Obesity in total hip replacement

A prospective, multi-centre study was carried out on 1421 total hip replacements between January 1999 and July 2007 to examine if obesity has an effect on clinical outcomes.

The patients were categorised into three groups: non-obese (body mass index (BMI) < 30 kg/m²), obese (BMI 30 to 40 kg/m²) and morbidly obese (BMI > 40 kg/m²). The primary outcome measure was the change in Oxford hip score at five years. Secondary outcome measures included dislocation and revision rates, increased haemorrhage, deep infection, deep-vein thrombosis and pulmonary embolism, mean operating time and length of hospital stay. Radiological analysis assessing heterotopic ossification, femoral ostitis and femoral stem positioning was performed. Data were incomplete for 362 hips (25.5%).

There was no difference in the change in the Oxford hip score, complication rates or radiological changes at five years between the groups. The morbidly obese group was significantly younger and required a significantly longer operating time. Obese and morbidly obese patients have as much to gain from total hip replacement as non-obese patients.

Obesity has been widely reported in scientific journals and more widely in the media as an epidemiological problem which affects not only the United Kingdom but other Western countries, most notably the United States. The body mass index (BMI) is a well established method of correlating weight-for-height index.1 The World Health Organisation (WHO) defines obesity as a BMI ≥ 30 kg/m² and morbid obesity as BMI ≥ 40 kg/m².2 In the United Kingdom, the prevalence of obesity increased from 16.4% in women and 13.2% in men in 1993, to 23.8% in women and 23.6% in men in 2004.3

There has been much concern that obesity is associated with anaesthetic and operative complications after total hip replacement (THR).4 Obese patients have a higher risk of adverse cardiovascular and respiratory events and obesity is an independent risk factor for the development of type II diabetes mellitus,5 a condition that carries an increased risk of post-operative morbidity. Other studies have demonstrated an increased risk of venous thromboembolic disease following joint replacement surgery in the obese.6,7 There is a strong association between obesity and prolonged wound drainage post-operatively which, in turn, is associated with a higher rate of wound infection.8 Namba et al9 concluded that obese patients have a 4.2 times higher risk of post-operative infection following THR. Furthermore, obesity has a bearing on health economics, with obese patients having an increased length of hospital stay compared with the general population.10

The effect of obesity may be gender-specific. Recently, Liibeke et al11 conducted a single hospital-based prospective cohort study to examine if obesity in women and men undergoing primary THR affected outcome, and found that the obese women had an increased rate of complication from infection and dislocation, lower functional outcomes and satisfaction scores, compared with the obese men. There appeared to be no difference in outcome between the obese and non-obese male patients. This provides some evidence that could be used to argue that surgery should be denied to obese patients (or at least female obese patients) because of poorer clinical outcomes and increased complication rates. In the current climate of budgetary restraint, this evidence may be used by hospital trusts in an effort to control waiting lists.

There is also evidence to support the view that obese patients, in general, have a good outcome in terms of patient satisfaction and have no increased risk of peri-operative complications following total joint replacement.12 A retrospective study by Ibrahim et al13 concluded that a BMI ≥ 30 kg/m² had no effect on post-operative complications or the need for revision surgery in
the short term. McLaughlin and Lee\textsuperscript{14} undertook a retrospective study of 285 patients in the United States and concluded that there was no difference in outcome between obese and non-obese patients.

Against this conflicting background, we undertook a large, prospective, multi-centre study to examine if the clinical outcomes of obese patients differed from those in non-obese patients in the United Kingdom. The cemented Exeter femoral component, which has been shown to have excellent long-term results,\textsuperscript{15} was used in all cases.

**Patients and Methods**

This was a prospective non-randomised multi-centre study involving seven centres. The period of enrolment into the study was between January 1999 and January 2002. There were 1356 patients (1421 hips), of whom 65 had bilateral THR. We examined 1421 THRs performed by consultant and non-consultant surgeons and using anterolateral or posterior approaches. A cemented Exeter femoral component (Stryker Howmedica Osteonics, Mahwah, New Jersey) was used in all cases with a number of different acetabular components. Data were incomplete for 362 hips (25.5%).

