We performed an independent survivorship analysis on 208 Kinematic Condylar knee replacements with a minimum follow-up of ten years and a mean of 12 years. Seven patients had been lost to follow-up. At ten years the estimated survival was 92% (95% confidence limits 95% and 87%) and when stratified for diagnosis and thickness of polyethylene there was no statistical difference (p > 0.05) in survivorship of knees with osteoarthritis or rheumatoid arthritis.

We conclude that the original design of the Kinematic Condylar knee replacement has a good record and that adequate evaluation of new designs of implant should be undertaken before they are widely introduced.

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The unconstrained condylar prosthesis has become the implant of choice in many centres for the treatment of arthritis of the knee, but there are few long-term independent survivorship studies, especially with a sufficient number of patients with complete follow-up. Our aim was to assess the long-term survivorship of the Kinematic Condylar Total Knee Replacement.

PATIENTS AND METHODS

Between 1981 and 1985 at the Freeman Hospital, Newcastle upon Tyne, we used the Kinematic Condylar Total Knee Replacement (Howmedica, Rutherford, New Jersey; Fig. 1) in 208 consecutive primary total knee arthroplasties in 177 patients. There were 47 men and 130 women with a mean age of 65 years (24 to 92); 31 had bilateral replacements. The diagnoses are shown in Table I.

All the procedures were carried out by the same surgeon (IMP) using the universal instrumentation with a standardised operating technique. The prosthesis allows sparing of the posterior cruciate ligament and has a metal-backed tibial component which is non-modular. The femoral and tibial components were cemented in place with the limb exsanguinated. None of the patellae was resurfaced; optimal tracking was obtained by reducing the patellar size and

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**Table I.** Original diagnosis in a consecutive series of 208 Kinematic Total Knee replacements (177 patients)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Inserted</th>
<th>Percentage</th>
<th>Revised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheumatoid arthritis</td>
<td>133</td>
<td>63.9</td>
<td>15</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>72</td>
<td>34.6</td>
<td>6</td>
</tr>
<tr>
<td>Psoriasis</td>
<td>2</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>PostTB</td>
<td>1</td>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>
removing the marginal osteophytes and by soft-tissue releases.

After the operation the knee was rested in a gutter splint for 48 hours and then mobilised under the supervision of a physiotherapist. Patients were allowed to bear weight as comfortable and discharged when active knee flexion of 90° was obtained.

We performed a standard preoperative assessment which allowed calculation of the Baltimore knee score (Hungerford and Kenna 1983). In patients who had bilateral arthroplasties a separate assessment was made for each knee. An excellent result scored 90 to 100 points, good 80 to 89 points, fair 70 to 79 points, and poor less than 70 points. This scoring system does not depend on the functional integrity of the other joints, which is of particular importance in assessing patients with polyarthropathy. All patients were evaluated clinically and radiologically at yearly intervals.

The mean duration of follow-up was 12 years (10 to 14) during which 44 patients (52 knee replacements) died (none had evidence of failure of the prosthesis) and 7 (3.4%) were lost to follow-up.

We used the actuarial life-table method (Armitage and Berry 1987) for analysis. Survival of the prosthesis, revision, and death or loss to follow-up were recorded at each annual interval for each knee. Calculation of the number at risk for each interval and the survival rates was then performed. We calculated 95% confidence limits by the method of Rothman (1978) as used by Murray, Carr and Bulstrode (1993). The log-rank test was used to assess statistical significance after stratification of the data.

RESULTS
Preoperative evaluation. The mean overall preoperative Baltimore knee score was 39 (5 to 70); for patients with rheumatoid arthritis it was 36 (5 to 70) and for those with osteoarthritis 45 (10 to 70) (Mann-Whitney U test, p = 0.001). For male patients the mean score was 43 and for female patients 36 (Mann-Whitney U test, p = 0.001).

Deformity in either a varus or valgus direction was 16° or more in 63 knees (30%) and 75 knees (36%) had a coronal arc of instability in excess of 15°.

Postoperative complications. There were no perioperative deaths and no clinically detected pulmonary emboli. One patient had an upper gastrointestinal haemorrhage. Two knees required manipulation under anaesthesia to achieve 90° flexion before discharge. There were two cases of superficial infection due to Staphylococcus aureus; they responded to intravenous antibiotics, and there were no long-term problems in either case. One deep infection (Staph. aureus) occurred at seven years and required a two-stage revision.

