Does body mass index affect clinical outcome post-operatively and at five years after primary unilateral total hip replacement performed for osteoarthritis?

A MULTIVARIATE ANALYSIS OF PROSPECTIVE DATA

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Studies describing the effect of body mass index (BMI) on the outcome of total hip replacement have been inconclusive and contradictory. We examined the effect of BMI on medium-term outcome in a cohort of 1617 patients who underwent a primary total hip replacement for osteoarthritis. These patients were followed prospectively for five years with the outcomes of dislocation, revision, duration of surgery and deep and superficial infection studied, as well as collecting Harris hip scores (HHS) and Short-Form 36 (SF-36) questionnaires pre-operatively and at review. A multivariate analysis was performed to see whether BMI is an independent predictor of poor outcome.

We found that patients with a BMI of ≥ 35 kg/m² have a 4.42 times higher rate of dislocation than those with a BMI < 25 kg/m². Increasing BMI is also associated with superficial infection and poorer HHS and SF-36 scores at five years. These trends remain significant even when multivariate analysis adjusts for age, gender, prosthesis, operating consultant, pre-operative HHS and SF-36, and comorbidities including diabetes mellitus, cardiac disease and osteoporosis.

Despite the increased risks, the five-year outcome scores indicate that obese patients have much to gain from total hip replacement. Thus total hip replacement should not be withheld from patients solely on the grounds of an elevated BMI. However, longer-term follow-up of this cohort is required to establish whether adverse outcomes become more evident with time.

In Scotland 23.6% of men and 23.8% of women are regarded as obese. Obesity is associated with an increased risk of osteoarthritis of the hip which is considered to be the consequence of the extra pressure exerted on the joint. Up to 81% of orthopaedic surgeons in Europe consider obesity to be a poor prognostic factor in patients undergoing elective total hip replacement (THR).

There is conflicting evidence about the effect of obesity on the outcome of THR. A number of studies have looked at post-operative and short-term outcomes with reported increases in operating time, thromboembolism, blood loss, post-operative infection and dislocation rates, but other short-term studies have suggested that body mass index (BMI), as an independent risk factor, is not a justification for withholding THR.

There is little evidence about the medium-term outcome of THR, and although Andrew et al have shown that there is no statistical difference between BMI groups in terms of hip scores, complication rates and radiological changes, their data only included 75% of the hips at five years’ follow-up.

Current guidelines from the National Institute of Health and Clinical Excellence (NICE) state that patient-specific factors, including obesity, should not be a barrier to referral for joint replacement surgery. The aim of this paper is to describe the five-year results of a large cohort of patients who underwent THR for osteoarthritis, and to use multiple regression analysis to see whether BMI independently affected their medium-term outcome.

Patients and Methods

Between January 1998 and January 2005, 1841 unilateral THRs were performed in our unit by eight orthopaedic surgeons. Patients were assessed pre-operatively by an independent audit nurse. Most operations (96.8%) involved cemented stems using either a Charnley prosthesis (De Puy International, Leeds, United Kingdom), a Charnley Elite...
prosthesis (De Puy International), or a Lubinus SPII prosthesis (Waldemar-Link GmbH, Germany). Each Charnley component had a 22 mm femoral head and each Lubinus a 32 mm head. All acetabular components were cemented Charnley all-polyethylene Ogee cups. A standard anterolateral surgical approach was used by all surgeons. Low molecular weight heparin was used for thromboprophylaxis in all patients. The post-operative rehabilitation programme was the same in every case, mobilising with a physiotherapist on the first post-operative day, with daily physiotherapy thereafter until discharge. Independent prospective follow-up was undertaken at five years by an audit team consisting of two specialist nurses who were not directly involved in this, or any other, study during data collection.

Of the 1841 unilateral THRs performed during the study period, 123 were excluded because the diagnosis was not osteoarthritis or there was no recorded diagnosis, 56 because the prosthesis was not one of the three main prostheses used by this unit (Charnley, Charnley Elite and Lubinus) or was not recorded, and 45 because of missing BMI data. This left 1617 patients for analysis.

Pre-operative and operative factors recorded included height and weight data needed to calculate BMI, age, gender, prosthesis used, operating consultant, pre-operative Harris hip score (HHS)²² and pre-operative Short-Form 36 (SF-36)²³ scores, and operating time. Comorbidities including cancer, atherosclerotic disease, hypertension, other cardiac disease, diabetes, osteoporosis and phlebitis were also recorded.

