Outcomes and complications of total hip replacement in super-obese patients

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The purpose of this study was to examine the complications and outcomes of total hip replacement (THR) in super-obese patients (body mass index (BMI) > 50 kg/m^2) compared with class I obese (BMI 30 to 34.9 kg/m^2) and normal-weight patients (BMI 18.5 to 24.9 kg/m^2), as defined by the World Health Organization.

A total of 39 THRs were performed in 30 super-obese patients with a mean age of 53 years (31 to 72), who were followed for a mean of 4.2 years (2.0 to 11.7). This group was matched with two cohorts of normal-weight and class I obese patients, each comprising 39 THRs in 39 patients. Statistical analysis was performed to determine differences among these groups with respect to complications and satisfaction based on the Western Ontario and McMaster Universities (WOMAC) osteoarthritis index, the Harris hip score (HHS) and the Short-Form (SF)-12 questionnaire.

Super-obese patients experienced significantly longer hospital stays and higher rates of major complications and readmissions than normal-weight and class I obese patients. Although super-obese patients demonstrated reduced pre-operative and post-operative satisfaction scores, there was no significant difference in improvement, or change in the score, with respect to HHS or the WOMAC osteoarthritis index.

Super-obese patients obtain similar satisfaction outcomes as class I obese and normal-weight patients with respect to improvement in their scores. However, they experience a significant increase in length of hospital stay and major complication and readmission rates.

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Obesity is a global problem, estimated to affect 500 million people worldwide.[1] The World Health Organization classifies obesity based on body mass index (BMI): patients with normal weight are considered to have a BMI between 18.5 and 24.9 kg/m^2 and overweight patients a BMI between 25 and 29.9 kg/m^2.[2] Obesity is defined as BMI ≥ 30 kg/m^2, and subdivided into class I (30 to 34.9 kg/m^2), class II (35 to 39.9 kg/m^2) and class III (≥ 40 kg/m^2), the latter termed 'morbid obesity'.[1] Among Canadians, 24% are obese and approximately 3% are morbidly obese.[3] It is well known that obesity leads to a multitude of adverse health outcomes, including hypertension, coronary artery disease, liver disease, type 2 diabetes, obstructive sleep apnoea and osteoarthritis.[4] It has been demonstrated that morbidly obese patients require total hip (THR) and total knee replacement (TKR) approximately 8.5 and 32.7 times more than normal-weight patients, respectively.[5] Furthermore, morbidly obese patients will require THR and TKR earlier than normal-weight patients by approximately ten and 13 years, respectively.[6] Many studies have demonstrated no increased risk to obese patients undergoing total joint arthroplasty,[7-10] but others have documented complications, notably infection, in these patients.[11-14] As the worldwide prevalence of obesity continues to increase, new terms are emerging. Specifically, studies are now examining patients with BMI > 50 kg/m^2, which has been given the designation of 'super-obese'.[15,16] There has been little research in the arthroplasty literature examining this particular group of patients. We proposed that super-obese patients would experience a significant increase in peri-operative morbidity compared with normal-weight patients.

Patients and Methods

Ethical approval was obtained from our institutional review board. We retrospectively reviewed the medical records in our institutional database from 1998 to 2009 of patients who underwent primary THR to identify those with a BMI > 50 kg/m^2 at the time of surgery. A total of 39 hips in 30 patients were identified with a minimum two-year follow-up. These patients were matched with 39 normal-weight

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Table I. Demographic data for normal-weight (body mass index (BMI) 18.5 to 24.9 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and super-obese (BMI > 50 kg/m^2) patients

Characteristic	Normal-weight	Class I obese	Super-obese	p-value
Patients/hips (n)	39/39	39/39	30/39	1.00*
Mean age (yrs) (range)	53.1 (29 to 72)	52.6 (30 to 72)	53.0 (31 to 72)	0.98†
Female (n, %)	33 (*85*)	31 (*79*)	25 (*83*)	0.84*
Indication (hips) (n, %)				
Osteoarthritis	27 (*69*)	22 (*56*)	24 (*62*)	0.50*
Inflammatory arthritis	1 (*3*)	0 (*0*)	0 (*0*)	0.37*
Post-traumatic arthritis	2 (*5*)	3 (*8*)	4 (*10*)	0.70*
Childhood hip dysplasia	9 (*23*)	14 (*36*)	11 (*28*)	0.46*
Mean time since surgery (yrs) (range)	6.6 (2 to 13)	7.0 (3 to 14)	6.7 (3 to 15)	0.89†
Mean follow-up (yrs) (range)	5.0 (2.0 to 12.3)	4.3 (2.0 to 12.5)	4.2 (2.0 to 11.7)	0.27†

* Pearson's chi-squared test
† ANOVA with Tukey's

patients (39 hips) and 39 class I obese patients (39 hips) with regard to primary diagnosis, gender, side of surgery, age and time since surgery. All surgeons contributing to the database were fully trained as independently practising surgeons who undertook a minimum of 100 primary THRs annually. Patients were operated on via a lateral or posterior approach. Post-operatively, patients were placed on antibiotic prophylaxis for 24 hours and provided with thromboembolic prophylaxis using either low-molecular-weight heparin or warfarin for a period of between 14 and 30 days.