Each patient’s BMI was calculated by dividing their weight in kilograms by their height in metres squared. The patients were categorised into three groups: non-obese (BMI < 30 kg/m\textsuperscript{2}), obese (BMI 30 kg/m\textsuperscript{2} to < 40 kg/m\textsuperscript{2}) and morbidly obese (BMI ≥ 40 kg/m\textsuperscript{2}).\textsuperscript{2} There were 1069 hips in the non-obese group with a mean BMI of 25.1 kg/m\textsuperscript{2} (15.2 to 29.9), 332 hips in the obese group with a mean BMI of 33.2 kg/m\textsuperscript{2} (30.0 to 39.9) and 18 in the morbidly obese group with a mean BMI of 44.8 kg/m\textsuperscript{2} (40 to 53.3).

The patient demographics and pre-operative details are shown in Table I. There were 402 men and 667 women in the non-obese group (45 bilateral THRs), 121 men and 209 women in the obese group (18 bilateral THRs) and five men and 13 women in the morbidly obese group (two bilateral THRs). There were four hips where the gender was not recorded, two in the non-obese group and two in the obese group. The mean age of the patients at time of surgery in the non-obese, obese and morbidly obese group was 69.1 years (21.3 to 94.9), 65.5 years (33.4 to 86.9), and 60.6 years (28.5 to 78.0) respectively (analysis of variance (ANOVA), p < 0.001). At five years follow-up, there were 1059 hips available for follow-up (795 in the non-obese group, 249 in the obese group and 15 in the morbidly obese group).

In the non-obese group of 1070 hips, 688 (64.3\%) involved a general anaesthetic, 472 (44.1\%) a spinal and 314 (29.3\%) an epidural. In the obese group of 332 hips, 219 (66.0\%) had a general, 139 (41.9\%) a spinal anaesthetic and 99 (29.8\%) an epidural, and in the morbidly obese group, 15 of 18 patients (83.3\%) had a general, five (27.7\%) had a spinal anaesthetic and ten (55.5\%) had an epidural.

The Oxford hip score (OHS)\textsuperscript{16} was used as a well-validated method of assessing clinical outcome on a patient-centred basis.\textsuperscript{17} It is scored between 12 (best outcome) and 60 (worst outcome) and consists of 12 questions, each scored out of five. Pre- and post-operative scores were collected by a dedicated research assistant at each centre and the change in OHS calculated at three months, one, two, three and five years post-operatively. The change in OHS was the primary outcome measure for all three groups.

Secondary outcome measures included the rate of complications for dislocation, haemorrhage requiring a blood transfusion, the presence of a deep infection, peri-operative deep-vein thrombosis (DVT) requiring anticoagulation therapy, pulmonary embolus and the need for revision surgery. Radiological analysis assessing the presence of heterotopic ossification (HO) (Brooker system\textsuperscript{18}) and femoral osteolysis (Gruen zones\textsuperscript{19,20}) at one and five years was performed. The position of the femoral component was assessed using one year post-operative radiographs and was categorised as being in a valgus, neutral or varus position. The mean operating time and mean length of hospital stay for each group was recorded.

**Statistical analysis.** For the normally-distributed numerical outcome measures, ANOVA and Tukey’s post hoc tests were used to compare any differences between the groups. Non-parametric categorical and frequency data were analysed with chi-squared and Fisher’s exact tests and the α-level of significance was defined as less than 5\% (p ≤ 0.05). SPSS 12.0.1 for Windows (SPSS Inc., Chicago, Illinois) software was used for the statistical analysis. The power of this study was sufficient (93\%) to detect a two-point difference in the change in OHS.

**Results**

**Change in Oxford hip score.** The mean pre-operative OHS was 43.3 (SD 8.0) in the non-obese group, 46.2 (SD 7.1) in the obese group and 46.7 (SD 6.4) in the morbidly obese group (worst score: ANOVA, p < 0.001). At three years, the mean OHS was significantly worse in the obese group (21.7, SD 8.8) and morbidly obese group (23.5, SD 11.4) compared with the non-obese group (19.6, SD 8.8) (ANOVA, p = 0.003). At five years, the mean OHS was still significantly better for the non-obese group (19.4, SD 8.6) compared with the obese (22.2, SD 9.3) and morbidly obese groups (25.6, SD 9.9) (ANOVA, p = 0.005) (Table II). The mean change in OHS at five years was 23.7 (SD 9.4) in the non-obese group, 23.7 (SD 9.7) in the obese group and 20.7 (SD 10.8) in the morbidly obese group. There was no statistically significant difference between the groups (ANOVA, p = 0.473) (Table II). The change in OHS is the more meaningful outcome variable as it defines the clinical benefit of surgery since each of the groups had a different pre-operative score.

