full flexion after total knee replacement in rheumatoid arthritis. *Int Orthop* 1990;14:13-6.
14. Ritter MA, Stringer EA. Predictive range of motion after total knee replacement. *Clin Orthop* 1979;143:115-9.
15. Skolnick MD, Bryan RS, Peterson LFA, Combs JJ Jr, Ilstrup DM. Polycentric total knee arthroplasty: two-year follow-up study. *J Bone Joint Surg [Am]* 1976;58-A:743-8.
16. Aglietti P, Windsor RE, Buzzi R, Insall JN. Arthroplasty for the stiff or ankylosed knee. *J Arthroplasty* 1989;4:1-5.
17. Mullen JO. Range of motion following total knee arthroplasty in ankylosed joints. *Clin Orthop* 1983;179:200-3.
18. Tanzer M, Miller J. The natural history of flexion contracture in total knee arthroplasty: a prospective study. *Clin Orthop* 1989;248:129-34.
19. Amendola A, Rorabeck CH, Bourne RB, Apyan PM. Total knee arthroplasty following high tibial osteotomy for osteoarthritis. *J Arthroplasty* 1989;4:suppl:S11-7.
20. Katz MM, Hungerford DS, Krackow KA, Lennox DW. Results of total knee arthroplasty after failed proximal tibial osteotomy for osteoarthritis. *J Bone Joint Surg [Am]* 1987;69-A:225-33.
21. Edwards E, Miller J, Chan K-H. The effect of postoperative collateral ligament laxity in total knee arthroplasty. *Clin Orthop* 1988;236:44-51.
22. Nielsen PT, Rechnagel K, Nielsen SE. No effect of continuous passive motion after arthroplasty of the knee. *Acta Orthop Scand* 1988; 59:580-1.