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The Effect of Obesity on the Clinical, Functional and Radiological Outcome of Cementless Total Hip Replacement: A Case-Matched Study With a Minimum 10-Year Follow-Up

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ABSTRACT

1420 primary cementless THRs with a minimum follow-up of 10-years were stratified according to BMI: non-obese (BMI < 30 kg/m^2) and obese (BMI ≥ 30 kg/m^2). Median age at surgery was younger in obese patients ($P < 0.001$). We case-matched 82 THRs in obese patients with 162 THRs in non-obese patients. No difference between groups was found in improvement in HHS ($P = 0.668$), satisfaction with surgery ($P = 0.644$), range of movement, prosthesis orientation, or radiological loosening. The obese cohort was further separated into those with a BMI below and above 35. No difference was found between groups in improvement in HHS, satisfaction with surgery, component orientation, or radiological loosening. There was no difference in the incidence of post-operative complications between obese and non-obese patients. After 10-years, the results of THR are not compromised by obesity.

The World Health Organisation (WHO) has defined obesity as a body mass index (BMI) of ≥30 kg/m^2, with the rise in obesity within the Western World being described as reaching epidemic proportions [1]. Obesity is associated with a number of medical conditions, including coronary artery disease, hypertension, stroke, type 2 diabetes, and osteoarthritis [2]. Obese patients are far more likely to require lower limb joint arthroplasty than non-obese patients [3]. As such, the rise in the numbers of obese individuals has seen a correlation with the number of patients undergoing total hip replacement (THR) [4]. A significant association has been demonstrated between a lower age at THR and an increasing BMI [5]. However, there is a paucity of evidence regarding the long-term results of THR in the obese patient. Perhaps this reflects a reluctance of some surgeons to operate on this cohort — indeed, Charnley [6] recommended that obesity should be a contraindication to THR. Furthermore, some NHS Primary Care Trusts have refused to fund lower limb joint arthroplasty surgery based on a patient's BMI [7]. It has been suggested that performing hip arthroplasty surgery on obese patients may result in a greater incidence of poor component positioning [8,9]. Therefore, it is important to determine the implications of obesity on the clinical, functional and radiological results in THR. We hypothesise that, after 10 years, obese patients have comparable clinical and radiological outcome to non-obese patients. Our aim here was to review the clinical and radiological results of obese patients who underwent cementless THR greater than 10 years ago and compare their data with matched non-obese patients.

Patients and Methods

We examined the results of 1420 consecutive primary cementless THRs which had been performed in 1301 patients between 1997 and 2003. The data from all operations and clinical and radiological examinations were routinely collected prospectively and stored in a database. The clinicians who were responsible for collecting the data (WLW, WKW, BAZ) were blinded to the study. Consent was obtained from all patients for the use of anonymous information for ongoing research projects.

All the procedures took place in a single institution, with the surgery being performed by one of two experienced surgeons (WKW, BAZ). The joint arthroplasty surgery was performed within a high air-flow environment, utilising a posterior approach to the hip joint. All the patients had an ABG2 (Stryker, Mahwah, New Jersey) cementless femoral component implanted, with 1345 also receiving an ABG2 (Stryker) cementless acetabular component. In the

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remaining 75 operations, cementless acetabular components of similar design were utilised. The ABG2 femoral component is an anatomical stem, composed of a $Ti_{12}Mo_6Zr_2Fe$ alloy with a proximal metaphyseal hydroxyapatite (HA) coating. The ABG2 acetabular component is manufactured using a $TiAl_6V_4$ alloy and is a hemispherical design with an HA coating. Of the 1420 hips, bearing combinations included ceramic-on-ceramic, ceramic-on-polyethylene and cobalt chrome-on-polyethylene. Post-operatively, patients had a standardised protocol, that included both mechanical and chemical thromboprophylactic measures, 48 hours of intravenous antibiotics, and mobilisation fully weight bearing as tolerated, under the supervision of physiotherapists. Patients were then followed-up at regular intervals. At each follow-up, patients were asked to complete a questionnaire and underwent a clinical examination performed by one of three senior surgeons (WLW, WKW, BAZ).

The patient's BMI was calculated by dividing their weight in kilogrammes by their height in metres squared. This data was collected at a pre-operative assessment, typically performed between 2 and 4 weeks prior to their joint arthroplasty surgery. It is the policy within our institution not to refuse THR purely on the grounds of a raised BMI. No other pre-operative selection criteria were applied. For the purposes of data analysis, patients were either categorised into obese (BMI $\geq$ 30 kg/m^2) and non-obese (BMI < 30 kg/m^2).

