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The Classic

Total Condylar Knee Replacement in Patients Who Have Rheumatoid Arthritis. A Ten-Year Follow-Up Study*†

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Abstract Eighty knee replacements with a total condylar prosthesis in patients who had rheumatoid arthritis were followed for ten years. At ten years, nineteen knees needed revision and sixty-one prostheses were still functioning. The major reasons for revision were loosening of the tibial component or late bacteremic seeding from another site. Radiolucency at the bone-cement interface adjacent to the tibial component was statistically related to malposition of the tibial component. According to the system of The Hospital for Special Surgery, the mean scores were 64 points preoperatively and 85 points postoperatively. Synovitis recurred in only 3 per cent of the knees. When revision, pain, or radiographic evidence of loosening were considered an indication of failure, the ten-year cumulative survival was 75 per cent.

Introduction

In 1981 [13], I reported on the early results of knee replacement with a total condylar prosthesis in ninety-one patients who had advanced seropositive rheumatoid arthritis. This report presents the results in this group over the ensuing eight years.

Materials and Methods

Between 1975 and 1978, 117 knee replacements were performed in ninety-one patients. The mean age of the patients was fifty-eight years old. Eighty-nine per cent had been taking systemic corticosteroids. Eighty per cent were women. All of the patients had seropositive rheumatoid arthritis, although in one there was the suggestion that the etiology was psoriatic arthropathy.

Of the original study group, ten patients (thirteen involved knees) died from causes unrelated to the knee arthroplasty, and twenty patients (twenty-four involved knees) were lost to follow-up. Of the sixty-one patients who were seen ten years after the operation, seventeen patients (nineteen knees) had needed additional operative treatment and forty-four patients (sixty-one knees) still had a functioning prosthesis.

The basic operative technique has been described previously' [9, 12, 14]. The patients were evaluated clinically and radiographically before the operation; six weeks, three months, and one year postoperatively; and yearly thereafter. The clinical data were summarized with use of the rating system of The Hospital for Special Surgery [9]. Posteroanterior, lateral, and patellar skyline radiographs were made

routinely. The over-all alignment of the extremity, as well as the orientation of the femoral and tibial components to the respective bones, was documented at each radiographic evaluation. The presence or absence of radiolucent lines was evaluated with the system of the Knee Society [2]. The statistical analysis was performed with the Student t test.

The diagnosis of loosening of a component was made on the basis of three radiographic criteria: (1) a global radiolucent line, more than one millimeter thick, about the entire bone-cement interface; (2) a progressing radiolucent line, more than one millimeter thick, in any one zone; or (3) gross subsidence or shift of the component.

Results

For the sixty-one knees that were not revised, The Hospital for Special Surgery score averaged 64 points preoperatively, 84 points two years postoperatively, and 85 points ten years postoperatively (Fig. 1A and B). The number of knees that were included in each of the categories, both preoperatively and ten years postoperatively, is shown in Table 1.

Preoperatively, the alignment between the anatomical axes of the femur and tibia (the femorotibial angle) was normal (between 3 and 10 degrees of valgus angulation) in six knees. Nine knees were in 0 to 3 degrees of valgus angulation and forty-four knees, in less than 0 degrees of valgus angulation; all of those fifty-three knees were considered to be in functional varus angulation. In only two knees was the femorotibial valgus angulation more than 10 degrees.

On the first postoperative radiographs, forty tibial components were seen to be in normal alignment. Nineteen tibial components were in functional varus angulation: fourteen of them were in 0 to 3 degrees of valgus angulation and five, in less than 0 degrees of valgus angulation.