The patients' medical records were reviewed to establish the presence of comorbidities, including cardiorespiratory disease, cerebrovascular disease, obstructive sleep apnoea, hypertension, type 2 diabetes and smoking. Technical information was gathered, including the prosthesis used and its manufacturer, material and method of fixation. A multitude of different hip systems were used during period of study. However, Smith and Nephew (Reflection, Synergy; London, United Kingdom) and DePuy (Duraloc, Pinnacle, Summit; Warsaw, Indiana) systems comprised the vast majority of components used. Peri-operative variables were gathered, including length of hospital stay, surgical time and pre- and post-operative haemoglobin levels. Finally, peri-operative complications were documented and were divided into major (including deep infection, dislocation, peri-prosthetic fracture, aseptic loosening, pulmonary embolus and acute kidney injury) and minor categories (including superficial infection, requirement for blood transfusion, urinary tract infection, deep-vein thrombosis and intra-operative fracture). A major complication was defined as one that resulted in revision surgery or injury to major organs. At discharge, patients were sent home, to their regional hospital or to a separate rehabilitation facility. The decision to transfer a patient to either of the latter institutions was based on the opinion of the treating physiotherapist and physician.

The patients' functional scores were obtained from our database. The pre-operative and post-operative Western Ontario and McMaster Universities (WOMAC) osteoarthritis index,[17,18] Harris hip score (HHS)[19] and Short-Form (SF)-12[20] (mental and physical components) outcome scores were used. Total composite scores are represented.

Statistical analysis. Data analysis included comparison of pre- and post-operative WOMAC, HHS and SF-12 scores as well as the change in outcome scores between super-obese, class I obese and normal-weight groups. Groups were also compared based on major and minor complication rates, and rate of readmission. Statistical testing was performed using SPSS v. 21 (IBM, Armonk, New York). Analysis of variance (ANOVA) with Tukey's test for multiple comparisons was used to test for the differences in continuous variables, and Pearson chi-squared analysis was used to test for the difference in non-numeric or categorical variables. A p-value < 0.05 was considered significant.

Results

In all, 39 THRs were performed in 30 super-obese patients and matched with class I obese and normal-weight controls (Table I). The medical comorbidities of the groups are shown in Table II. There were significantly more patients with type 2 diabetes (chi-squared test, p < 0.001), hypertension (chi-squared test, p = 0.01) and obstructive sleep apnoea (chi-squared test, p = 0.01) in the super-obese group than in the class I obese and normal-weight groups. The types of implant and methods of fixation were not significantly different among the groups (Table III).

Complete pre- and post-operative outcome scores were available for 25 THRs in 19 super-obese patients. However, all data in the super-obese group, complete and partial, is included in Figure 1. Super-obese patients demonstrated significantly lower mean pre- and post-operative WOMAC scores than class I obese (ANOVA with Tukey's, p = 0.004 and p = 0.001, respectively) and normal-weight patients (ANOVA with Tukey's, p = 0.02 and p < 0.001, respectively). However, there was no significant difference in the change in the WOMAC osteoarthritis indices comparing the super-obese group with class I obese (p = 0.82) and normal-weight

Table II. Medical comorbidities at the time of hip replacement in normal-weight (body mass index (BMI) 18.5 to 24.9 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and super-obese patients (BMI > 50 kg/m^2)

Comorbidity (n, %)	Normal-weight (39 patients)	Class I obese (39 patients)	Super-obese (30 patients)	p-value*
Smoking	3 (*8*)	3 (*8*)	6 (*20*)	0.11
Type 2 diabetes	1 (*3*)	1 (*3*)	11 (*37*)	< 0.001
Hypertension	10 (*26*)	11 (*28*)	22 (*73*)	0.01
Coronary artery disease	1 (*3*)	0	4 (*13*)	0.07
Obstructive sleep apnoea	0	1 (*3*)	7 (*23*)	0.01

* Pearson's chi-squared test

Table III. Implant specifications in normal-weight (body mass index (BMI) 18.5 to 24.9 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and super-obese patients (BMI > 50 kg/m^2)

