The relationship between obesity and the age at which hip and knee replacement is undertaken

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We audited the relationship between obesity and the age at which hip and knee replacement was undertaken at our centre. The database was analysed for age, the Oxford hip or knee score and the body mass index (BMI) at the time of surgery. In total, 1369 patients were studied, 1025 treated by hip replacement and 344 by knee replacement. The patients were divided into five groups based on their BMI (normal, overweight, moderately obese, severely obese and morbidly obese).

The difference in the mean Oxford score at surgery was not statistically significant between the groups (p > 0.05). For those undergoing hip replacement, the mean age of the morbidly obese patients was ten years less than that of those with a normal BMI. For those treated by knee replacement, the difference was 13 years. The age at surgery fell significantly for those with a BMI > 35 kg/m² for both hip and knee replacement (p > 0.05). This association was stronger for patients treated by knee than by hip replacement.

In the Health Survey for England 2005 it was identified that the proportion of men classified as obese (body mass index (BMI) > 30 kg/m²) had increased from 13.2% in 1993 to 23.1% in 2005. For women the increase was from 16.4% to 24.8% over the same time period. The International Obesity Task Force has documented a varying prevalence of obesity around the world, with many countries having a prevalence which exceeds that of the United Kingdom. Obesity is associated with degenerative arthritis, coronary artery disease, hypertension and type-2 diabetes. It affects men and women of all age groups, of all socio-economic strata and of all ethnic groups. Its prevalence increases with advancing age and peaks in the age group of 55 to 64 years. In this subgroup, 21% of men and 29% of women are obese.

Degenerative joint disease can affect any synovial joint, most commonly the hip, knee, hands, feet and spine. Risk factors associated with its development include age, obesity, gender, previous joint trauma, joint dysplasia and excessive work or sports activity. Of these, age appears to be the most influential. This is attributed to decreasing chondrocyte function with advancing age and a reduced ability to synthesise appropriate proteoglycan aggregates. These proteoglycan aggregates are less responsive to cytokines and mechanical forces and thus predispose to the degeneration of cartilage.

Several models have also sought to explain the association between obesity and the development of degenerative joint disease. It has been suggested that obesity leads to the repetitive application of excessive axial loading forces on the surface of a joint, resulting in degeneration of articular cartilage and inhibits its repair.

Although it has been shown that obesity predisposes to premature osteoarthritis (OA) in large weight-bearing joints, it has not been ascertained whether this is associated with a requirement for hip and knee replacement at a younger age. We have, therefore, examined the relationship between obesity and the age at which hip and knee replacements are undertaken at our centre.

Patients and Methods

Our data on patients who had undergone primary hip or knee replacement were gathered from three sources. The first was the database established for the Joint Replacement Review Programme at St Helier Hospital, Carshalton, United Kingdom. This programme monitored patients whose hip or knee replacement had been performed between 1995 and 2004. The second source was the parallel database at St Anthony’s Hospital, Cheam, United Kingdom, which monitored patients whose hip or knee
replacement had been performed since 1995, and the third was the database used to track patients who had undergone hip or knee replacement at the South West London Elective Orthopaedic centre since January 2004. Unfortunately, the transcription of the patients’ pre-operative height and weight from the hospital records to our databases was inconsistent and we have only been able to extract a complete dataset for 1369 patients.

We subdivided our patients according to whether they underwent hip or knee replacement. In cases in which the same patient underwent both types of replacement, we included the pre-operative data for each, as available. For patients undergoing bilateral replacement of the hip or knee, the data have been recorded as a single procedure.

Our dataset comprised the following information for each patient: the age, height and weight at the time of surgery, the pre-operative Oxford hip score (OHS)\(^{13}\) or Oxford knee score (OKS)\(^{14}\) and the BMI calculated by the formula:

\[
\text{BMI} = \frac{\text{weight in kg}}{\text{height in metres}^2}
\]

The patients were divided into five subgroups according to their BMI: normal (< 25 kg/m\(^2\)), overweight (25 kg/m\(^2\) to 29.9 kg/m\(^2\)), moderately obese (30 kg/m\(^2\) to 34.9 kg/m\(^2\)), severely obese (35 kg/m\(^2\) to 39.9 kg/m\(^2\)) and morbidly obese (≥ 40 kg/m\(^2\)). In order to analyse the results, we designated the group of patients with a BMI < 25 kg/m\(^2\) as our control group.

**Statistical analysis.** This was undertaken using an independent sample \(t\)-test on SPSS software version 15 (SPSS Inc., Chicago, Illinois). The level of statistical significance was set at \(p \leq 0.05\). Pearson’s correlation coefficient \((r)\) was determined between BMI and age at surgery.

**Results**

**Hip replacement.** We analysed 1025 patients. Their mean age at surgery was 65 years (25 to 93). The mean age and OHS at surgery for each subgroup is shown in Table I and Figure 1. No statistical difference was identified between the mean OHS of the subgroups compared with the control group \((p > 0.05)\). A statistically significant correlation between the age at surgery and BMI for those undergoing hip replacement \((r = 0.1; p < 0.001)\) was seen. A progressive and statistically significant fall in the age at which hip replacement was undertaken was only observed as the BMI increased to 35 kg/m\(^2\) or more \((p < 0.05)\). The mean age of the morbidly obese patients \((\text{BMI} \geq 40 \text{ kg/m}^2)\) was ten years less that of those with normal weight for their height.