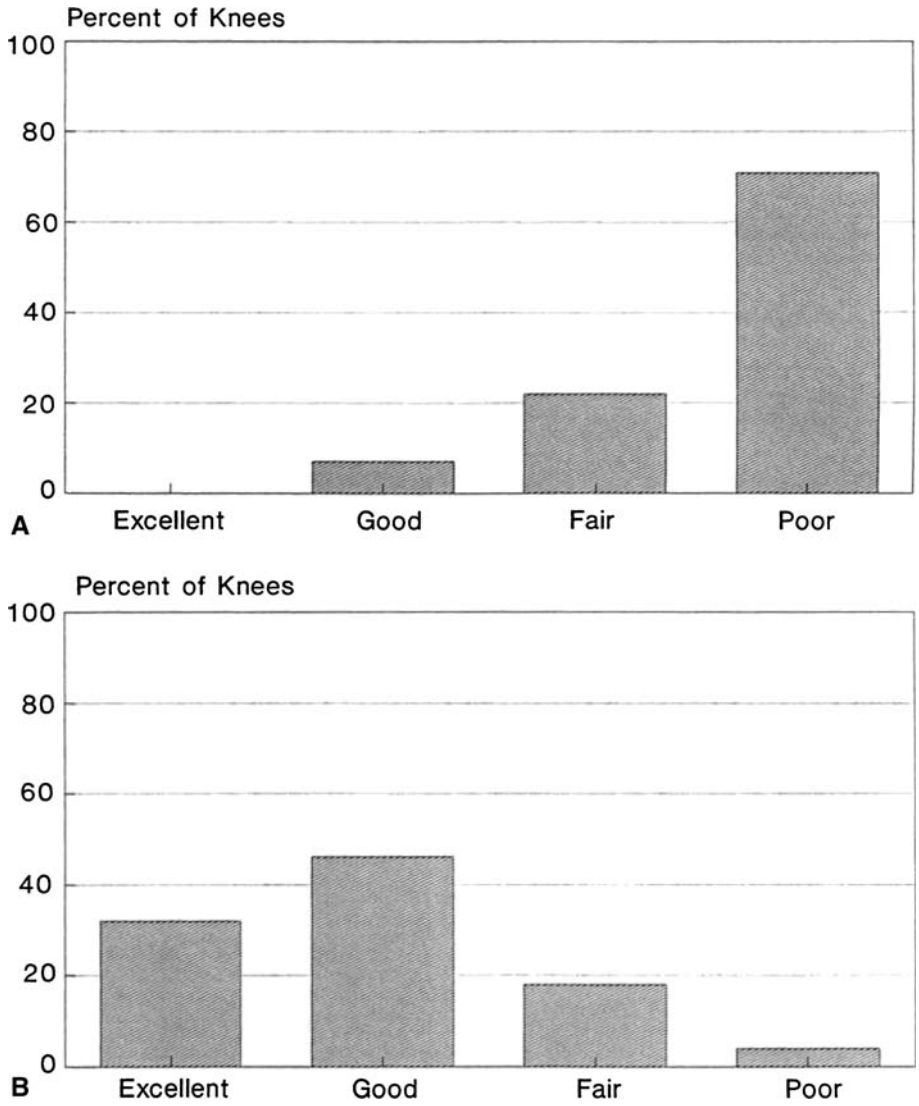

Fig. 1A–B The scores according to the rating system of The Hospital for Special Surgery. An excellent score is 85 to 100 points; good, 75 to 84 points; fair, 65 to 74 points; and poor, less than 65 points. (**A**) Preoperative scores. (**B**) Scores ten years postoperatively.

Table 1. Ratings according to the system of the hospital for special surgery.

	No. of knees	
	Preop.	Postop.
Pain when walking		
None	0	48
Mild	1	12
Moderate	17	1
Severe	43	0
Pain at rest		
None	6	58
Mild	10	3
Moderate	13	0
Severe	32	0
Walking distance		
Unlimited	0	18
6–10 blocks	5	28
1–5 blocks	27	12
< 1 block	26	3
Cannot walk	3	0
Stair-climbing		
Normal	11	13
With support	50	48
Transfer		
Normal	10	19
With support	51	42
Mean range of motion	87 degrees	96 degrees
Strength of quadriceps		
Grade 5	2	41
Grade 4	52	20
Grade 3 or worse	7	0
Flexion deformity		
None	10	38
5–10 degrees	22	23
11–20 degrees	25	0
> 20 degrees	4	0
Instability		
0–5 degrees	15	35
5–15 degrees	32	26
> 15 degrees	14	0
External support		
None	20	42
One cane or worse	41	19
Extension lag		
< 5 degrees	46	48
5–10 degrees	14	13
> 10 degrees	1	0
Alignment of lower limb		
3 to 10 degrees of valgus	6	40
< 3 degrees of valgus	53	19
> 10 degrees of valgus	2	2

In two knees, the femorotibial valgus angulation was more than 10 degrees.