Implant	Normal-weight (n = 39 THRs)	Class I obese (n = 39 THRs)	Super-obese (n = 39 THRs)	p-value*
Acetabular component (n, %)				
Press-fit fixation without screws	22 (*56*)	28 (*72*)	27 (*69*)	0.35
Press-fit fixation with screws	17 (*44*)	10 (*25*)	12 (*31*)	0.34
Cemented fixation	0	1 (*3*)	0	0.37
Stem component (n, %)				
Cementless stem fixation	39 (*100*)	38 (*97*)	38 (*97*)	0.36
Cemented stem fixation	0	1 (*3*)	1 (*3*)	0.36
Liner (n, %)				
Lip	8 (*21*)	8 (*21*)	15 (*38*)	0.09
Neutral	31 (*79*)	31 (*79*)	24 (*62*)	0.09
Neck (n, %)				
Standard-offset	25 (*64*)	18 (*46*)	17 (*44*)	0.08
High-offset	14 (*36*)	21 (*54*)	22 (*56*)	0.14

* Pearson's chi-squared test

patients (p = 0.36) (Fig. 1a). Regarding the mean HHS, the super-obese patients demonstrated significantly lower pre- and post-operative scores than class I obese (ANOVA with Tukey's, p < 0.001 and p < 0.001, respectively) and normal-weight patients (ANOVA with Tukey's, p < 0.001 and p < 0.001, respectively). However, there was no significant difference in the change in the HHS comparing the super-obese group with class I obese (ANOVA with Tukey's, p = 0.80) and normal-weight patients (ANOVA with Tukey's, p = 1.00) (Fig. 1b). For the mean SF-12 mental scores super-obese patients demonstrated a significantly lower pre-operative score compared with class I obese patients (ANOVA with Tukey's, p = 0.05). Additionally super-obese patients demonstrated a significantly lower post-operative score than class I obese (ANOVA with Tukey's, p = 0.03) and normal-weight patients (ANOVA with Tukey's, p = 0.02). However, there was no difference in the change in the SF-12 mental score when the super-obese group were compared with class I obese (ANOVA with Tukey's, p = 0.97) and normal-weight patients (ANOVA with Tukey's, p = 0.66) (Fig. 1c). The super-obese patients demonstrated significantly lower mean SF-12 physical scores pre- and post-operatively, as well as the mean change in the score, compared with class I obese (ANOVA with Tukey's, p = 0.24, p < 0.001 and p = 0.02, respectively) and normal-weight patients (ANOVA with Tukey's, p = 0.04, p < 0.001 and p = 0.03, respectively) (Fig. 1d).

Super-obese patients were found to have a significant increase in both major (chi-squared test, p = 0.01) and minor complications (chi-squared test, p = 0.02) compared with class I obese and normal-weight patients (Fig. 2). Major complications in the super-obese group included three deep infections, which arose at 15 days, 8.3 weeks and ten years post-operatively, respectively. There was also one dislocation associated with a fracture of the greater trochanter at 3.8 weeks post-operatively, one Vancouver B2 peri-prosthetic fracture[21] at 20.1 weeks post-operatively, one case of acute kidney injury and one pulmonary embolism. Two patients in the super-obese group had died at the time of this review from causes unrelated to their surgery. In the super-obese there were six readmissions with re-operation, comprising four wound lavages and debridements, one revision for peri-prosthetic fracture and one revision for dislocation. In the class I obese patients there were two readmissions, but no readmissions among the normal-weight patients. The increased incidence of readmission and reoperation for super-obese patients was statistically significant (chi-squared test, p = 0.03).

We found no statistical difference among groups with respect to change in the mean pre- and post-operative haemoglobin levels measured on post-operative day 3. However, the mean hospital stay for super-obese patients was significantly longer than for class I obese (ANOVA with

