The impact of obesity on weight change and outcomes at 12 months in patients undergoing total hip arthroplasty

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ABSTRACT

Objectives: To establish the rate of clinically significant weight change after 12 months in patients who have had a primary total hip arthroplasty (THA); to identify patient characteristics that predicted weight loss or gain; and to compare clinical and functional outcomes between obese and non-obese patients.

Design, setting and participants: Prospective study of 471 patients who underwent THA between 2006 and 2007 at St Vincent's Hospital, Melbourne, a university-affiliated tertiary referral centre. Patients were classified as non-obese, obese and morbidly obese, and were assessed using the Harris Hip Score (HHS) and 12-item Short Form Health Survey (SF-12).

Main outcome measures: Incidence of weight loss or gain 12 months after surgery; preoperative patient variables predictive of weight change; functional and quality-of-life outcomes and rate of adverse events at 12 months; differences in outcomes between obese and non-obese patients.

Results: 194 patients (41%) were obese or morbidly obese. At 12-month follow-up, 18 obese or morbidly obese patients (9%) had lost ⩾ 5% of their preoperative weight and 118 patients (25%) had gained ⩾ 5% of their preoperative weight. No preoperative predictor of weight loss was identified, but weight gain was associated with lower preoperative SF-12 mental health scores (odds ratio [OR], 0.98 [95% CI, 0.96–0.99]; $P = 0.04$). There were no significant differences between obesity groups in improvement in HHS or SF-12 physical health scores. Improvement in SF-12 mental health scores was greater in obese (+ 3.6 [SD, 12.2]) and morbidly obese (+ 3.7 [SD, 9.4]) patients than in non-obese patients (– 0.1 [SD, 11.7]) ($P = 0.01$). Compared with non-obese patients, the odds of a postoperative complication were significantly greater in obese patients (OR, 1.81 [95% CI, 1.05–3.11]) and morbidly obese patients (OR, 5.77 [95% CI, 2.10-15.86]).

Conclusion: Clinically significant weight loss in obese patients after THA is uncommon. Obese and morbidly obese patients experience comparable reduction in pain and improvement in function after THA, but the risk of complications in the first 12 months after surgery is significantly greater than the risk in non-obese patients.

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Currently, in Australia, osteoarthritis accounts for a significant portion of the morbidity burden (4.8% of total years of life lived with disability), third only to depression (8.0%) and dementia (5.6%).[1] Fifteen per cent of the Australian population is afflicted with osteoarthritis.[2] Total joint arthroplasty is the treatment of choice (among suitably "fit" candidates) for end-stage osteoarthritis,[3] given its effectiveness in relieving pain and restoring function.[4-6]

Obesity is over-represented in patients presenting for total hip arthroplasty (THA).[7,8] However, little is known about the impact of obesity on postoperative outcomes and weight change. Results of current research on the impact of obesity on functional and quality-of-life (QOL) outcomes after THA are equivocal — possibly due, in part, to significant variation in study methodologies.[9-12] Studies that have examined weight change after THA consistently report that most obese patients do not lose weight after the procedure.[13-17] What is yet to be investigated is whether certain patient characteristics are predictive of weight change after hip replacement. Knowing this would enable health professionals to identify patients who are unlikely to lose weight and to accurately target such patients for appropriate intervention. With this in mind, the primary aims of our study were to establish the rate of clinically significant weight change after 12 months in patients who have had primary THA and to identify patient characteristics that predicted weight loss or gain. A secondary aim was to compare clinical and functional outcomes between obese and non-obese patients.

METHODS

Design and setting

We conducted a prospective cohort study of consecutive patients undergoing elective primary THA at St Vincent's Hospital, Melbourne (SVHM), a university-affiliated tertiary referral centre. Recruitment for the study commenced in January 2006 and finished in December 2007, and 12-month follow-up was completed by December 2008.

Selection criteria

All patients admitted to SVHM for elective primary THA between January 2006 and December 2007 were eligible for enrolment in the study. Patients undergoing arthroplasty for neoplastic disease or revision joint replacement, and those who did not give informed consent, were excluded. If patients had a staged bilateral hip replacement, only the second procedure was included in our analysis.

Data collection

All data were collected prospectively and entered into a dedicated database. Preoperative data were collected during a patient's preadmission clinic assessment, which occurred within 6 weeks of surgery. Operative data were collected during the patient's hospital stay, and 12-month follow-up data were recorded during a review appointment in the orthopaedic outpatients clinic. Data recorded before the operation included age, sex, height, weight, comorbidities, Charnley classification,[18] and functional and QOL assessments. Data recorded after the operation included length of stay, complications, discharge destination, functional and QOL assessments, and height and weight at 12 months.