**Complications.** At five years, there had been 14 dislocations of 1071 hips (1.3\%) in the non-obese group, nine in the obese group of 332 hips (2.7\%) and one in the morbidly obese group of 18 hips (5.6\%). There was no statistically significant difference in the rate of dislocation between the groups (chi-squared test, p = 0.221).

**Revisions.** At five years there had been 14 revisions in the non-obese group (1.3\%), five in the obese group (1.5\%) and none in the morbidly obese group. The differences between the groups were not statistically significant (chi-squared test, p = 0.851).
Deep infection. There were two cases of deep infection in the non-obese group (0.2%), five in the obese group (1.5%) and none in the morbidly obese group. There was no significant difference between groups (chi-squared test, p = 0.115).

Haemorrhage. There were 29 cases (2.7%) of haemorrhage requiring extra blood transfusion in the non-obese group, four (1.2%) in the obese group and none in the morbidly obese group (chi-squared test, p = 0.155).

Deep-vein thrombosis. There were 15 cases (1.4%) of symptomatic DVT in the peri-operative period which needed anti-coagulation therapy in the non-obese group, eight (2.4%) in the obese group, and none in the morbidly obese group. There was no statistically significant difference in the incidence of DVT between the groups (chi-squared test, p = 0.754).

Pulmonary embolism. In the non-obese group, there were 12 cases of pulmonary embolism (1.1%), in the obese group, there were five (1.5%) and in the morbidly obese group there were none. There was no statistically significant difference in the incidence of pulmonary embolism between the groups (chi-squared test, p = 0.769).

Heterotopic ossification. Heterotopic ossification (HO) was identified on the one-year post-operative radiographs in 169 of the 827 hips (20.4%) in the non-obese group for whom radiological data were available. In the obese group of 250 hips, 45 (18%) had HO present and in the morbidly obese group, only one of 13 hips (7.6%) had HO. There was no significant difference in the incidence of HO at one year (chi-squared test, p = 0.383). At five years, in the non-obese group

Table I. Demographic and pre-operative data in the different body mass index groups

<table>
<thead>
<tr>
<th>Number of total hip replacements</th>
<th>Non-obese</th>
<th>Obese</th>
<th>Morbidly obese</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (total)</td>
<td>1417</td>
<td>528</td>
<td>889</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>528</td>
<td>402</td>
<td>121</td>
<td>5</td>
</tr>
<tr>
<td>Women</td>
<td>889</td>
<td>667</td>
<td>209</td>
<td>13</td>
</tr>
<tr>
<td>Available for assessment</td>
<td>1069</td>
<td>330</td>
<td>18</td>
<td>0.671</td>
</tr>
<tr>
<td>Mean age at operation in yrs (SD)</td>
<td>1420</td>
<td>69.1</td>
<td>(11.1)</td>
<td>65.5</td>
</tr>
<tr>
<td>Available for assessment</td>
<td>1070</td>
<td>332</td>
<td>18</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Surgical approach</td>
<td>1030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterolateral</td>
<td>666</td>
<td>494</td>
<td>162</td>
<td>10</td>
</tr>
<tr>
<td>Posterior</td>
<td>364</td>
<td>270</td>
<td>91</td>
<td>3</td>
</tr>
<tr>
<td>Available for assessment</td>
<td>764</td>
<td>253</td>
<td>13</td>
<td>0.638</td>
</tr>
<tr>
<td>Pre-operative diagnosis (%)</td>
<td>1418</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary osteoarthritis</td>
<td>1197</td>
<td>896</td>
<td>(83.9)</td>
<td>285</td>
</tr>
<tr>
<td>Secondary osteoarthritis</td>
<td>75</td>
<td>56</td>
<td>(5.3)</td>
<td>17</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>86</td>
<td>72</td>
<td>(6.7)</td>
<td>14</td>
</tr>
<tr>
<td>Fracture</td>
<td>20</td>
<td>14</td>
<td>(1.3)</td>
<td>6</td>
</tr>
<tr>
<td>Osteonecrosis</td>
<td>36</td>
<td>27</td>
<td>(2.5)</td>
<td>9</td>
</tr>
<tr>
<td>Deposition/metabolic</td>
<td>4</td>
<td>3</td>
<td>(0.3)</td>
<td>1</td>
</tr>
<tr>
<td>Available for assessment</td>
<td>1068</td>
<td>332</td>
<td>18</td>
<td>0.785</td>
</tr>
</tbody>
</table>

