SURVIVORSHIP ANALYSIS OF THE KINEMATIC STABILIZER TOTAL KNEE REPLACEMENT

A 10- TO 14-YEAR FOLLOW-UP

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The Kinematic Stabilizer is a posterior-cruciate-substituting design of total knee replacement. We have reviewed 109 primary total knee replacements in 95 patients at a mean follow-up time of 12.7 years (10 to 14). We used survival analysis with failure defined as revision of the implant. This gave a cumulative survival rate of 95% (95% CI $\pm$ 5%) at ten years and 87% ($\pm$ 10%) at 13 years.

These results from an independent centre confirm the value of an established design of cemented total knee replacement and question the wisdom of the introduction of modifications and new designs without properly controlled trials.

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There are few reports from independent centres of total knee replacement with follow-up longer than ten years and we could find no long-term reports of knee replacement using the Kinematic Stabilizer design. We describe our 10- to 14-year results with this posterior stabilised total knee replacement.

PATIENTS AND METHODS

From 1980 to 1983 inclusive we performed 109 primary total knee replacements on 95 patients, most with rheumatoid arthritis, using the Kinematic Stabilizer prosthesis (Howmedica, Rutherford, New Jersey). In the first year, this

implant was used for all knee replacements performed at this hospital. Subsequently, other types became available and the Kinematic Stabilizer was used only when the posterior cruciate ligament was absent or not functioning. All revisions were excluded from the series. All the operations were performed by the senior author (IMP) using the Universal-1 instrumentation and a standard operating technique. No patellae were resurfaced and all components were cemented.

The Kinematic Stabilizer total knee replacement is a posterior-cruciate-substituting design (Walker 1980) in which a contoured central post on the tibial polyethylene tray engages a housing in the femoral component. The guiding surfaces provide anteroposterior stability from full extension to 30° of flexion. Posterior stability is maintained as flexion proceeds and the surfaces act to guide femoral roll-back (Figs 1 and 2).

Our series included 78 women and 17 men; their average age was 64 years (37 to 86) and 17 were under 55. The primary diagnosis was rheumatoid arthritis in 63, osteoarthritis in 29 and psoriatic arthritis in 3.

All patients were reviewed annually. Those who did not attend at ten years were traced and contacted. Four patients (six knees) were unwilling to attend but provided information over the telephone. Patients were assessed according to the Knee Society clinical rating system (Insall et al 1989), in which points are allocated for pain, range of motion and stability. Deductions are made for flexion contracture, extensor lag and poor coronal alignment. For the function score, points are gained for walking distance and stair-climbing, and deducted for the use of walking-aids. Each score is given out of a possible 100. Radiographs were obtained and assessed according to the Knee Society Radiological Evaluation Form (Ewald 1989).

We performed survival analysis by constructing a life table (Armitage and Berry 1994) and calculating the cumulative survival rate at yearly intervals from the time of operation. Four possible end-points were recorded: survival, revision, death or loss to follow-up. From the adjusted number at risk, the annual success rate and cumulative success rate were calculated. Knees were withdrawn when their length of follow-up was less than the longitudinal length of the study. A survival curve was plotted showing the 95% confidence limits. A second 'worst case' curve (Murray,

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Fig. 1

Fig. 2

Figure 1 – The prosthesis. The intercondylar guiding surfaces provide anteroposterior stability from full extension to 30° flexion.

Figure 2 – As flexion proceeds the guiding surfaces produce posterior rollback of the femoral condyles on the tibial surface.

Carr, and Bulstrode 1993) was plotted by assuming that all knees lost to follow-up had failed.

RESULTS

The mean follow-up was 12.7 years (10 to 14). Four patients (five knees) were lost to follow-up, and 36 patients (40 knees) died before their ten-year review.

At 14 years, 55 arthroplasties were still in place and 48 were available for clinical assessment, of which 34 (71%) were recorded as giving no pain. The mean maximum flexion in the 48 knees was 98° (SD 18°; range 25 to 130), the mean flexion contracture was 1.6° (SD 4°; range 0 to 20) and the mean alignment was 4.8° valgus (SD 2°; range 2° varus to 10° valgus). The mean knee score was 84 (SD 16; range 31 to 100). Thirty-seven patients (77%) were unable to walk more than 0.5 km or were housebound, and 27 (56%) were unable to manage stairs. Only eight (17%) could manage without a walking-aid and 24 (50%) required one stick. The mean function score was 27 (SD 27; range 0 to 90). It should be noted that nearly all the surviving patients had polyarticular rheumatoid arthritis.

Forty-eight knees were assessed radiologically, but due to the lack of fluoroscopic control adequate films with reproducible alignment were obtained for only 32 knees to be scored on the Knee Society Radiological Evaluation Form. On the anteroposterior (AP) and lateral views of the tibial component, 56% showed a radiolucent line in at least one zone on the tibia (Figs 3 and 4). Most radiolucent lines

were under the lateral tibial plateau on the AP view (62%) and under the posterior margin on the lateral view (64%). None of the surviving knees had evidence of implant migration or a complete radiolucent line.

Nine revisions had been performed (Table I), four for gross polyethylene wear, three for loosening with no evidence of wear debris or infection, and one after infection with *Staphylococcus aureus*. One knee was revised after traumatic rupture of the medial collateral ligament.