Revision. This was required in 22 knees (10.6%), in five as...
a result of fractured base plates, in 12 because of polyethyl-
ene wear, and in one for infection. The other reasons for
revision are outlined in Table II. None of the 11 large tibial
components (6 mm) has failed.

The mean time to revision was eight years (6 months to
13 years). The primary diagnosis in knees requiring revi-
sion was rheumatoid arthritis in 15 (68%), osteoarthritis in
six (26%) and psoriasis in one.

The mean preoperative Baltimore knee score in the
revision group was 37. Nine knees (41%) had a varus or
valgus deformity greater than 16° and ten (46%) had an arc
of instability in the coronal plane in excess of 15°.

Survivorship analysis. Actuarial analysis, using recom-
mandation for revision as the endpoint, showed cumulative
estimates of survival of 92% at 10 years (95% confidence
limits (CL) 95% and 87%) and 87% at 12 years (95% CL
91% and 81%) (Table III and Fig. 2).

When stratified for diagnosis the estimate for survival
at ten years of patients with rheumatoid arthritis was
90% (95% CL 94% and 84%) and for those with osteo-
arthritis 95% (95% CL 98% and 87%) (Table IV). There
was no statistical difference in survivorship between the
rheumatoid and osteoarthritic groups (log-rank test,
p = 0.79).

When stratified for polyethylene thickness, there was no
statistical difference in survivorship between 6 mm and
8 mm polyethylene inserts (log-rank test, p = 0.43).

A ‘worst case’ scenario for the patients lost to follow-up,
assuming that they have failed, shows that the survivorship
figures deteriorate by 3%, but the curves remain unchanged
(Fig. 3).

DISCUSSION

The design of the Kinematic Condylar Knee allows sparing
of the posterior cruciate ligament. The results from our
study show a survivorship at ten years of 92% (95% CL
95% and 87%). Malkani et al (1995) reported a survivor-
ship of 96% at ten years for the Kinematic Condylar
prosthesis although not all the knees were assessed in the
same institution. Scuderi et al (1989) reported a ten-year
survivorship of 97% for the posterior stabilised prosthesis,
a posterior-cruciate-sacrificing implant. They also reported
an estimated survival of 90% at ten years for the Total
Condylar prosthesis, but it is not clear how many patients
were lost to follow-up in this study. They suggested that the
modification of the Total Condylar prosthesis to a posterior-
stabilised prosthesis improved the longevity of the knee
replacement. In both of these studies most of the patients
had osteoarthritis whereas in our study there were a large
number with rheumatoid arthritis.

The loss to follow-up is always a problem in survivor-
ship studies. It is never known if the implant remains in
situ or has been revised elsewhere, and the method of
survivorship analysis assumes that those patients who are lost to follow-up are still subject to the same failure rates as the remaining cohort. In our series only seven patients have not been traced. We recommend that all published survivorship studies include a ‘worst-case’ scenario which assumes that all patients lost to follow-up have failed. Using these criteria, the estimated survival for the Kinematic Condylar Total Knee Replacement is 89% at ten years.

Our results appear to be poorer than in previous studies, in particular those of the posterior-stabilised implant. Many of the studies, however, failed to report the number of patients lost to follow-up. This may be an important factor, particularly at long follow-up intervals when the number of surviving patients may be small.

It is clear that the difference in survival between posterior-cruciate-retaining and sacrificing designs is small up to 15 years. Longer follow-up is required, but only a prospective randomised trial will be able to determine clearly the difference in outcome between these two designs. Comparison with the survivorship of the Kinematic Stabilizer

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**Table III.** Survivorship analysis for 208 Kinematic Condylar knee arthroplasties (95% confidence limits according to Rothman (1978))

