Does obesity influence the clinical outcome at five years following total knee replacement for osteoarthritis?

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A total of 370 consecutive primary total knee replacements performed for osteoarthritis were followed up prospectively at 6, 18, 36 and 60 months. The Knee Society score and complications (peri-operative mortality, superficial and deep wound infection, deep-vein thrombosis and revision rate) were recorded. By dividing the study sample into subgroups based on the body mass index overall, the body mass index in female patients and the absolute body-weight. The outcome in obese and non-obese patients was compared. A repeated measures analysis of variance showed no difference in the Knee Society score between the subgroups. There was no statistically-significant difference in the complication rates for the subgroups studied. Obesity did not influence the clinical outcome five years after total knee replacement.

Obesity has been linked to the development of osteoarthritis of the knee. The body mass index (BMI) is currently accepted as an assessment of obesity. This is calculated by dividing the subject’s weight in kilograms by their height in metres squared. It correlates well with the amount of total body fat. Obesity is defined as a BMI > 30 kg/m$^2$. A high body-weight increases the stress transferred through a total knee replacement (TKR) to the surrounding bone. This suggests that TKR may be associated with a poor outcome and a higher failure rate in obese patients, owing to the higher peak stresses and cyclical loading across the knee joint. The literature is divided over the influence of obesity on outcome in TKR. Some reports have found similar results for obese and non-obese patients, whereas others describe obesity as having a negative influence on outcome. It has also been suggested that female gender and absolute body-weight influence the outcome in obese patients undergoing TKR.

The aim of our study was to compare the clinical outcome and complications five years after primary TKR in a consecutive series of obese and non-obese patients, obese and non-obese female patients, and for the patients subdivided into groups based entirely on absolute body-weight.

Patients and Methods

Between January 1995 and December 1997, 370 consecutive primary cemented Press Fit Condylar (PFC) TKRs (Depuy, Leeds, UK) were carried out in 320 patients with osteoarthritis, at a single hospital.

Patients were prospectively followed at intervals of 6, 18, 36 and 60 months after TKR in an independently-managed dedicated knee audit unit, led by a nurse practitioner. Patients were evaluated clinically and radiographically. All pre-operative patient data, post-operative complications and subsequent follow-up Knee Society score (KSS), based on the Knee Society clinical rating system and comprising a separate knee and function score, were prospectively recorded on a database.

In 37 patients who died during the follow-up period 42 TKRs were excluded from the comparison of clinical outcome as they lacked a KSS for all four follow-up intervals. The study sample for the analysis of the KSS therefore comprised the remaining 328 TKRs in 283 patients. Three separate analyses were performed, with two subgroups in each:

1. In analysis A all the patients were divided into two subgroups based on BMI: non-obese (BMI < 30, 181 TKRs) and obese (BMI > 30, 147 TKRs).
2. In analysis B, the women were divided into two subgroups based on BMI: non-obese (BMI < 30, 84 TKRs) and obese (BMI > 30, 87 TKRs).
3. In analysis C the two subgroups were based on absolute body-weight alone: weight < 100 kg (300 TKRs) and weight > 100 kg (28 TKRs).
Table I. Pre-operative characteristics for patients in analyses A, B and C

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-obese</td>
<td>Obese</td>
<td>Non-obese women</td>
</tr>
<tr>
<td>Number of patients</td>
<td>158</td>
<td>125</td>
<td>75</td>
</tr>
<tr>
<td>Number of knees</td>
<td>181</td>
<td>147</td>
<td>84</td>
</tr>
<tr>
<td>Mean (%)</td>
<td>97 (54)</td>
<td>60 (41)</td>
<td>-</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>69.8 (7.6)</td>
<td>67.4 (7.5)</td>
<td>70.5 (8.2)</td>
</tr>
<tr>
<td>Mean BMI* (SD)</td>
<td>26.3 (2.3)</td>
<td>34.2 (2.1)</td>
<td>34.6 (2.1)</td>
</tr>
<tr>
<td>Mean pre-op knee score (SD)</td>
<td>31.3 (15.7)</td>
<td>28.5 (17.9)</td>
<td>32.0 (16.3)</td>
</tr>
<tr>
<td>Mean pre-op function score (SD)</td>
<td>54.0 (14.5)</td>
<td>49.4 (13.6)</td>
<td>51.7 (13.5)</td>
</tr>
</tbody>
</table>

* BMI, body mass index

For the comparison of complications, the entire consecutive series of 370 TKRs (320 patients) was evaluated by including in analyses A, B and C the 42 TKRs in 37 patients who had died. The complications compared were superficial and deep-wound infection, deep-vein thrombosis, peri-operative mortality and revision rate at five years. A wound infection was considered to be superficial if treated successfully with oral antibiotics alone, and deep if a re-operation or revision procedure was required. All cases of deep-vein thrombosis were confirmed by venography or duplex ultrasonography. Peri-operative mortality was defined as a death during the immediate peri-operative period or within three months of knee replacement.