On the postoperative posteroanterior radiographs, the orientation of the tibial component to the anatomical axis of the tibia was within 3 degrees of the optimum 90 degrees in forty limbs (65 per cent). Nineteen components were in varus malposition and two, in valgus malposition. On the lateral radiographs, the angle between the tibial component and the anatomical axis of the tibia was seen to be within 3 degrees of the optimum 90 degrees in forty-eight limbs. Of the remaining components, approximately half were sloped slightly posteriorly (an angle of more than 93 degrees) and approximately half were sloped slightly anteriorly (an angle of less than 87 degrees).

Postoperatively, there was a strong correlation between varus alignment of the limb and varus malposition of the tibial component ($p < 0.001$).

In fifty-two limbs (85 per cent), the angle between the femoral component and the anatomical axis of the femur was within 3 degrees of the optimum 7 degrees on the posteroanterior radiograph. In thirteen limbs (21 per cent), the angle between the femoral component and the anatomical axis of the femur was between the optimum 87 to 93 degrees on the lateral radiographs. Most of the remaining components were in slight flexion.

At ten years, forty-eight knees (79 per cent) were completely pain-free during walking. Twelve caused mild discomfort, which was well controlled with salicylates. One knee was moderately painful, and the patient used codeine routinely. Of the knees in the patients who had died or were lost to follow-up, all but two knees were completely painfree during walking when the patient was seen last. The remaining two knees were mildly painful. At the ten-year examination, fifty-eight knees caused no pain when the patient was at rest and three caused mild discomfort.

For the sixty-one knees that were not revised, the mean range of motion was 87 degrees preoperatively, 95 degrees after two years, and 96 degrees after ten years. The differences were not significant.

During the ten-year period of follow-up, twelve of the original group of patients had a revision of a loose tibial component. Each of these knees had been painful when the patient bore weight on the limb. In one knee, the symptoms began after the patient fell, although in retrospect it was realized that radiolucency at the bone-cement interface around the tibial component had been progressing for three years. In one patient, the patellar component had loosened as well, and both components were revised.

At the ten-year evaluation, six of the sixty-one knees that had not been revised had a loose tibial component. One patient had a loose patellar component, which had avulsed from the patella within the first few weeks after the

operation. This patient also had a loose tibial component and the only loose femoral component in the series. Despite these findings, the patient declined additional operative treatment of the knee. At eleven years, he continued to function with the original implants.

At ten years, 85 per cent of the tibial components had some radiolucency in one or more zones of the bone-cement interface as seen on the posteroanterior radiographs (Fig. 2). All nineteen tibial components that were in varus angulation had a radiolucent line. Of the forty tibial components that were properly aligned, thirty-three (77 per cent) were associated with a radiolucent line. The difference in the percentages of radiolucent lines associated with properly and improperly aligned tibial components was significant ($p < 0.01$). There was no significant difference in the demographics or preoperative findings between patients who had a properly aligned tibial component and those in whom the tibial component was in varus angulation.

Only three femoral components were associated with any radiolucency at the bone-cement interface. In two knees, a line that was less than one millimeter thick was noted anteriorly. In the third knee, in which the femoral component was loose (as described), a two-millimeter-thick radiolucent line completely surrounded the bone-cement interface.

Radiolucency was seen at the bone-cement interface of every patellar component. However, this line was more than one millimeter wide in only two knees. Only four patellar components were tilted on the patellar skyline radiograph that was made at ten years. In none of these knees was the radiolucent line more than one millimeter wide.