* gender details were not available for four patients

Table II. Mean (sd) pre-operative and five-year Oxford hip score (OHS) and change in OHS in the non-obese, obese and morbidly obese groups at up to five years follow-up. OHS (12, best; 60, worst). Change in OHS (0, worst; 48, best)

<table>
<thead>
<tr>
<th>Number of total hip replacements</th>
<th>Non-obese</th>
<th>Obese</th>
<th>Morbidly obese</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative OHS</td>
<td>1421</td>
<td>1071</td>
<td>43.3 (8.0)</td>
<td>332</td>
</tr>
<tr>
<td>Absolute OHS at five years</td>
<td>1059</td>
<td>795</td>
<td>19.4 (8.6)</td>
<td>249</td>
</tr>
<tr>
<td>Mean change in OHS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 mths</td>
<td>1210</td>
<td>912</td>
<td>18.5 (9.6)</td>
<td>283</td>
</tr>
<tr>
<td>1 yr</td>
<td>1195</td>
<td>899</td>
<td>23.4 (9.6)</td>
<td>280</td>
</tr>
<tr>
<td>2 yrs</td>
<td>1111</td>
<td>836</td>
<td>23.0 (9.9)</td>
<td>63</td>
</tr>
<tr>
<td>3 yrs</td>
<td>1093</td>
<td>825</td>
<td>23.3 (9.8)</td>
<td>255</td>
</tr>
<tr>
<td>5 yrs</td>
<td>1059</td>
<td>795</td>
<td>23.7 (9.4)</td>
<td>249</td>
</tr>
</tbody>
</table>

* analysis of variance
of 738 hips, 179 (24.3%) had HO, in the obese group, 49 of 225 hips (21.8%) had HO and in the morbidly obese group two of 11 hips (18.2%) had HO. There was no significant difference between the groups (chi-squared test, p = 0.681).

**Femoral osteolysis.** At one year, femoral osteolysis was noted in 68 of the 830 non-obese hips (8.2%) for whom data were available and in 15 of 250 hips (6%) in the obese group without significant difference between the groups (chi-squared test, p = 0.521). There was a single case (7.7%) of femoral osteolysis among the 13 hips in the morbidly obese group. There was also no significant difference in the incidence of femoral osteolysis between the groups at five years (chi-squared test, p = 0.604). In the non-obese group of 740 hips, 69 (9.3%) had femoral osteolysis, in the obese group of 22 of 225 hips, (9.8%) had femoral osteolysis and in the morbidly obese group of 11 hips, osteolysis occurred around two femoral components (18.2%). It should be noted that there were only a small number of patients in the morbidly obese group.

**Femoral stem position.** In the non-obese group of 831 hips for whom data were available, 48 (5.8%) had a valgus femoral component position, 630 hips (75.8%) were in a neutral position and 153 (18.4%) were in a varus position. In the obese group, of 251 hips, 13 (5.2%) were in a valgus position, 194 (77.3%) were in a neutral position and 44 (17.5%) were in a varus position. In the morbidly obese group of 13 hips, ten (76.9%) femoral components were in a neutral position and three (23.1%) were in a varus position. There was no significant difference between the groups (chi-squared test, p = 0.884).

**Mean operating time.** There were 1367 hips available for this assessment. In the non-obese group the mean operating time was 91.9 minutes (SD 34.9), in the obese group the mean time was 94.6 minutes (SD 32.9) and in the morbidly obese group, the mean time was significantly prolonged at 117.2 minutes (SD 49.5) (ANOVA, p = 0.005).

**Length of hospital stay.** There were 1416 hips available for this assessment. The mean length of hospital stay was 9.8 days (SD 7.2) in the non-obese group, 9.1 days (SD 4.5) in the obese group and 8.9 days (SD 3.1) in the morbidly obese group (ANOVA, p = 0.232).

**Discussion**

The numbers of patients presenting for THR who are obese is increasing and there have been concerns that these patients have an increased risk of complications and a reduced benefit of surgery in terms of function and pain relief. Obesity has been linked to the development of osteoarthritis in the knee joint, and to a lesser extent, in the hip joint.\(^{21,22}\) In 2003, Karlson et al.\(^{23}\) showed an association between increased BMI and the risk of developing osteoarthritis of the hip severe enough to warrant surgical intervention.