The clinical outcome of the surgery was assessed using the Harris hip score [10] (HHS) a valid and reliable test for determining the outcome of total hip arthroplasty [11]. Known complications specifically relating to the prosthesis (peri-prosthetic fracture, dislocation and infection) were recorded in the database regardless of time after surgery and whether or not the complications were treated at our institution. Our national joint registry was not used to determine the incidence of complications, as only revision rates due to those complications are noted. Infection was defined as deep infection that required surgical intervention. Pulmonary embolism was detected by CT pulmonary angiography. Cerebrovascular accident (CVA) was diagnosed by CT. Cardiovascular complications were only recorded if they occurred within 3 months of the surgery. Other peri-operative data such as superficial wound complications that did not progress to deep infection, transfusion rates, analgesia requirements and lower respiratory tract infections were not recorded.

Patient satisfaction with the surgery was determined using a ten-point visual analogue scale in which zero indicated complete dissatisfaction and ten points total satisfaction. The post-operative range of movement was independently assessed at each clinical follow-up by one of the senior authors (WLW, WKW, BAZ). Radiological assessment of the hip prostheses was performed utilising anteroposterior (AP) pelvic and lateral radiographs. The images were scored by arthroplasty fellows who were blinded to the patient's BMI. None of the arthroplasty fellows were involved in the initial surgery or subsequent clinical follow-up. The radiological assessment of the acetabular component included evaluation for the presence or absence of radiolucent lines and osteolysis according to the three zones described by DeLee and Charnley [12]. The cup inclination (the angle between the face of the component and the transverse axis of the pelvis) was also measured [13]. Each of the seven zones of the femoral component described by Gruen et al [14] was assessed for the presence or absence of radiolucency, osteolysis, femoral cortical hypertrophy, and stress shielding. These areas were also examined for the presence of endosteal weld spots between the implant and surrounding bone [15]. Alignment of the femoral component was classified as either being neutral or non-neutral (varus or valgus). Femoral components were examined for evidence of subsidence by comparing serial radiographs.

A case matched study was performed on all obese patients who had their original primary THR in situ, and had minimum clinical and radiological follow-up of ten years. Patients were matched on the basis of age within 2.5 years, gender, laterality, surgeon, pre-operative diagnosis, and bearing configuration. Given the broad spectrum of co-existing diseases in THR patients, it proved impossible to match patients for co-morbidities. However, pre-operatively, all patients underwent a full anaesthetic assessment to identify and optimise any significant co-morbidities. All case-matched patients had ABG2 femoral and acetabular components implanted. Patients were excluded if any of the required data were incomplete or missing. After application of all inclusion and exclusion criteria we were able to match 82 hip arthroplasties performed in obese patients with those performed in non-obese patients. In all but two cases, we were able to match two non-obese to one obese THR, resulting in a total of 162 hips in the control (non-obese) cohort. A subsequent subgroup analysis of the obese cohort was performed by dividing these patients according to BMI 30–34.9 kg/m^2 (n = 55) and BMI > 35 kg/m^2 (n = 27).

Sample Size

Having identified HHS as the primary indicator of functional outcome, presuming a normal distribution of HHS, a minimum of 73 cases per group was needed to detect a change of 7 points (SD = 15), with a two sided 5% significance level and 80% power [16]. A change of 7 points is the smallest change necessary to suggest a clinically important difference [17].

Statistical Analysis

The results of the analyses were compared using the paired and unpaired two-tailed t-tests. Statistical analysis of the presence or absence of radiographic abnormalities and post-operative complications was performed with Chi-squared tests, with significance set at $P < 0.05$.

Results

Demographics

In the entire series (Table 1), the median age at time of surgery of non-obese patients was 6.8 years older than that of obese patients ($P < 0.001$). The proportion of males to females was 1:1.2 in the non-obese groups and 1:1.1 in the obese group. The demographics of the case-matched series are recorded in Table 2.

Harris Hip Score

In the case matched study, the obese cohort demonstrated statistically significant lower mean pre-operative HHS ($P = 0.006$) (Table 3). Individual components of the pre-operative HHS were not available for analysis, however, post-operatively, the obese patients had significantly worse scores for function ($P < 0.001$) and activities ($P < 0.001$). The total mean HHS was also significantly worse in the obese cohort ($P < 0.001$). However, the obese cohort demonstrated an equivalent mean improvement in HHS (36.5) when compared with the non-obese cohort (35.3, $P = 0.668$).

Table 1
Details for Analysis of the Entire Series.

	All	Non-Obese	Obese	*P* Value
Total Number Implants (%)	1420	1154 (81.3)	266 (18.7)	
Total Number Patients (%)	1301	1060 (81.5)	241 (18.5)	
Gender (%)				
Male	604	489 (81)	115 (19)	
Female	697	571 (81.9)	126 (18.1)	
Median Age in Years (SD)	67.8 (11.6)	69.2 (11.5)	62.4 (10.8)	<0.001
Mean BMI (SD)	26.5 (4.6)	24.8 (2.9)	33.7 (3.2)	

Data analysis: Student T-test.