Secondary bacteremic seeding and infection developed in five knees (Table 2), all of which were revised before the ten-year follow-up examination. An initial attempt at débridement, drainage, and six weeks of parenteral antibiotics did not eradicate any of the infections. The implants

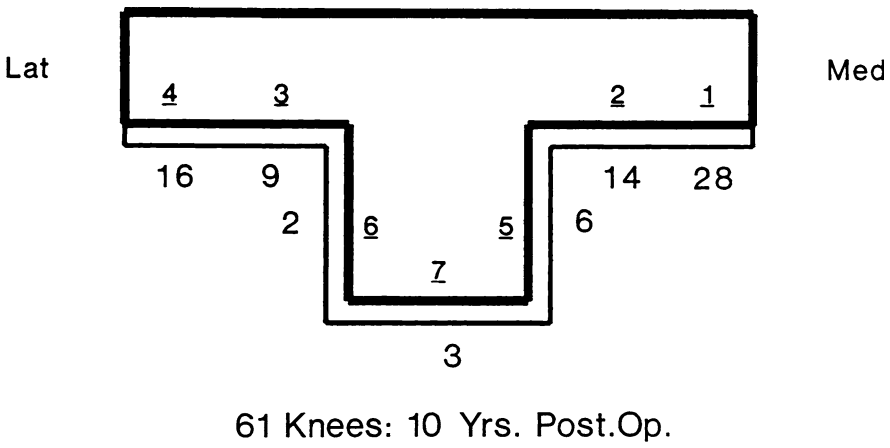

Fig. 2 Distribution of tibial radiolucent lines on posteroanterior radiographs ten years postoperatively. The numbers of the zones (Knee Society rating system) are noted within the component and the numbers of radiolucent lines, outside the component.

Table 2. Late infections

Case	Sex, Age (yrs.)	Time to infection postop. (yrs.)	Type of infection	Treatment	Result
1	M, 63	3	*E. coli* secondary to acute cholecystitis	Implants removed, compression arthrodesis attempted	Pseudarthrosis, 20° of painless motion
2	F, 61	6	Pseudomonas secondary to acute diverticulitis	Implants removed, compression arthrodesis attempted	Pseudarthrosis, 100° of slightly painful motion
3	F, 51	6.5	*S. aureus,* etiology unknown	Implants removed, compression arthrodesis attempted	Eventual fibrous ankylosis with no pain
4	F, 54	7	Streptococcus secondary to gingival infection	High-dose penicillin, initial resolution; recurrence; implants removed, compression arthrodesis attempted	Successful fusion
5	F, 59	7	Pseudomonas secondary to acute appendicitis with peritonitis	Implants removed, compression arthrodesis attempted	Pseudarthrosis, 15° of painless motion

were removed from all five knees and a compression arthrodesis was attempted. It was successful in only one knee.

Nine knees had moderate anterior-posterior instability when they were flexed 90 degrees. This instability was unrelated to the development of synovitis preoperatively or postoperatively and to the range of motion postoperatively. Varus-valgus instability in full extension was found in ten knees at the two-year evaluation and in fifteen knees at the ten-year evaluation. In none of these knees was the instability more than 5 to 10 degrees.

Fragmentation was seen in four patellae. In each, an extensive lateral release had been performed at the time of the replacement operation. None of these patients complained of pain in the anterior part of the knee.

One patient had a supracondylar fracture of the femur four years after the initial arthroplasty. In retrospect, it was realized that the anterior part of the cortex had been notched during the operation. The fracture was not displaced, and it healed while the limb was in a brace. At the most recent follow-up examination, there was no evidence of loosening.

Survivorship analysis was performed with the method of Kaplan and Meier. When revision of the arthroplasty was used as the only determinant of failure, the ten-year cumulative survival was 80 per cent (Fig. 3 and Table 3). When the patients who had moderate pain or radiographic evidence of loosening were included with the patients who had a revision, the ten-year cumulative survival was 75 per cent (Fig. 3 and Table 4).

Discussion

Since 1983, there have been several retrospective studies on the use of the total condylar prosthesis in patients who have rheumatoid arthritis or osteoarthrosis [5, 7, 8, 11, 12]. In the present report, only patients who had rheumatoid arthritis were evaluated, after treatment with a specific operative protocol that was devised in 1975. To my knowledge, the present study included the longest followup of patients who had rheumatoid arthritis and were all treated with the same prosthesis.