Height and weight

Height and weight were measured at preadmission and at 12-month follow-up by health professionals independent of the study. The same two sets of weight scales (one in each clinic at preadmission and follow-up) were used throughout the study and were calibrated to ensure that they remained concordant at each weighing.

Health questionnaires

Functional assessment was monitored using the Harris Hip Score (HHS) for hip arthroplasty, a validated scoring system for hip

1 Demographics and operative details*

Variable	Non-obese ($n = 277$)†	Obese ($n = 173$)	Morbidly obese ($n = 21$)	*P*
Mean BMI (kg/m^2) (SD)	25.8 (2.9)	33.9 (2.8)	43.3 (3.0)	
Mean age (years) (SD)	68.6 (10.8)	67.0 (9.7)	65.6 (10.7)	0.18
Sex				0.04
Male ($n = 185$)	116 (63%)	66 (36%)	3 (2%)	
Female ($n = 286$)	161 (56%)	107 (37%)	18 (6%)	
Aetiology				0.70
Osteoarthritis	230 (58%)	148 (37%)	18 (5%)	
Rheumatoid arthritis	9 (47%)	8 (42%)	2 (11%)	
Necrosis	24 (67%)	11 (31%)	1 (3%)	
Congenital dysplasia of the hip	14 (70%)	6 (30%)	0	
Charnley classification				0.39
A	258 (60%)	158 (36%)	17 (4%)	
B	10 (53%)	7 (37%)	2 (11%)	
C	9 (47%)	8 (42%)	2 (11%)	
Mean number of comorbidities (SD)	2.3 (1.6)	2.8 (1.7)‡	2.8 (1.2)	< 0.01
Type of comorbity§				
Cardiovascular	155 (56%)	123 (71%)	15 (71%)	< 0.01
Diabetes	27 (10%)	35 (20%)	6 (29%)	< 0.01
Respiratory	42 (15%)	33 (19%)	5 (24%)	0.39
Cementation of prosthesis				0.34
Uncemented	56 (54%)	44 (42%)	4 (4%)	
Hybrid	192 (60%)	111 (35%)	17 (5%)	
Fully cemented	29 (62%)	18 (38%)	0	
Length of stay (days) (SD)	6.0 (2.2)	6.1 (1.7)	7.7 (7.8)‡	0.01
Discharge				0.85
To home	209 (59%)	131 (37%)	15 (4%)	
To rehabilitation	68 (59%)	42 (36%)	6 (5%)	

BMI = body mass index. * Data are number (%), except where otherwise specified. † Reference group. ‡ Denotes which comparison group differed significantly from reference group. § Percentages relate to the proportion of patients in each weight category who had the specified comorbidity. For example, 155/277 non-obese patients (56%) had a cardiovascular comorbidity; 123/173 obese patients (71%) had a cardiovascular comorbidity (some patients had more than one type of comorbity). ◆

function.[19] The maximum score for the HHS is 100 points, with maximum possible scores for its component parts as follows: pain (44), function (47), range of motion (5) and deformity (4).[20] (A higher HHS score indicates better function.) Physical and mental health were assessed using the 12-item Short Form Health Survey (SF-12), a validated measure of QOL in joint replacement.[21] The SF-12 has physical health (Physical Component Summary [PCS]) and mental health (Mental Component Summary [MCS]) scores, with maximum scores (56.58 for PCS and 60.76 for MCS) based on population norms. (A lower SF-12 score indicates poorer physical and/or mental health.)

Obesity definitions

World Health Organization definitions were used to classify patients into obesity categories.[22] Patients with a body mass index (BMI) < 30 kg/m^2 were defined as non-obese, those with BMI 30–39 kg/m^2 as obese, and those with BMI ⩾ 40kg/m^2 as morbidly obese.

Weight change

Weight change was considered clinically significant if the loss or gain was at least 5% of the patient's preoperative weight. The United States Food and Drug Administration defines clinically significant weight loss as 5% or more of baseline weight.[23] Five per cent weight loss in overweight patients has been documented as the minimum amount of weight loss required to induce metabolic and cardiovascular health benefits.[24]

Patient follow-up

Patients were mailed the SF-12 questionnaire and questions on subjective components of the HHS, with instructions to complete the forms and bring them to their 12-month review appointment. The objective components of the HHS were completed by the attending orthopaedic consultant or registrar during the review. Patients who did not bring their questionnaires to the appointment were subsequently contacted (by a health professional independent of the study) to complete them via telephone interview. The interviewer was blinded to the patient's height and weight.