**Knee replacement.** We analysed 344 patients. Their mean age at surgery was 72 years (44 to 90). The mean OKS and the mean age at surgery for each subgroup is shown in Table II and Figure 2. As was shown for hip replacement there was no statistical difference between the mean OKS of the different subgroups compared with the control group \((p > 0.05)\). A statistically significant correlation was found between the age at surgery and the BMI for those undergoing knee replacement \((r = 0.3; p < 0.001)\). A progressive fall in the age at which knee replacement was undertaken was seen across all the subgroups. However, this was only statistically significant when the BMI reached 35 kg/m\(^2\) or more \((p = 0.001)\). The mean age of the morbidly obese patients was 13 years less than those with normal weight for their height.

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**Table I.** Mean values for the Oxford hip score\(^{13}\) (OHS) (95% confidence interval (CI)) and age (range) at surgery, for the different body mass index (BMI) groups, in 1025 patients treated by hip replacement

<table>
<thead>
<tr>
<th>Group (BMI in kg/m(^2))</th>
<th>Number of patients</th>
<th>OHS at surgery (p-value* )</th>
<th>Age at surgery (yrs) (p-value* )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (&lt; 25)</td>
<td>281</td>
<td>41 (41 to 43) –</td>
<td>71 (32 to 92) –</td>
</tr>
<tr>
<td>Overweight (25 to 29.9)</td>
<td>491</td>
<td>42 (41 to 43) 0.8</td>
<td>68 (26 to 93) 0.05</td>
</tr>
<tr>
<td>Moderately obese (30 to 34.9)</td>
<td>163</td>
<td>43 (42 to 45) 0.1</td>
<td>69 (25 to 90) 0.2</td>
</tr>
<tr>
<td>Severely obese (35 to 39.9)</td>
<td>67</td>
<td>44 (42 to 46) 0.4</td>
<td>65 (36 to 86) 0.01</td>
</tr>
<tr>
<td>Morbidly obese (≥ 40)</td>
<td>23</td>
<td>47 (42 to 52) 0.06</td>
<td>61 (40 to 81) 0.002</td>
</tr>
</tbody>
</table>

* \(t\)-test

**Fig. 1**

Bar chart showing the mean Oxford hip score\(^{13}\) (OHS) and the mean age at surgery for each subgroup in patients treated by hip replacement.
Discussion

We were only able to extract a complete dataset from just over 10% of the patients in our three databases. This is a clear example of a poorly-structured process which ensured completion of questionnaires by patients, but which failed to generate translation of the data on the BMI from the hospital notes to the databases. This problem has now been addressed.

Our use of patients with a normal BMI as a control group was an arbitrary decision which is justified on the basis that these individuals are of normal weight for their height. The absence of any difference in the pre-operative OHS and OKS between the different subgroups reduces any potential selection bias or inconsistency in the selection of patients for joint replacement.

Previously published studies in the literature have shown an association between an increasing BMI and the development of OA. Manek et al.\textsuperscript{12} reported a strong association between a high BMI and the presence of OA of the knee in female twins with a mean age of 54.5 years. A moderate association of OA of the hip with obesity has also been described in previous studies.\textsuperscript{5,11}

We have observed that both hip and knee replacements were undertaken at a younger age as the BMI increased above normal. However, statistical significance was not reached until the BMI reached 35 kg/m\textsuperscript{2}.

Our study shows that severe obesity is associated with a premature requirement for hip and knee replacement. The association is stronger for patients requiring knee replacement than for hip replacement and the age difference is greater. This finding correlates with the weak to moderate relationship described in the literature between the BMI and OA of the hip.\textsuperscript{5,11}

Relatively few of our patients were morbidly obese. In part this was a result of the relatively small percentage of the population with a BMI > 40 kg/m\textsuperscript{2}. Also, it has been shown that a proportion of morbidly obese patients will be unfit for hip or knee replacement because of co-morbidities.\textsuperscript{15}

Previous studies comparing the clinical and radiological results of hip\textsuperscript{16} and knee\textsuperscript{17} replacement in obese compared with non-obese patients have reported a lower age at surgery for obese patients. However, these studies did not explore the effect of increasing obesity or identify the magnitude of the reduction in the mean age at surgery in relation to the BMI subgroups.

The rising incidence of obesity in the developed world is a source of constant media attention. From an orthopaedic point of view we should expect a growing number of patients to present for hip and knee replacement surgery at a younger age than has been hitherto accepted. It remains to be seen whether these interventions will provide such patients with a satisfactory lifetime solution for their degenerative joint disease.

We acknowledge the valuable contribution to this study of Mr P. Moonot (MS, MRCS) and other members of the research team.

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References


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Table II. Mean values for the Oxford knee score\textsuperscript{14} (OKS) (95% confidence interval (CI)) and age (range) at surgery for the different body mass index (BMI) groups in 344 patients treated by knee replacement.

<table>
<thead>
<tr>
<th>Group (BMI in kg/m\textsuperscript{2})</th>
<th>Number of patients</th>
<th>OKS at surgery p-value*</th>
<th>Age at surgery (yrs) p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (&lt; 25)</td>
<td>59</td>
<td>40 (38 to 43)</td>
<td>–</td>
</tr>
<tr>
<td>Overweight (25 to 29.9)</td>
<td>134</td>
<td>40 (38 to 41)</td>
<td>0.5</td>
</tr>
<tr>
<td>Moderately obese (30 to 34.9)</td>
<td>104</td>
<td>40 (38 to 42)</td>
<td>0.5</td>
</tr>
<tr>
<td>Severely obese (35 to 39.9)</td>
<td>36</td>
<td>43 (40 to 46)</td>
<td>0.11</td>
</tr>
<tr>
<td>Morbidly obese (≥ 40)</td>
<td>11</td>
<td>47 (38 to 48)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

* t-test

Fig. 2

Bar chart showing the mean Oxford knee score\textsuperscript{14} (OKS) and the mean age at surgery for each subgroup in patients treated by knee replacement.