Recorded outcomes included dislocation, superficial and deep infection, revision surgery, HHS and SF-36 at five years. Deep infection suspected on clinical and radiological grounds was only recorded as such after confirmation by a microbiological culture taken during the revision. Superficial infection was diagnosed if there was discharge from the wound with a positive culture, or spreading cellulitis. Patients were divided into four groups for the purposes of comparison: BMI < 25 kg/m², 25 kg/m² to 29.9 kg/m², 30 kg/m² to 34.9 kg/m² and ≥ 35 kg/m².

SF-36 is a measure of a patient’s general health and generates scores in nine domains of quality of life. A score of 100 in each domain is best, 0 is worst. Scoring of SF-36 was carried out according to the coding and formulae detailed in the United Kingdom SF-36 analysis and interpretation manual.²⁴

In all, 1609 patients (99%) completed a pre-operative HHS and 1593 (99%) completed a pre-operative SF-36; 1163 (72%) completed a HHS at five years and 1095 (68%) completed an SF-36 at five years.

Statistical analysis. The PASW Statistics v.17 computer package (SPSS Inc., Chicago, Illinois) was used to analyse the data, odds ratios were calculated using 95% confidence intervals. The multivariate analyses were carried out using multiple regression linear analysis for continuous outcomes such as HHS, length of operation, or binary logistic regression for binary outcomes such as dislocation. These multivariate analyses were performed considering age, gender, operating consultant, pre-operative HHS and SF-36 scores, and a diagnosis of cancer, atherosclerotic disease, cardiac disease, diabetes mellitus, osteoporosis and phlebitis as potential confounders to see whether BMI was a risk factor independent of these.

In order to indicate at what point along the BMI scale various outcomes become less favourable, multivariate analyses were repeated with a comparison of two adjacent BMI groups as the dependant variable. The level of statistical significance was set at a p-value < 0.05.

Results

By five years there had been 42 dislocations (2.6%); 39 hips (2.4%) had been revised; there had been 15 deep infections (0.9%) and 83 superficial infections (5.1%).

The multivariate analysis showed that even when potential confounding factors and comorbidities are taken into account, increased BMI is an independent statistically significant predictor of worse outcomes for the following clinical outcomes: dislocation, superficial wound infection, five-year HHS and most of the SF-36 domains at five years (Tables II and III).

There was no statistically significant relationship between BMI and revision rate (p = 0.262), deep infection (p = 0.44), and the SF-36 categories of mental health (p = 0.913) and change in health (p = 0.201).

Dislocation

Our analysis revealed the greater the patient’s BMI, the higher the risk of dislocation: 6.8% of patients with BMI ≥ 35 kg/m² had a dislocation by five years, compared with 3.2% with a BMI of 30 to 34.9, 2.0% with a BMI of 25 to 29.9, and 1.5% with a BMI < 25 (Fig. 1). Multivariate analysis showed that increasing BMI is an independent pre-
dictor of increased dislocation rate with the risk of dislocation increasing by 113.9% for every additional 10 BMI units (p = 0.023).

Superficial infection. A large increased risk of superficial infection was identified in patients with a BMI of ≥ 35 kg/m² (Fig. 2): 14.2% of these had a superficial infection, compared with 4.4% of those with BMI < 25, 3.7% of those with a BMI of 25 to 29.9, and 4.6% of those with a BMI of 30 to 34.9. Multivariate analysis showed that there was no statistically significant differences between adjacent BMI groups (p = 0.942, 0.898) until the comparison between BMI ≥ 35 and 30 to 34.9, where patients in the heavier group had a 3.37 times (95% CI 1.494 to 7.583) greater chance of superficial wound infection than those with a lower BMI.

Short Form-36 score. In every domain apart from mental health and change in health the scores decreased significantly p < 0.03 with increasing BMI even after

<table>
<thead>
<tr>
<th>Event</th>
<th>Overall odds of event</th>
<th>% increase in odds per 10 point BMI increase</th>
<th>95% confidence interval</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Dislocation</td>
<td>0.0260</td>
<td>113.9</td>
<td>11.5 to 308.1</td>
<td>0.023</td>
</tr>
<tr>
<td>Revision</td>
<td>0.0247</td>
<td>52.4</td>
<td>270 decrease to 219.0</td>
<td>0.262</td>
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<td>Deep infection</td>
<td>0.0094</td>
<td>61.3</td>
<td>52.1 decrease to 450.6</td>
<td>0.440</td>
</tr>
<tr>
<td>Superficial infection</td>
<td>0.0541</td>
<td>89.5</td>
<td>18.4 to 205.1</td>
<td>0.008</td>
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</tbody>
</table>