Clinical outcomes for all patients were followed and recorded over 12 months. Adverse events were a composite of (i) death related to the original procedure; (ii) perioperative complications (medical or surgical); (iii) postoperative complications (medical or surgical) that resulted in a delay in discharge; (iv) suture line problems (necrosis, haematoma, dehiscence); (v) wound or joint infection (as defined by the US Centers for Disease Control[25]); and (vi) unplanned procedures and/or readmissions during the first 12 months after THA. Deaths in the first 12 months that were clearly unrelated to the index surgery were censored at the date of death.

Statistical analysis

Non-obese, obese and morbidly obese groups were compared for differences in functional and QOL outcomes and adverse events. Patients were also grouped according to weight loss or gain at 12 months. Data were analysed using SigmaPlot 11 (SYSTAT Software Inc, Chicago, Ill, USA). Analysis of variance was used to compare functional and QOL data between obesity groups. Regression methods were used to derive odds ratios (ORs) associated with preoperative patient and surgical variables and the occurrence of weight loss or gain and adverse events. Logistic regression analysis, adjusting for age and sex, was also used to derive the odds associated with increasing BMI and the occurrence of an adverse event.

Ethics approval

Our study was approved by the Human Research Ethics Committee of SVHM.

RESULTS

A total of 511 primary THAs were performed on 480 patients during the study period. Nine patients were excluded from the analysis because informed consent was not obtained ($n = 5$) or the operation involved hip resurfacing ($n = 4$). No simultaneous bilateral procedures were performed during the study period. For the 31 patients who underwent staged bilateral hip replacement, only the second procedure was included in our analysis. There were six deaths before the 12-month review, and one patient did not complete the health questionnaires. Thus 464/471 patients (98.5%) completed the functional and QOL assessment.

Of the 471 patients, 286 (60.7%) were women and 259 (55.0%) had procedures on the right hip. The mean age of patients was 68.9 years (SD, 10.4 years), and the mean BMI was 29.5 kg/m^2 (SD, 5.6 kg/m^2). Of the total group, 277 (58.8%) were non-obese, 173 (36.7%) obese and 21 (4.5%) morbidly obese. Demographic and surgical data for each weight group are summarised in Box 1. Significantly more women were obese. The number of total comorbidities and proportions of patients with cardiovascular comorbidities and diabetes were higher in the obese and morbidly obese groups than in the non-obese group. Length of stay in hospital was significantly greater in morbidly obese patients.

2 Patient preoperative variables tested for association with weight change at 12 months

	Weight loss		Weight gain	
Variable	OR (95% CI)	*P*	OR (95% CI)	*P*
Age	1.02 (0.97–1.07)	0.52	1.00 (0.98–1.02)	0.82
Male sex	1.22 (0.45–3.30)	0.90	1.06 (0.69–1.63)	0.87
Aetiology				
Osteoarthritis*	1.00		1.00	
Rheumatoid arthritis	1.08 (0.13–8.90)	0.97	1.37 (0.51–3.70)	0.72
Avascular necrosis	0.96 (0.12–8.00)	0.96	1.67 (0.80–3.50)	0.24
Congenital dysplasia of the hip	na		0.98 (0.35–2.70)	0.83
Charnley classification				
A*	1.00		1.00	
B	1.07 (0.13–9.00)	0.95	0.72 (0.24–2.20)	0.76
C	1.07 (0.13–9.00)	0.95	1.37 (0.51–3.70)	0.72
Number of comorbidities	1.08 (0.80–1.50)	0.61	1.02 (0.90–1.16)	0.74
Type of comorbidity				
Diabetes	0.73 (0.20–2.66)	0.86	0.76 (0.41–1.40)	0.49
Cardiovascular	0.27 (0.06–1.23)	0.13	1.20 (0.78–1.90)	0.47
Respiratory	1.75 (0.58–5.53)	0.49	1.25 (0.70–2.24)	0.55
Preadmission scores				
HHS (pain)	1.10 (0.99–1.21)	0.07	0.97 (0.92–1.03)	0.30
HHS (function)	0.99 (0.93–1.05)	0.70	0.98 (0.96–1.01)	0.12
HHS (total)	1.02 (0.97–1.06)	0.51	0.98 (0.96–1.00)	0.07
SF-12 PCS	0.94 (0.84–1.06)	0.31	1.02 (0.98–1.06)	0.36
SF-12 MCS	1.02 (0.97–1.07)	0.45	0.98 (0.96–0.99)	0.04