A standard surgical approach using a medial parapatellar incision and arthrotomy was employed. The patella was resurfaced selectively and the posterior cruciate ligament was preserved whenever possible. Low molecular weight heparin was used for thromboprophylaxis in all patients. The post-operative rehabilitation programme, based on an evaluation combining between-subjects and within-subjects variables was used. The between-subjects independent variable was the BMI (analyses A and B) or body-weight in kilograms (analysis C). The within-subjects independent variable was time. The dependent variable was the knee score or function score component of the KSS recorded at each of the four follow-up intervals (6, 18, 36 and 60 months). The pre-operative knee and function scores for each subgroup were included in the repeated measures models as covariates to control for the pre-operative differences in the scores. Observations recorded for each TKR were assumed to be independent for the purpose of the study. Proportions were compared using Fisher’s exact test. The level of significance was set at p < 0.05. There were no serious violations of Levene’s test of equality of error variances, used to test the assumption of homogeneity of variance (p > 0.05).

RESULTS

The pre-operative characteristics of the two subgroups in analyses A, B and C are shown in Table I. In analysis A, 45% of the TKRs were in patients who were obese. Similarly, in analysis B, 51% of the TKRs were in female patients who were obese. In analysis C, however, the proportion of TKRs in patients weighing more than 100 kg was small (8%). Non-obese patients were older than the obese patients. The difference in the pre-operative knee score for the subgroups was not significant for analysis A (t-test, p = 0.1), approached significance in analysis B (p = 0.05), but was significant for analysis C (p = 0.03). The difference in the pre-operative function score for the subgroups was significant for analyses A (p = 0.004) and B (p = 0.02) but not significant for analysis C (p = 0.9). The 6-, 18-, 36- and 60-month follow-ups were available for 99.7%, 99.1%, 95.7% and 92.1% of the 328 TKRs, respectively. Loss to follow-up occurred when patients were unable to attend because of illness, or when they had moved away. For the repeated measures analysis of variance, the sample sizes at each level of the independent variables were therefore 327 (6 months), 325 (18 months), 313 (36 months) and 302 (60 months).

Figure 1 summarises the mean knee score and function score at 6, 18, 36 and 60 months after TKR for each of the two subgroups in analyses A, B and C. Repeated measures analysis showed no significant difference in the knee or the function score subgroups in analyses A (knee p = 0.03; function p = 0.2), B (knee p = 0.3; function p = 0.1) or C (knee p = 0.4; function p = 0.4).

Table II summarises the complications for the entire consecutive series of 370 TKRs, including the 42 performed in 37 patients who had died. There was no statistically-significant difference for superficial and deep-wound infection, deep venous thrombosis, peri-operative mortality, or the number of revisions at five years for subgroups in analyses A, B and C (p > 0.05 for all comparisons). Of the 13 superficial wound infections, eight had confirmed bacteriological cultures, but no organisms were obtained for the remaining five. All three patients with deep infection had a positive culture. Of the three patients who developed a deep infection, two in the non-obese subgroup required revision and one in the obese subgroup required a washout of the knee.
DOES OBESITY INFLUENCE THE CLINICAL OUTCOME AT FIVE YEARS FOLLOWING TOTAL KNEE REPLACEMENT FOR OSTEOARTHRITIS?

![Graph](image1)

**Fig. 1a**

**Fig. 1b**

**Fig. 1c**
Comparison of the knee score and function score at 6, 18, 36 and 60 months after total knee replacement for subgroups in analyses A, B and C. The x axis represents time and shows the scores obtained pre-operatively and at the four follow-up intervals. The y axis represents the mean score obtained and ranges from 0 to 100 points.
but no revision. None of the proven cases of deep venous thrombosis developed thromboembolic complications. There was one peri-operative death in the non-obese subgroup. This was a 76-year-old man who died from pneumonia six weeks after knee replacement. Of the seven TKRs which were revised, two were for aseptic loosening, three for patellar resurfacing and two for deep infection.

There were 50 bilateral TKRs performed, 43 of them simultaneously and the remaining seven sequentially, five staged at three-month intervals and two as separate procedures when osteoarthritis developed in the opposite knee. All patients with sequential TKRs had follow-up data collected at the specified intervals for each knee. There were four superficial wound infections in patients who underwent bilateral TKRs: all occurred in patients who had simultaneous procedures. In one patient (male, non-obese) there was a superficial infection in both knees post-operatively. The other two superficial infections occurred in one knee in two patients (both female, one obese, one non-obese). There were no problems with the contralateral knee wound in either patient. There was one deep-vein thrombosis in an obese (BMI 39.3) female patient following her first TKR. She had a TKR in the other knee two years later without complications. There were no deep infections, revisions or peri-operative deaths in patients who had bilateral TKRs.

Only six patients in this study were morbidly obese (BMI > 40 kg/m²) and all six had satisfactory Knee Society scores at five years, with no complications. The number of morbidly obese patients was too small for further statistical analysis.