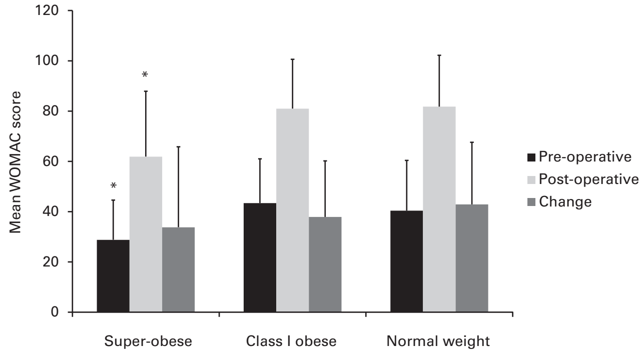

Fig. 1a

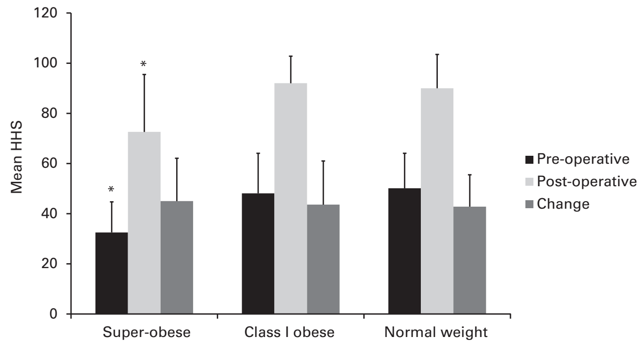

Fig. 1b

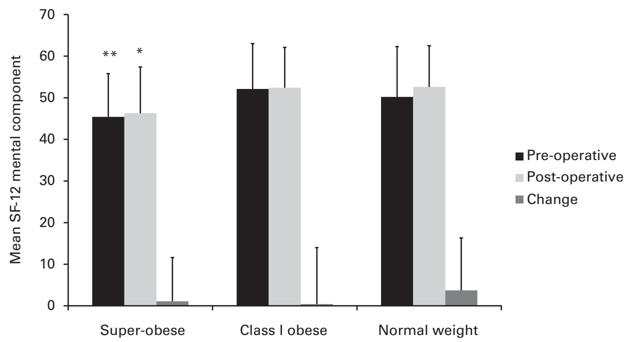

Fig. 1c

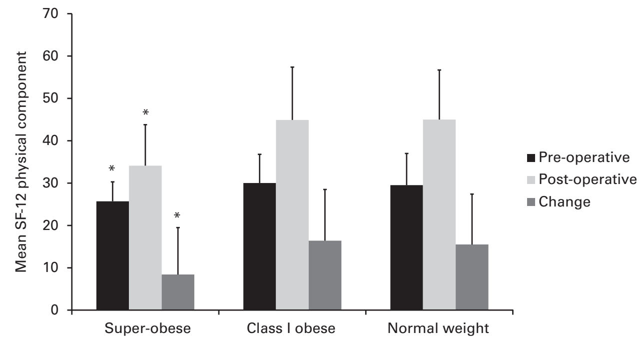

Fig. 1d

Histograms showing the mean a) Western Ontario and McMaster Universities (WOMAC) index, b) Harris hip score (HHS), c) Short-Form (SF)-12 mental component and d) SF-12 physical component scores in super-obese (body mass index (BMI) > 50 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and normal-weight patients (BMI 18.5 to 24.9 kg/m^2). The error bars represent the 95% confidence intervals. * indicates a statistically significant difference compared with both class I obese and normal-weight patients, and ** a significant difference compared with class I obese patients only (see text for full p-values).

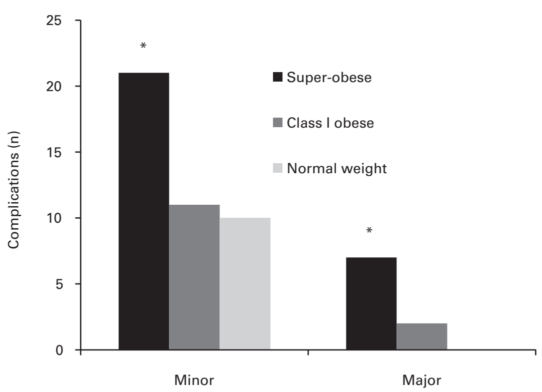

Fig. 2

Histogram showing the incidence of major and minor complications following total hip replacement in super-obese (body mass index (BMI) > 50 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and normal-weight patients (BMI 18.5 to 24.9 kg/m^2). * indicates a statistically significant difference compared with class I obese and normal-weight patients (see text for full p-values).

Tukey's, p = 0.01) and normal-weight patients (ANOVA with Tukey's, p = 0.03) (Table IV). Furthermore, a significantly higher number of super-obese patients required transfer to their regional hospital or rehabilitation facility before going home compared with class I obese or normal-weight patients (chi-squared test, p = 0.001).

Discussion

Our study demonstrates a significant morbidity associated with super-obese patients undergoing THR. Specifically, we have shown that super-obese patients have an approximately sevenfold increase in major complications compared with normal-weight patients, as well as a longer hospital stay. Six major complications were experienced within six months of surgery. These findings are similar to those of a study by Schwarzkopf et al,[16] who demonstrated a significant increase in peri-operative complications and length of hospital stay in patients with BMIs > 45 kg/m^2. This group also found that these variables increased in a linear fashion with every 5 kg/m^2 increase in BMI. Similarly, a meta-analysis published by Haverkamp et al[22] compared the complication rate in patients with BMIs > 30 kg/m^2 with that of normal-weight patients. After pooling data from 15 studies, they demonstrated an increase in dislocation, aseptic loosening, infection and venous thromboembolism in obese patients compared to normal-weight patients. These findings are similar to complication rates seen in our study.

