Patient demographics as a predictor of the ten-year survival rate in primary total knee replacement

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As the surgical indications for total knee replacement (TKR) expand to include younger, heavier and more active patients, knowledge of the effect of these demographic variables on the outcome and survival of the implant is increasingly important.

Between November 1986 and September 1990, 402 patients underwent 562 primary cemented cruciate-retaining TKRs carried out by a single surgical team. The overall results showed a survival of 96.8% at 14 years with 1.44% lost to follow-up. Evaluating the demographics of these patients showed that certain groups fared significantly less well. The best results were seen in non-obese women with osteoarthritis who were over 60 years of age in whom there was ten-year survival of 99.4%. The worst results were in obese men with osteoarthritis who were less than 60 years of age in whom there was a ten-year survival of 35.7%. Caution should be exercised when considering TKR on a patient with this combination of poor risk factors.

By identifying demographic factors at the time of consultation the surgeon is better able to predict the survival of the TKR. This information is important when considering the best options for treatment of a patient and in providing accurate information during preoperative counselling.

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Total knee replacement (TKR) is a procedure with excellent long-term results. Many authors have reported a success rate of more than 95% at ten years.1-7 The indications for TKR are being expanded to include younger, heavier and more active patients and there is concern therefore as to how long the replacements will last. The effect of demographic variables must be taken into account when considering the best options for treatment of a patient and in providing accurate information during preoperative counselling.

There are several studies which consider the effects of pathological diagnosis, age, gender and body mass on the outcome of TKR. Many of these, however, have small numbers of patients, a follow-up of less than ten years and include a variety of implants, surgical technique and completeness of follow-up. Our aim was to determine the effect of patient demographic features on the survival at ten years of a large number of TKRs undertaken by a single surgical team, using a standard technique and a single implant system. We hoped to provide statistics which would be useful to both patients and surgeons.

Patients and Methods

Between November 1986 and September 1990, 562 primary cemented cruciate-retaining AGC (Biomet, Warsaw, Indiana) TKRs were carried out on 402 patients by the same surgical team. None of the prostheses was of the all-polyethylene design. There were 242 unilateral and 160 simultaneous bilateral procedures. Osteoarthritis was the diagnosis in 528 knees (94%) and rheumatoid arthritis in 31 (5.5%). Three patients who had other diagnoses were excluded from the study. The mean age was 71 years (41 to 92).

We followed 145 patients (212 knees) for more than ten years (10 to 14). They were reviewed annually by clinical assessment, determination of the Knee Society Score (KSS)4 and radiography at each visit. The results were stored in a computer database. The 99 patients (134 knees) who were unable to attend for follow-up were reviewed by telephone interview (Fig. 1) and radiographs were obtained from their last review or from their general physicians whenever possible. In order to compare the scores of those patients who were reviewed with those who were interviewed by telephone, points were assigned to questions
PATIENT DEMOGRAPHICS AS A PREDICTOR OF THE TEN-YEAR SURVIVAL RATE IN PRIMARY TOTAL KNEE REPLACEMENT

Fig. 1 regarding pain, range of movement, stability and function in order to arrive at an estimated KSS. The intention of reporting telephone scores in this way was to assess how the patients and their knees were functioning, not to develop a new subjective scoring system. It is possible that by assigning arbitrary numbers to these answers, an under- or overestimate of the performance of the knees could result. Information on deceased patients and those lost to follow-up was obtained from hospital and outpatient records, phone searches and commercial search services. A total of 131 patients (184 knees) had died and eight (eight knees) were lost to follow-up (1.44%). Failure was defined as a revision procedure or removal of any prosthetic component for any cause and included any TKR for which a revision was planned.