During the time that this prosthesis was implanted (1975 to 1977), only one size of femoral component was available. The component had two condylar surfaces and a broad trochlear facet for articulation with an all-polyethylene, symmetrical patellar button. Two tibial components were available; they had the same anterior-posterior and medial-lateral dimensions but different thicknesses (7.5 and fifteen millimeters). Consequently, complete coverage of the surface of the resected tibial plateau, which is now

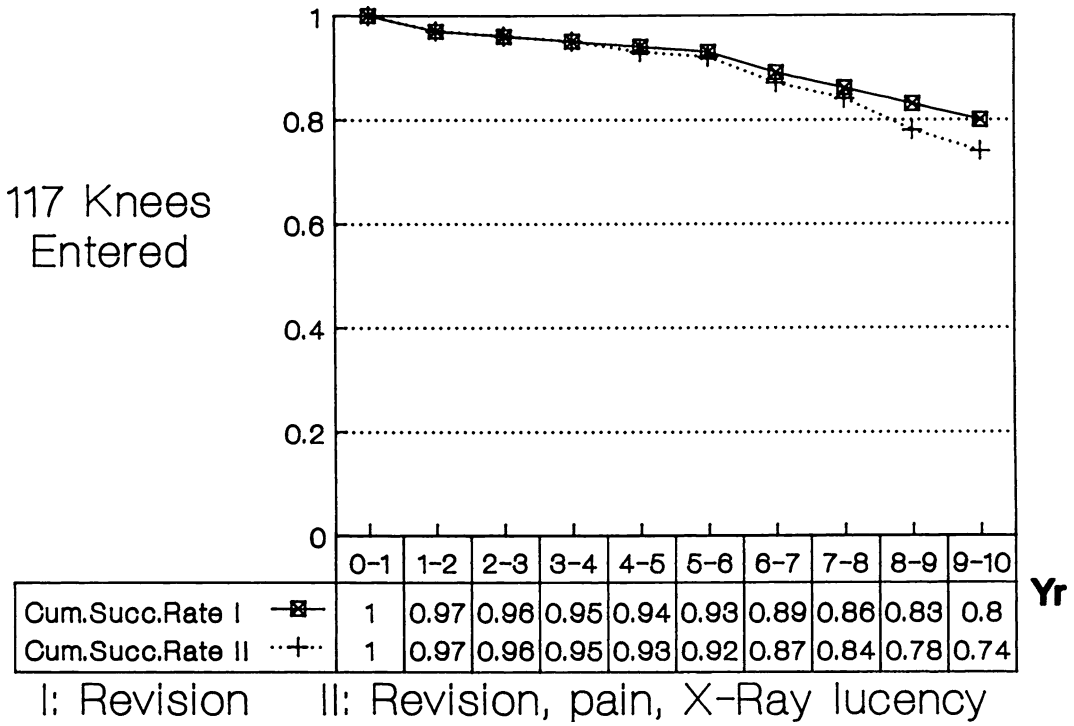

Fig. 3 Survivorship curve. The solid line shows the curve that was derived when revision was the only indication of failure; the cumulative success rate was 80 per cent. The dotted line shows the curve that was derived when revision, radiographic evidence of a loose component, or recurrence of pain was considered evidence of failure; the cumulative survival was 75 per cent.

Table 3. Survivorship analysis for revision*

Time postop. (yrs.)	Total No. of knees	No. lost to follow-up	No. of deaths	No. revised	Weighted No. at risk†	Probability of failure	Probability of success	Cumulative survival
0–1	117	0	0	3	117	0.025	0.974	1.000
1–2	114	0	0	1	114	0.008	0.991	0.974
2–3	113	2	1	1	112	0.009	0.991	0.966
3–4	109	3	1	2	107	0.019	0.981	0.957
4–5	103	6	2	1	99	0.010	0.990	0.939
5–6	94	4	2	3	91	0.033	0.967	0.930
6–7	85	4	2	3	82	0.037	0.963	0.899
7–8	76	3	3	3	73	0.041	0.959	0.866
8–9	67	1	1	2	66	0.030	0.970	0.830
9–10	63	1	1	0	62	0.000	1.00	0.806

* Failure was considered to have occurred when an arthroplasty had to be revised.

† Calculated as the total number of knees minus one-half of the sum of the number of knees lost to follow-up and the number of knees of patients who died.