In the United Kingdom, some primary care trusts have started using obesity as a reason to exclude patients from hip replacement surgery.\(^{24}\) An editorial by Horan\(^{25}\) has recently highlighted the debate about obesity and joint replacement and concluded that it is only the morbidly obese in whom serious contraindications to surgery may exist, and that obese patients should not be denied THR on the grounds of obesity. Our data supports this view.

Of a total of 1421 hips requiring THR in our series, 330 (23%) were obese and 18 (1.3%) were morbidly obese. Although the pre-operative OHS results were significantly different, with the morbidly obese patients having worse scores, we found no difference in the more meaningful change in OHS between the non-obese and obese groups of patients at three and five years follow-up. This implies that the clinical benefit of surgery is independent of BMI. It should be noted that this gain could be hidden in studies of a retrospective design where only the post-operative OHS is reported; the cross-sectional OHS being significantly lower at five years in obese patients.

Our data complements some of the results found in other studies conducted in the United States,\(^{14,26}\) Switzerland\(^{11}\) and the United Kingdom\(^{13,27}\) which similarly found no difference in outcome using the Harris hip score\(^{28}\) and other quality of life health questionnaires. The obese and morbidly obese patients had a higher (worse) OHS pre-operatively and post-operatively at three and five years, suggesting that despite gaining similar benefits, the final outcome for such patients is not as good when compared with non-obese patients. In a study by Hajat et al.,\(^{29}\) patients who started with a worse pre-operative score also had a poorer post-operative OHS and our data supports this.

Furthermore, in our study, there did not appear to be a significant association between obesity and the risk of revision surgery\(^{30}\) or other complications. However, whilst there was no significant difference in dislocation rates, there was a trend toward increased dislocation in the obese and morbidly obese patient (2.7% and 5.6% respectively compared with 1.3% in the non-obese group). Radiological analysis showed no significant differences in the incidence of HO, femoral osteolysis or femoral component positioning between the groups. The morbidly obese patients were significantly younger than the non-obese patients and this may have implications in terms of the need for revision surgery in the future and an increase in complication rates as a result.\(^{31}\) The mean operating time in the morbidly obese group was also significantly longer. This might affect operating theatre schedules with more time being allocated when a morbidly obese patient is listed for THR.

The lack of consensus regarding the impact of obesity on THR may be explained in part by the different definitions of obesity which have been used. Previous studies have also been limited by the small number of cases and only comparing obese with non-obese patients. Our study is one of the few to evaluate the effects of morbid obesity on outcome scores and complication rates over the longer term in a large cohort of patients.\(^{32,33}\) Interestingly, unlike the situation in total knee replacements, where the morbidly obese have been shown to have inferior results,\(^{32}\) morbidly obese patients undergoing THR do not have a significant difference in the change in OHS compared with non-obese or obese patients.

This was a large and prospective study by design but it did have incomplete data involving 362 hips (25.5%) at five
years follow-up. It is recognised that these patients may have an impact on the clinical outcome and this represents the major limitation of the study. However, demographic data suggest that those patients with incomplete data were similar to those patients for whom complete information was available. Therefore we remain confident that the analyses were unlikely to have been adversely influenced. Furthermore, the majority of data loss (226 hips) occurred during the first year of follow-up and therefore, the authors felt that the effect of the missing cases on the five-year results would be minimal.

Although the study by McLaughlin and Lee\textsuperscript{14} followed patients for between ten and 18 years, the size of that study, involving an uncentred prosthesis, was relatively small with 285 patients, of whom complete radiological and clinical follow-up was available for only 209 patients, representing a similar loss to follow-up as our study. We acknowledge that a longer follow-up period (of seven or ten years) would be desirable but feel that the five-year data provides strong evidence that there is little difference in clinical outcome in the medium term, between the obese and non-obese patient population. Very few studies to our knowledge have prospectively assessed such a large group of patients for this duration post-operatively, using a cemented femoral prosthesis.\textsuperscript{3,6,9,12,26,27,34,35}

The trend towards obesity is disturbing and is associated with a range of serious medical conditions including type II diabetes mellitus, ischaemic heart disease, hypertension and obstructive sleep apnoea.\textsuperscript{34} Indeed, morbidly obese patients are more likely to suffer a sudden unexplained death than the non-obese.\textsuperscript{34} The impact of weight and body mass index on the length of stay in hospital and the risk of post-operative complications among patients undergoing total hip replacement. J Bone Joint Surg (Br) 2006;88-B:136-38.