The patients were divided into two groups by diagnosis of osteoarthritis and rheumatoid arthritis. Those with osteoarthritis were also divided into subgroups by age, gender and body mass index (BMI). The age of 60 years was chosen as the dividing line between the older and the younger patients since the mean age of those patients with TKRs which failed was 58 years (44 to 69) at the time of the initial arthroplasty. The mean age at which surgery was carried out was 69 years in patients with TKRs which survived for more than ten years. Choosing 60 years as the cut-off age was arbitrary and done for ease of memory; 63 years may have been more accurate, but would also have been more difficult in practice.

The patients were divided into two groups according to their BMI: greater or less than 30. The BMI was measured once only, just before surgery. Despite promises to the contrary, it is unusual to see significant weight loss after operation in patients who undergo arthroplasty. The BMI or Quetelet index relates well to the percentage of body fat. This index is defined by the individual’s body weight (kg) divided by the square of the height (m): $BMI = \frac{kg}{m^2}$. Patients with a BMI of between 20 and 30 are considered to be of normal weight, between 30 and 40 obese and over 40, morbidly obese.

Table I. Survival rate (%) at ten years for TKRs in patients divided into demographic subgroups by gender, age and BMI

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>&lt;60</td>
<td>&gt;60</td>
</tr>
<tr>
<td>&lt;30</td>
<td>92.86</td>
<td>97.50</td>
</tr>
<tr>
<td>(n = 14)</td>
<td>(n = 95)</td>
<td>(n = 16)</td>
</tr>
<tr>
<td>&gt;30</td>
<td>35.71</td>
<td>94.86</td>
</tr>
<tr>
<td>(n = 6)</td>
<td>(n = 49)</td>
<td>(n = 6)</td>
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</table>

(Fig. 1) The telephone score format used to estimate the KSS for patients who were unable to attend a clinical assessment after a TKR.
Cox’s F-test for comparing survival rates between groups was used to determine statistical significance. Implant survival tables were made and a summary table showing the percentage survival for each demographic group was created.

Results

Of the 559 knees, 184 (32.9%) were in patients who had died. For this group, the mean age at the time of surgery was 75 years compared with 69 years in those who survived. The mean number of comorbid diagnoses in patients who had died was 2.15 and the mean time to death after surgery was 6.3 years. The overall survival at ten years for all patient demographic groups was 96.8%.

The most significant demographic factor associated with a lower ten-year survival was the age of the patient at the time of arthroplasty. Patients who were younger than 60 years with osteoarthritis had a survival rate of 82.4% compared with those older than 60 years who had a survival rate of 99.1% at ten years (p = 0.00005).

Gender made a significant difference in the group with osteoarthritis since women had a higher survival rate at ten years than men, 98.6% versus 94.5% (p = 0.042). Women with osteoarthritis who were younger than 60 years had a survival rate of 85.14% compared with those who were older than 60 years, who had a survival rate of 99.33% at ten years (p = 0.0031). Men with osteoarthritis who were younger than 60 years had a survival rate of 81.87% compared with those who were older than 60 years who had a survival rate of 97.19% at ten years (p = 0.004).

Patients with osteoarthritis and a BMI of above 30 had a survival rate of 92.74% at ten years compared with those with a BMI below 30 who had a survival of 98.45% (p = 0.0015). Of the patients whose TKRs failed 66% were in the obese groups with a BMI greater than 30. The mean weight of the women was 77 kg and that of the men was 83 kg. The mean weight of the women whose TKRs failed was 100 kg and for the men, 85 kg.

Table I summarises the survival rate at ten years for each of the above subgroups for whom all information was available. The survival for the group of men who were aged less than 60 years with a BMI of greater than 30 was only 35.7%, but this subgroup included only six patients. Tables II and III show the survival analysis of the AGC TKRs according to diagnosis, gender and age.

The patients with rheumatoid arthritis had an overall survival of 92.8% at 14 years. The small size of the individual subgroups for this population precluded statistical analysis.

Discussion

As the indications for TKR expand to include younger, heavier and more active patients, knowledge of the effect of these variables on the outcome and survival of the implant is increasingly significant. It is especially important to identify factors which may predict an increased risk of early failure. The overall survival rate of this patient population was 97% at ten years with the AGC-cemented cruciate-retaining knee system. Significantly lower survival rates were found, however, for certain groups.