Table 4. Survivorship analysis for revision, pain, or radiolucency*

Time postop. (yrs.)	Total No. of knees	No. lost to follow-up	No. of deaths	No. revised	Other failure	Weighted No. at risk†	Probability of failure	Probability of success	Cumulative survival
0–1	117	0	0	3		117	0.025	0.974	1.000
1–2	114	0	0	1		114	0.008	0.991	0.974
2–3	113	2	1	1		112	0.009	0.991	0.966
3–4	109	3	1	2	1	107	0.028	0.972	0.957
4–5	102	6	2	1		98	0.010	0.990	0.930
5–6	93	4	2	3	1	90	0.044	0.956	0.920
6–7	85	4	2	3		80	0.038	0.962	0.879
7–8	74	3	3	3	2	71	0.070	0.930	0.846
8–9	63	1	1	2	1	62	0.048	0.952	0.787
9–10	58	1	1	0		57	0.000	1.00	0.749

* Failure was considered to have occurred when the arthroplasty had to be revised or did not have to be revised but was more than mildly painful, or when there was radiographic evidence of a loose component.

† Calculated as the total number of knees minus one-half of the sum of the number of knees lost to follow-up and the number of knees of patients who died.

advocated, was not possible in most of the patients in this series.

The instruments that were used for placement and alignment of the prosthesis were primitive. They did not affix to the bones, and no provision was made for restoring the joint line to its proper height. Furthermore, the guide for cutting the femur from anterior to posterior did not use the anterior part of the femoral cortex as a reference point. Consequently, notching of the femoral cortex was common. All of the implants were affixed by finger-packing doughy polymethylmethacrylate onto the surfaces of the cancellous bone.

Relief of pain was well maintained for the ten years of the study. Ten of the twelve patients who needed salicylates for occasional pain had had this same level of discomfort since two years postoperatively. In only two patients had there been a deterioration from a rating of no pain two years postoperatively. Range of motion was also well maintained over the decade. The difference between the mean range of motion at two and ten years was not significant ($p > 0.1$). More importantly, the range of flexion differed by more than 10 degrees between the second and tenth-year measurements in only four knees. In two of these knees, flexion decreased (by 15 degrees in one and by 10 degrees in the other); in the other two knees, it increased (by 15 degrees in each).

The tibial articular surface of the implant was cupshaped and was oriented in an anteroposterior direction. Consequently, tibiofemoral roll-back was not possible, and posterior impingement often occurred at about 95 degrees

of flexion. In two knees for which the range of flexion was more than 120 degrees, posterior impingement resulted from opening of the joint anteriorly and subluxation of the femoral component posteriorly on the lip of the tibial component.

Although 95 per cent of the knees had been affected by recurrent synovitis preoperatively, and a synovectomy had not been performed at the operation, the synovitis recurred in only three knees over the ten-year period. The immune response that causes recurrence of synovitis can be controlled by removing all of the articular cartilage. Extensive synovectomy, with its attendant problem of stiffness of the joint, is unnecessary.

Lotke and Ecker showed that varus positioning of the tibial component is associated with a high incidence of loosening of the tibial component. Tew and Waugh found that properly aligned tibial components are the most successful, but proper alignment alone does not guarantee long-term success. Varus malposition of the component usually means that the medial line of resection was distal to the optimum level. This results in seating of the component on weak trabecular bone, and it ultimately may lead to radiolucency that indicates compressive failure.

On the basis of a study of rheumatoid knees, Hvid et al. thought that varus malposition of the tibial component might increase the incidence and extent of radiolucent lines at the bone-cement interface, but they could not prove this assertion. They did not attempt to correlate combined varus position of the limb and varus position of the tibial component with radiographic loosening. In the present series, almost every tibial component that was in a varus position also had a varus femorotibial axis of the entire limb. The findings of this study therefore must be related to this combined malposition. Varus positioning of the tibial component was correlated ($p < 0.01$) with radiolucency at the bone-cement interface, especially in zones 1, 2, and 4.

Placement of the tibial component so that the posterior aspect is higher than the anterior portion (that is, lateral alignment of the component of more than 90 degrees) narrows the flexion space and, of itself, can decrease flexion. Although eight tibial components were inserted in this malposition, there was no significant difference between the flexion in that group and the flexion in the remaining knees. However, the maximum malposition was only 7 degrees.