Table IV. Peri-operative variables in normal-weight (body mass index (BMI) 18.5 to 24.9 kg/m^2), class I obese (BMI 30.0 to 34.9 kg/m^2) and super-obese patients (BMI > 50 kg/m^2)

Variable	Normal-weight (n = 39 THRs)	Class I obese (n = 39 THRs)	Super-obese (n = 39 THRs)	p-value
Approach (n, %)				
Lateral	37 (*95*)	37 (*95*)	37 (*95*)	1.00*
Posterior	2 (*5*)	2 (*5*)	2 (*5*)	1.00*
Mean surgical time (mins) (range)	98.6 (62 to 187)	93.1 (64 to 155)	93.5 (52 to 142)	0.74†
Mean fall in haemoglobin (range)	41.7 (12 to 73)	39.4 (11 to 63)	38.7 (20 to 66)	0.52†
Mean hospital stay (days) (range)	5.2 (2 to 14)	4.9 (3 to 10)	7.0 (3 to 28)	0.01†
Patients requiring rehabilitation facility (%)	0% (0 of 39)	5% (2 of 39)	37 (11 of 30)	0.001*

* Pearson's chi-squared test
† ANOVA with Tukey's

Our study also demonstrates that super-obese patients undergoing THR obtain a similar benefit with respect to pain relief and function, which is consistent with a previous study by McCalden et al[23] in morbidly obese patients. Specifically, with respect to HHS, WOMAC and SF-12, there was no significant difference in change score between groups. This study suggests that morbidly obese patients should not be prevented from obtaining access to THR because of weight alone, and this is supported by other studies.[24,25] Studies have also examined the effect of arthroplasty on post-operative weight loss as a result of increased ability to walk. Surprisingly, a study by Middleton and Boardman[26] showed that patients demonstrated increases in BMI following THR regardless of pre-operative BMI or gender. This has been supported by similar studies[27,28] and suggests that weight loss in obese patients is not promoted by pain-alleviating arthroplasty surgery.

In our study, two patients in the super-obese group had previously undergone gastric-bypass procedures, but unfortunately these had failed to provide long-term weight loss. Previous studies have examined the utility of bariatric surgery prior to arthroplasty surgery. Specifically, Kulkarni et al[29] examined a population of obese patients, some of whom received bariatric surgery prior to total joint replacement and some who received the surgery after total joint replacement. They found a 3.5-fold reduction in the rate of infection and a sevenfold reduction in 30-day readmission in patients undergoing bariatric surgery before total joint arthroplasty. The cost-effectiveness of treating obesity with a form of bariatric surgery has also been demonstrated previously.[30] However, bariatric surgery also carries risks and an overall mortality of 0.28%, which must be taken into consideration.[30]

Several regions in the United Kingdom are now implementing weight loss strategies before total joint arthroplasty.[31] Although obesity is not a contraindication to referral, many hospitals are seeking evidence to support an attempt at weight loss in patients with BMIs > 40.0 kg/m^2 before considering the patient as a candidate for joint replacement.[32-34] Given the incidence of complications seen in super-obese patients, this trend is likely to continue. Furthermore, in the United States, hospitals and physicians may soon be ranked by the Center for Medicare and Medicaid Services (CMS) based on arthroplasty-specific outcomes.[35,36] These include the risk-standardised complication rate and the risk-standardised 30-day all-cause readmission rate. Based on these criteria, physicians and hospitals may be inclined to refuse treatment to patients who are super-obese to keep their complication rates low. In an attempt to reduce this bias, we would recommend that super-obese patients be placed in a specific category by the CMS.

This study has limitations, including the retrospective collation of data, the relatively small sample size and the use of a database to which multiple surgeons contribute. However, its strengths include the matched controls and outcome scores. It is also the only study in the literature to date that examines complications as well as outcome scores of super-obese patients undergoing THR.

In conclusion, we have demonstrated a significant increase in major complications, readmission rates and length of stay in hospital in super-obese patients compared with class I obese and normal-weight patients. Super-obese patients have lower pre- and post-operative outcome scores but show similar changes in their WOMAC osteoarthritic indices and HHSs. Super-obese patients should be made aware that they can achieve significant clinical benefit from THR, but that the potential risks are higher than for normal-weight patients.

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