Survival analysis showed 98% (95% CI $\pm 3\%$) survival at five years, 95% ($\pm 5\%$) at ten years and 87% ($\pm 10\%$) at 13 years (Table II and Fig. 5). We found no significant difference in survival related to age, gender or primary diagnosis. The 'worst case' curve closely follows the original curve (Fig. 6).

Survival analysis using the time of recommendation of revision as the end-point is shown in Figure 7 which again is little different, since all revisions were performed within ten weeks of the decision. One patient died before a recommended revision after 11 years and another was waiting for revision after 13 years. The survival at ten years remains at 95% and falls to 83% at 13 years.

DISCUSSION

The Kinematic Stabilizer total knee replacement uses a central polyethylene post to provide anteroposterior stability and provides good early results. Hanssen and Rand (1988) reviewed 79 arthroplasties in 66 patients at a mean of 37

Fig. 3

Fig. 4

Figure 3 – An example of failure at ten years; the tibial component was easily removed at revision.

Figure 4 – An example of a knee surviving at ten years showing minimal cementing of the tibial component. The patient had no symptoms.

Table I. Details of the nine patients who had revision

Age at primary operation (yr)	Diagnosis*	Time to revision (yr)	Reason for failure	Revision implant
74	OA	2	Trauma	Rotating hinge
67	OA	4	Loosening	Rotating hinge
65	RA	7	Polyethylene wear	Stabilizer
39	RA	9	Loosening	Stabilizer
56	RA	11	Infection	Stabilizer
40	RA	11	Polyethylene wear	Stabilizer
43	RA	11	Polyethylene wear	Stabilizer
69	RA	12	Loosening	Stabilizer
69	OA	13	Polyethylene wear	Rotating hinge

* OA = osteoarthritis; RA = rheumatoid arthritis

Table II. Survival analysis of 109 Kinematic Stabilizer prostheses

Years since operation	Number at start	Failure	Died	Lost	Withdrawn	Adjusted number at risk	Annual failure rate (%)	Annual success rate (%)	Cumulative success rate (%)	95% Confidence limits ($\pm$ %)
0 to 1	109			3		107.5	0.00	100.00	100.00	0
1 to 2	106	1	2			104.5	0.96	99.04	99.04	2
2 to 3	103		5	1		100	0.00	100.00	99.04	2
3 to 4	97	1	7			93	1.08	98.92	97.97	3
4 to 5	89		4			87	0.00	100.00	97.97	3
5 to 6	85		2	1		83.5	0.00	100.00	97.97	3
6 to 7	82	1	4			79.5	1.26	98.74	96.71	4
7 to 8	77		3			75.5	0.00	100.00	96.71	4
8 to 9	74	1	4			71.5	1.40	98.60	95.31	5
9 to 10	69		5			66.5	0.00	100.00	95.31	5
10 to 11	64	3	2			61.5	4.88	95.12	90.43	7
11 to 12	59	1	1		3	58	1.72	98.28	88.71	8
12 to 13	57	1			18	56.5	1.77	98.23	86.94	10
13 to 14	56		1		32	55.5	0.00	100.00	86.94	38

Fig. 5

Survival curve showing the 95% confidence limits.

Fig. 6

'Worst case' survival curve, assuming failure in all knees lost to follow-up.

Fig. 7

Survival curve using the time of recommendation of revision as the end-point.

months (24 to 74). Of these, 53 were revisions. Of the 26 primary replacements there were good or excellent results in 24 by the Hospital for Special Surgery scoring system; only one had required revision.

Our series of 109 Kinematic Stabilizer total knee replacements shows excellent medium-term results with survival of 95% at ten years and 87% at 13 years. Of the 48 assessed in detail at ten years 71% were painfree and the

mean knee score was 84 out of 100. The functional outcomes were not as good, with a mean score of 27, but most of the patients had polyarticular rheumatoid arthritis with multiple joint problems.

The 10- to 15-year survival of a number of cemented total knee replacements has been reported, but the series differ considerably and cannot be compared with any degree of reliability (Table III). All the reports show survival of

Table III. Comparison of 10- to 15-year survival of cemented knee replacements in previous series

Authors	Type of prosthesis	Number of knees	Mean follow-up (yr:range)	Revisions	Knees lost to follow-up (number: %)	Survivorship (%)			95% Confidence limits
						10 years	13 years	15 years	
Scuderi et al (1989)	Total Condylar	224	-	12	-	91		91	No
Scuderi et al (1989)	Posterior Stabilised	289	-	6	-	97			No
Ritter et al (1989)	Kinematic Condylar	394	4.7 (0.75 to 10.9)	6	21 (5)	95			No
Stern and Insall (1992)	Posterior Stabilised	289	- (9 to 12)	14	29 (10)	96	94		No
Ranawat et al (1993)	Total Condylar	112	13.2 (11 to 18)	5	15 (13)	99	97	94	No
Malkani et al (1995)	Kinematic Condylar	168	10 (6.2 to 12.0)	6	2 (1)	96			Yes
Present (1996)	Kinematic Stabilizer	109	12.7 (10 to 14)	9	5 (5)	95	87		Yes

over 90% at ten years, despite the use of early cementing techniques and instrumentation. Our series has a small loss to follow-up, and a 'worst case' survival curve still shows 90% survival up to ten years.

Our results seem to confirm the value of a posterior-cruciate-substituting design of cemented total knee replacement. Many new designs have become available in recent years, but these are unproven. The continued success of earlier models suggests that the early widespread adoption of new designs should be restricted. Long-term, prospective, randomised trials are necessary for the evaluation of new developments in total knee replacement.

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