The paucity of radiolucent lines at the bone-cement interface can possibly be attributed to the osseous stabilization of the femoral component by five contact surfaces (anterior, posterior, two chamfer, and distal surfaces) as well as by the configuration of the intercondylar "box" of the femoral component. One of the femoral components that was not associated with radiolucency at the bone-cement interface had a posterior flange that extended proximally beyond the bone of the femoral condyle. This may have had a toggling effect on the femoral component as the patient rose from the seated position, and it may have caused the radiolucency [18].

When anterior-posterior instability was absent after the operation, it meant that the flexion space had been filled during the operation. With only two thicknesses of tibial component available, it could be expected that some knees would have had such instability at the time of follow-up, as, indeed, did nine knees in the current series. In only one of the patients, however, was this instability manifested by sensation of instability in the knee. Varus-valgus instability was noted ten years postoperatively in fifteen knees, but only one of these patients described feeling a sensation of unsteadiness when he walked.

Although anterior notching of the femur was alarmingly frequent, there was only one supracondylar fracture. Despite this low incidence, it is crucial that the femoral component not be seated in such a way that the femur is notched anteriorly. When I first reported on this series in 1981, I stated that some in-setting of the femoral component into the femur anteriorly was beneficial, as it would help prevent patellar problems [15]. This concept was wrong; insetting should be assiduously avoided.

Almost all of the patellar components had some evidence of radiolucency at the bone-cement interface. However, the line was more than one millimeter wide in only two knees. Patellar failure was not a problem in this series. In retrospect, it appears that this may have been due to the determined effort to ensure patellar centralization at operation and to the fact that the large trochlear facet on the femoral component facilitated such centralization. This view is substantiated by the fact that patellar tilting was found on only four of the patellar skyline radiographs that were made ten years postoperatively. The incidence of patellar tilting was lower than that reported by Gomes et al., who used a variety of other prostheses. However, the rate of tilting in the present series was equivalent to that reported by Ranawat et al. [17–19], who also used the total condylar prosthesis.

Late bacteremic seeding remains a potential complication for any patient who has a joint replacement. It is especially problematic in patients who have rheumatoid arthritis, many of whom take immunosuppressive medication. The fact that only one arthrodesis resulted in fusion in the patients who had an infection indicates a failure of technique. At the time of the arthrodesis, an external fixator was used with two bicortical pins proximally and distally. I have since learned that fixation in the sagittal plane is equally important, to counter the force of the hamstring and quadriceps muscles. At the Long Island Jewish Medical Center, an anterior unicortical pin is now added on both the femoral and tibial side. In patients who were subsequently

treated at our center, the rate of fusion when this method was followed has approached 85 per cent.

Kaplan-Meier survivorship analysis graphically demonstrates the probability of any technique or procedure not failing at a particular time [1, 10]. However, it is crucial that what constitutes a failure be determined properly. In this series, when revision alone was considered the determinant of failure, the ten-year success rate was 80 per cent. However, when revision, radiographic evidence of a loose component, and recurrence of pain were all used as determinants of failure, the cumulative rate of success was only 75 per cent. I think that the latter evaluation is the more important of the two. The 75 per cent rate of success was slightly less than that described by Ranawat and Boachie-Adjei [18], who evaluated total condylar knee replacements in patients who had rheumatoid arthritis and in those who had osteoarthrosis. In their series, however, revision or radiographic evidence of loosening alone was considered to be the indication of failure. I believe that recurrence of pain must be considered to be a determinant of failure when survivorship of any arthroplasty is discussed.

The total score with The Hospital for Special Surgery system deteriorated somewhat between the two and ten-year follow-up periods. In almost every patient, this was due to deterioration of other areas that were involved by the rheumatoid arthritis rather than to deterioration of the knee itself. This factor was also noted by Goldberg et al., who studied both patients who had osteoarthrosis and those who had rheumatoid arthritis. This is one of the inherent problems of a rating system that does not clearly separate general function from function of an individual joint, especially in a patient in whom several joints are involved. The prospective use of the rating system of the Knee Society should overcome this problem.