Previous studies discuss good and excellent results of TKR in patients younger than 55 years and compare these with excellent results obtained in the elderly.3-7 Most reports in the literature on younger patients having a TKR include a large proportion with rheumatoid arthritis.3,7,12,13 Gill et al3 reported on 68 TKRs in 50 patients with a mean follow-up of 9.9 years. Four different implant systems were used and 43% of the patients had rheumatoid arthritis. The mean KSS was 97; two required revision for loosening and the cumulative survivorship rate at ten years was 96.5%.

Diduch et al4 reported an analysis of survivorship of 108 cemented posterior-stabilised TKRs in 88 patients with a mean age of 51 years. The mean follow-up was for eight years, but only 36 knees were followed for more than ten years. The survival rate, with revision of any component as the endpoint, was 87% at ten years. They concluded that
TKR was acceptable for the younger patient with osteoarthritis, but that this observation could be significantly altered with longer follow-up. Stern et al described 68 cemented TKRs in 50 patients with osteoarthritis who were aged less than 55 years with a mean follow-up of 6.2 years. The mean KSS was 92 for pain and 84 for function. Four further operations were required for loosening of the patellar component. Coyte et al reviewing administrative data on rates of revision of TKR in Ontario, Canada, found that young age (55 years or less) was associated with a higher revision rate and a shortened survival time.

Several articles describe knee scores after TKR in obese patients. Stern and Insall, with a mean follow-up of four years, found no differences in the scores among five weight groups, including 54 patients who were either moderately or severely obese. Patellofemoral symptoms, however, were present in 30% of the obese. Griffin et al compared the results of 32 TKRs in obese patients at ten years with 41 procedures in non-obese patients. The obese patients had poorer Knee Society function and patellar scores. The overall Hospital for Special Surgery Scores, KSS and revision rates were comparable between the two groups and further study was advocated. Winiarsky et al reported an increased incidence of perioperative complications including wound healing, infection and avulsion of the medial collateral ligament in 40 morbidly obese patients (50 TKRs) using at least five different types of implant. Knee pain and function scores were also statistically worse in morbidly obese patients. In our study, 138 patients with a BMI of greater than 30 were followed up for more than ten years after TKR using a standard implant and technique. The overall survival in this group was 92.7% using the AGC knee replacement system which is similar to previous studies and shows that good results are obtainable in the obese group, but that they are not quite as good as the ten-year survival rate of 98.5% in the non-obese group (Table III). This is likely to be due to the higher peak stresses placed on the components during cyclic loading in patients with a high body mass.

The effect of gender on the outcome of TKR has been noted previously, some studies showing no difference with gender and some showing a worse outcome for men. These large studies contained a wide mixture of diagnoses, patient ages, implants, surgeons and techniques. As shown in Table II our study supports the finding that men with osteoarthritis have a lower ten-year survival (94.5%) compared with women (98.7%).

In our study, age, gender and BMI all made a difference to the survival rate in the group with osteoarthritis. These findings correlate with most previous studies. The best results were seen in non-obese women over 60 years of age whose survival at ten years was 99.4%. The worst results were in obese men with osteoarthritis who were less than 60 years of age and who had survival at ten years of 35.7%. It is interesting to note that the non-obese men with osteoarthritis aged less than 60 years had a survival at ten years of 92.7% and 66% of all patients whose TKR failed had a BMI which was in the obese category. It appears that young obese men with osteoarthritis are likely to produce excessive demands on their TKR leading to early failure.

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


Table III. Survival analysis (%) for TKR in relation to osteoarthritis, gender and age, and osteoarthritis and BMI

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<th>Women &gt;60 years (n = 312)</th>
<th>Women &lt;60 years (n = 22)</th>
<th>Men &gt;60 years (n = 172)</th>
<th>Men &lt;60 years (n = 297)</th>
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