<table>
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<tr>
<th>SF-36 category</th>
<th>% decrease in score per 10 point BMI increase</th>
<th>95% confidence interval</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>8.19</td>
<td>4.74 to 11.63</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Role limitation: physical</td>
<td>10.41</td>
<td>4.64 to 16.18</td>
<td>&lt; 0.001</td>
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<tr>
<td>Role limitation: emotional</td>
<td>8.38</td>
<td>2.03 to 14.73</td>
<td>0.010</td>
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<tr>
<td>Social function</td>
<td>6.08</td>
<td>2.19 to 9.97</td>
<td>0.002</td>
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<tr>
<td>Mental health</td>
<td>0.13</td>
<td>2.22 to 2.48</td>
<td>0.913</td>
</tr>
<tr>
<td>Energy/vitality</td>
<td>4.31</td>
<td>1.32 to 6.94</td>
<td>0.004</td>
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<tr>
<td>Pain</td>
<td>3.98</td>
<td>0.29 to 7.66</td>
<td>0.034</td>
</tr>
<tr>
<td>General health perception</td>
<td>3.44</td>
<td>0.65 to 6.23</td>
<td>0.016</td>
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<tr>
<td>Change in health</td>
<td>1.85 increase</td>
<td>4.69 increase to 0.99</td>
<td>0.201</td>
</tr>
</tbody>
</table>

Histogram showing dislocation rates at five years according to body mass index (BMI) category.
adjustment for confounding factors, including pre-operative SF-36, and comorbidities (Table III). There were few striking trends found when adjacent BMI groups were compared. Most noticeably there was a large difference between social function at five years between those of ideal weight (BMI < 25) and the overweight (BMI 25 to 29.9) with the heavier group expected to score 6.16 points fewer (p = 0.019).

Harris hip score. Despite the statistically significant negative relationship (p < 0.001) between BMI and HHS at five years, a patient can be expected to score 0.302 HHS points (95% CI 0.163 to 0.440) less for every unit increase in BMI. This equates to a potential loss of 3 HHS points out of 100 per 10 BMI unit increase (Fig. 3).

Duration of operation. The duration of surgery can be expected to increase by 3.16 minutes (95% CI 0.30 to 6.03) per 10 units of BMI.

Discussion
Obesity has been shown to predispose to the development of osteoarthritis of the hip. There is a trend towards increasing obesity in patients presenting for surgery for osteoarthritis which might reflect the increased risk in this cohort of the onset of arthritis. Our study has twice the number of obese patients reported elsewhere and with a follow-up of around 70%.

In contrast to the previous literature, we have shown that BMI is an independent predictor for an increased dislocation rate. Dislocation rates increase sequentially across the whole range of BMI. There were no statistically significant differences between adjacent BMI groups suggesting that the dislocation rate increases linearly with BMI, with no particular point at which it increases dramatically. This should not preclude obese patients from undergoing THR. However, dislocation is a distressing complication that requires reduction and, potentially, further surgery. Surgeons should therefore ensure that obese patients are aware of the increased risk of dislocation. As the prevalence of obesity increases it should be expected that national databases will identify an increasing rate of dislocation.

BMI was found to be an independent predictor for an increased rate of superficial infection, and in patients with a BMI of there was a large increase in the rate of super-
ficial infection even after comorbidities were taken into account. Although previous literature has demonstrated a link between infection and BMI, the authors did not differentiate between deep and superficial infection. In our study there was no significant relationship between BMI and deep infection. This may reflect the small number of deep infections in the study. Further research with a larger cohort of obese patients will be needed to identify any correlation between deep infection and BMI.

As in previous studies, the duration of the operation increased with increasing BMI, although it should be noted that the mean overall increase in operating time was 3.16 minutes for every increase by 10 units of BMI, and therefore obesity alone has a minimal effect on operating time.

Both the HHS and SF-36 are widely used outcome measures that have been shown to be reliable. As in the previous literature, increased BMI predicted lower HHS and SF-36 (excluding mental health and change in health domains) scores at five years. However, patients who are considered obese with a BMI of 30 had a mean pre-operative HHS of 40.34 (10 to 74), which improved by a mean of 46.23 (-10 to 74) points to a mean of 86.57 (37 to 100). Although the scores of obese patients do not increase as much as those of their slimmer counterparts, there is still a dramatic improvement.

Obesity has a negative impact on the five-year outcome of THR. Although non-obese patients see the greatest benefit after surgery, those with a higher BMI also see significant improvement in function and symptoms. Our findings suggest obese patients should be encouraged to lose weight before surgery to optimise their outcome and be made aware that obesity is a cause of an increased rate of dislocation and superficial infection. However, it is unreasonable to deny these patients the opportunity to improve their quality of life and function by refusing them a THR. Our research supports the NICE recommendation that obesity should not be a barrier to THR.

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References