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References

1. Dorey, F., and Amstutz, H. C.: Survivorship Analysis in the Evaluation of Joint Replacement. J. Arthroplasty, **1:** 63–69, 1986.
2. Ewald, F. C.; Hsu, H. P.; and Walker, P. S.: Is Kinematic Total Knee Replacement Better than Total Hip Replacement? Orthop. Clin. North America, **20:** 79–88, 1989.
3. Goldberg, V. M.; Figgie, M. P.; Figgie, H. E., III; Heiple, K. G.; Sobel, Mark: Use of a Total Condylar Knee Prosthesis for Treatment of Osteoarthritis and Rheumatoid Arthritis. Long-Term Results. J. Bone and Joint Surg., **70-A:** 802–811, July 1988.
4. Gomes, L. S. M.; Bechtold, J. E.; and Gustilo, R. B.: Patellar Prosthesis Positioning in Total Knee Arthroplasty. A Roentgenographic Study. Clin. Orthop., **236:** 72–81, 1988.
5. Hvid, Ivan; Kjaersgaard-Andersen, Per; Wethelund, J.-O.; and Sneppen, Otto: Knee Arthroplasty in Rheumatoid Arthritis. Four- to Six-Year Follow-up Study. J. Arthroplasty, **2:** 233–239, 1987.
6. Insall, J. N.; and Kelly, Michael: The Total Condylar Prosthesis. Clin. Orthop., **205:** 43–48, 1986.
7. Insall, J.; Scott, W. N.; and Ranawat, C. S.: The Total Condylar Knee Prosthesis. A Report of Two Hundred and Twenty Cases. J. Bone and Joint Surg., **61-A:** 173–180, March 1979.
8. Insall, J. N.; Hoot, R. W.; Flawn, L. B.; and Sullivan, D. J.: The Total Condylar Knee Prosthesis in Gonarthrosis. A Five to Nine-Year Follow-up of the First One Hundred Consecutive Replacements. J. Bone and Joint Surg., **65-A:** 619–628, 1983.
9. Insall, John; Ranawat, C. S.; Scott, W. N.; and Walker, Peter: Total Condylar Knee Replacement. Preliminary Report. Clin. Orthop., **120:** 149–154, 1976.
10. Kaplan, E. L.; and Meier, Paul: Nonparametric Estimation from Incomplete Observations. J. Am. Statist. Assn. **53:** 457–481, 1958.
11. Kjaersgaard-Andersen, P.; Hvid, I.; Wethelund, J. O.; and Sneppen, O.: Total Condylar Knee Arthroplasty in Osteoarthritis. A Four- to Six-Year Follow-up Evaluation of 103 Cases. Clin. Orthop., **238:** 167–173, 1989.
12. Knutson, Kaj; Lindstrand, Anders; and Lidgren, Lars: Survival of Knee Arthroplasties. A Nation-Wide Multicentre Investigation of 8000 Cases. J. Bone and Joint Surg., **68-B(5):** 795–803, 1986.
13. Laskin, R. S.: Total Condylar Knee Replacement in Rheumatoid Arthritis. A Review of One Hundred and Seventeen Knees. J. Bone and Joint Surg., **63-A:** 29–35, Jan. 1981.
14. Laskin, R. S.: Replacement of the Knee. New York, Springer, 1984.
15. Laskin, R. S.: Total Condylar Knee Replacement in Rheumatoid Arthritis. Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, San Francisco, California, Feb. 24, 1979.
16. Lotke, P. A.; and Ecker, M. L.: Influence of Positioning of Prosthesis in Total Knee Replacement. J. Bone and Joint Surg., **59-A:** 77–79, 1977.
17. Ranawat, C. S.: The Patellofemoral Joint in Total Condylar Knee Arthroplasty. Pros and Cons Based on Five- to Ten-Year Follow-up Observations. Clin. Orthop., **205:** 93–99, 1986.
18. Ranawat, C. S.; and Boachie-Adjei, O.: Survivorship Analysis and Results of Total Condylar Knee Arthroplasty. Eight- to 11-Year Follow-up Period. Clin. Orthop., **226:** 6–13, 1988.
19. Ranawat, C. S.; Rose, H. A.; and Bryan, W. J.: Replacement of the Patellofemoral Joint with the Total Condylar Knee Arthroplasty. Internat. Orthop., **8:** 61–65, 1984.
20. Tew, M.; and Waugh, W.: Estimating the Survival Time of Knee Replacements. J. Bone and Joint Surg., **64-B(5):** 579–582, 1982.