<table>
<thead>
<tr>
<th>Years since operation</th>
<th>Number at start</th>
<th>Failure</th>
<th>Withdrawn</th>
<th>Lost to follow-up</th>
<th>Died</th>
<th>Number at risk</th>
<th>Annual failure rate (%)</th>
<th>Annual success rate (%)</th>
<th>Survival rate (%)</th>
<th>Confidence limits</th>
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<tr>
<td>0 to 1</td>
<td>208</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<td>0.48</td>
<td>99.5</td>
<td>99.5</td>
<td>100</td>
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<tr>
<td>1 to 2</td>
<td>206</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>203</td>
<td>0.49</td>
<td>99.5</td>
<td>99.0</td>
<td>100</td>
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<td>2 to 3</td>
<td>199</td>
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<td>3</td>
<td>1</td>
<td>2</td>
<td>197.5</td>
<td>0.51</td>
<td>99.5</td>
<td>98.5</td>
<td>99</td>
</tr>
<tr>
<td>3 to 4</td>
<td>195</td>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>194.5</td>
<td>0.00</td>
<td>100.0</td>
<td>98.5</td>
<td>100</td>
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<td>194</td>
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<td>5</td>
<td>4</td>
<td>1</td>
<td>191.5</td>
<td>0.00</td>
<td>100.0</td>
<td>98.5</td>
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<td>5</td>
<td>0</td>
<td>5</td>
<td>186.5</td>
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<td>99</td>
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<td>9</td>
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<td>97.4</td>
<td>99</td>
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<td>4</td>
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<td>1</td>
<td>6</td>
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<td>0</td>
<td>7</td>
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<td>91</td>
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<td>0</td>
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<td>2.06</td>
<td>97.9</td>
<td>85.3</td>
<td>90</td>
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<td>26</td>
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<td>0</td>
<td>18</td>
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<td>94.4</td>
<td>80.5</td>
<td>87</td>
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<tr>
<td>14 to 15</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.00</td>
<td>100.0</td>
<td>80.5</td>
<td>92</td>
</tr>
</tbody>
</table>

---

**Table IV.** Comparison of percentage survivorship between knees with rheumatoid arthritis and osteoarthritis

<table>
<thead>
<tr>
<th>Year</th>
<th>Rheumatoid arthritis (n = 133)</th>
<th>Osteoarthritis (n = 72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
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<td>5 to 6</td>
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<td>6 to 7</td>
<td>96.8</td>
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<td>7 to 8</td>
<td>94.1</td>
<td>98.6</td>
</tr>
<tr>
<td>8 to 9</td>
<td>92.3</td>
<td>97.0</td>
</tr>
<tr>
<td>9 to 10</td>
<td>90.3</td>
<td>95.2</td>
</tr>
<tr>
<td>10 to 11</td>
<td>88.1</td>
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<td>11 to 12</td>
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<td>90.3</td>
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<td>12 to 13</td>
<td>86.6</td>
<td>85.7</td>
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<tr>
<td>13 to 14</td>
<td>78.4</td>
<td>85.7</td>
</tr>
<tr>
<td>14 to 15</td>
<td>78.4</td>
<td>85.7</td>
</tr>
</tbody>
</table>

---

**Fig. 4**

A comparison between the survivorship of the Kinematic Condylar and Stabilizer implants.

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survivorship analysis assumes that those patients who are lost to follow-up are still subject to the same failure rates as the remaining cohort. In our series only seven patients have not been traced. We recommend that all published survivorship studies include a ‘worst-case’ scenario which assumes that all patients lost to follow-up have failed. Using these criteria, the estimated survival for the Kinematic Condylar Total Knee Replacement is 89% at ten years.

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It is clear that the difference in survival between posterior-cruciate-retaining and sacrificing designs is small up to 15 years. Longer follow-up is required, but only a prospective randomised trial will be able to determine clearly the difference in outcome between these two designs. Comparison with the survivorship of the Kinematic Stabilizer...
knee arthroplasty which has also been used in our institution by the same surgeon on a similar patient population, shows that the survivorship is almost identical (Fig. 4) (Emmerson, Moran and Pinder 1996).

Over the past decade an evolution in implant design has taken place and it will be at least another ten years before we are able to determine if the current designs of knee arthroplasty will perform better than the original designs. Some of the new designs have been failures (Moran et al 1991). The original designs of the Condylar Knee Replacement have now established a good track record, with results reproducible in different centres. Widespread introduction of new designs should be allowed only after adequate laboratory and clinical evaluation of the implant.

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