Discussion

These results suggest that there is no difference in the clinical outcome at mid-term between obese and non-obese patients, obese and non-obese female patients, and between patients who weigh more than 100 kg and those who weigh less than 100 kg.

Studies evaluating the short-term clinical outcome after knee replacement have found no difference between obese and non-obese patients.6,7,11-13 Mid-term results, however, have been more conflicting, and are summarised in Table III. Foran et al,16 in a study of 78 TKRs in 68 obese patients matched with the same number of non-obese patients, found that obesity had a negative effect on the outcome after knee replacement. Although there was no significant difference in the revision rates between the obese and non-obese groups, survivorship analysis based on re-operation, clinical failure (KSS < 80) and radiographic failure as end-points suggested that a decreased survival in the obese group became apparent only after about 80 months. Other studies with a similar or longer follow-up have been unable to demonstrate inferior results in the obese group.8-10 There is greater agreement regarding a poor outcome in morbidly obese patients (BMI > 40 kg/m²) at five years following TKR compared to that in non-morbidly obese patients.5,10,16 Long-term results comparing TKR in obese and non-obese patients have been reported in only one study,17 and the authors found that at 15 years there was a trend for obesity to influence the rate of aseptic loosening although this was not statistically significant.17

Studies evaluating the results of TKR in obese and non-obese patients cannot be randomised. Matched studies are useful as the effect of confounding factors is minimised, but published studies have involved relatively small numbers,8,16,17 with retrospective measurement of outcome scores. The follow-up in this study was prospective and undertaken by an independent knee audit team blind to the

Table II. Comparison of complications for the 370 consecutive TKRs:* 42 TKRs performed in 37 patients who died are included in analyses A, B and C (expressed as actual numbers (%))

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>A Non-obese n = 210</th>
<th>B Non-obese women n = 96</th>
<th>C Obesewomen n = 94</th>
<th>Weight &lt; 100 kg n = 340</th>
<th>Weight &gt; 100 kg n = 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial infection</td>
<td>6 (2.8)</td>
<td>3 (3.1)</td>
<td>5 (5.3)</td>
<td>12 (3.5)</td>
<td>1 (3.3)</td>
</tr>
<tr>
<td>Deep infection</td>
<td>2 (0.9)</td>
<td>1 (1.1)</td>
<td>1 (0.9)</td>
<td>3 (0.9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Deep-vein thrombosis</td>
<td>1 (0.5)</td>
<td>1 (1.0)</td>
<td>2 (2.1)</td>
<td>6 (1.8)</td>
<td>1 (3.3)</td>
</tr>
<tr>
<td>Peri-operative mortality</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Revisions</td>
<td>3 (1.4)</td>
<td>2 (2.1)</td>
<td>3 (3.1)</td>
<td>6 (1.8)</td>
<td>1 (3.3)</td>
</tr>
</tbody>
</table>

* TKRs, total knee replacements

Table III. Outcome and revision rates after TKR† in obese and non-obese subgroups previously reported

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of TKRs (obese vs non-obese)</th>
<th>Follow-up (yrs)</th>
<th>Clinical outcome (based on KSS†)</th>
<th>Revision rate (%) (obese vs non-obese)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spicer et al10</td>
<td>326 vs 425</td>
<td>6</td>
<td>No difference</td>
<td>4.9 vs 3.1</td>
</tr>
<tr>
<td>Foran et al16</td>
<td>78 vs 78</td>
<td>6.6</td>
<td>Better in non-obese</td>
<td>5 vs 0</td>
</tr>
<tr>
<td>Mont et al8</td>
<td>50 vs 50</td>
<td>7</td>
<td>No difference</td>
<td>8 vs 4‡</td>
</tr>
<tr>
<td>Griffin et al9</td>
<td>32 vs 41</td>
<td>10</td>
<td>No difference</td>
<td>0 vs 7.3‡</td>
</tr>
</tbody>
</table>

† TKR, total knee replacement
‡ KSS, Knee Society score
‡ calculated from numbers provided in study

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aims of the study. It also involved a large consecutive patient series, several surgeons at a single institution and a single type of prosthesis, reflecting overall clinical results that can be expected by other general hospitals with a similar case mix.

The observation that obese patients have an inferior outcome as the increased load across the knee replacement contributes to early wear\(^5,21\) has not been proved in clinical studies. The relatively short follow-up period of most studies, including our own, may partly explain this, and we may find that the results deteriorate with time. However, it has been suggested that obese patients have lower activity levels than non-obese patients,\(^22\) and this may compensate for the higher load across the knee replacement, with overall results comparable to those of non-obese patients.

In conclusion, obesity does not influence the clinical outcome and complication rates at five years following TKR. We accept that our study has not included a radiographic analysis. Therefore, we cannot be certain that prosthetic fixation has not been compromised by the patient’s obesity and will lead to premature failure, but at five years this has not manifested itself by deteriorating KSSs. Further studies are essential to determine the long-term success of TKR in obese patients.

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References