HHS = Harris Hip Score. MCS = Mental Component Summary. na = not applicable. OR = odds ratio. PCS = Physical Component Summary. SF-12 = 12-item Short Form Health Survey. * Reference group. ◆

Weight change

There was no significant difference in mean weight change between non-obese and obese patient groups (the following figures are mean weight change [SD] in kg): non-obese, + 1.0 (4.0); obese + 0.7 (4.8); and morbidly obese – 0.1 (5.8) ($P = 0.49$). Using 5% change from preoperative weight as the cut-off, 52 patients (11.2%) had lost weight and 118 (25.4%) had gained weight at 12-month follow-up. Fifteen obese and three morbidly obese patients had lost weight at 12 months, and 33 obese and four morbidly obese patients had gained weight. No preoperative variable tested predicted weight loss after primary THA (Box 2). However, weight gain after THA was associated with lower preoperative MCS scores (OR, 0.98 [95% CI, 0.96–0.99]; $P = 0.04$).

Functional and quality-of-life outcomes

HHSs were significantly lower in morbidly obese patients than in non-obese patients, both before and 12 months after THA (Box 3). However, there were no significant differences in the mean change in scores ($P = 0.63$), with improvement demonstrated in all groups: non-obese, + 44.1 (SD, 18.0); obese, + 44.1 (SD, 16.8); and morbidly obese, + 40.3 (SD, 18.3) (Box 3).

Mean preoperative SF-12 PCS scores were similar in non-obese (25.7 [SD, 5.6]) and obese (25.3 [SD, 4.5]) patients and slightly lower in morbidly obese patients (22.9 [SD, 3.6]) ($P = 0.05$). Mean SF-12 PCS scores at 12 months were significantly lower in obese (37.5 [SD, 11.0]) and morbidly obese (33.6 [SD, 10.2]) patients than in non-obese patients (40.0 [SD, 11.4]) ($P = 0.01$). However, there were no significant differences between groups in the level of improvement in PCS scores ($P = 0.09$) (Box 3).

Mean preoperative SF-12 MCS scores were lower in obese (46.9 [SD, 10.4]) and morbidly obese (47.2 [SD, 10.3]) patients than in non-obese patients (50.8 [SD, 9.8]) ($P < 0.01$). At 12 months, mean MCS scores were comparable for all groups because of greater improvements in scores among obese (+ 3.6 [SD, 12.2]) and morbidly obese (+ 3.7 [SD, 9.4]) patients compared with non-obese patients (– 0.1 [SD, 11.7]) ($P = 0.01$). The greater improvement in MCS at 12 months was significant for the obese group only (Box 3).

Adverse events

Adverse events from admission to 12 months were captured in all patients. Factors independently associated with risk of an adverse event or complication were obesity (OR, 1.81 [95% CI, 1.05–3.11]; $P = 0.03$) and morbid obesity (OR, 5.77 [95% CI, 2.10–15.86]; $P < 0.01$); number of comorbidities (OR, 1.23 for each additional comorbidity [95% CI, 1.05–1.44]; $P = 0.01$); and age (OR, 1.05 for each 1-year increase [95% CI, 1.01–1.08]; $P < 0.01$) (Box 4). Each unit increase in BMI also increased the risk of an adverse event (OR, 1.07 [95% CI, 1.03–1.12]; $P < 0.01$), after adjusting for age and sex.

3 Functional and quality-of-life scores*

Score	Non-obese†	Obese	Morbidly obese	*P*
Pain score‡				
Preadmission	11.9 (4.4)	11.8 (4.0)	11.0 (3.0)	0.64
At 12 months	38.4 (9.4)	39.1 (8.7)	37.5 (10.6)	0.64
Change	+ 26.5 (10.2)	+ 27.3 (9.2)	+ 26.6 (11.5)	0.71
Function score‡				
Preadmission	18.0 (9.2)	16.9 (8.7)	13.4 (9.0)§	0.05
At 12 months	34.2 (10.9)	32.5 (10.8)	24.9 (11.5)§	< 0.01
Change	+ 16.2 (11.4)	+ 15.6 (10.2)	+ 11.5 (8.2)	0.16
Total score				
Preadmission	36.6 (11.4)	35.4 (10.7)	30.2 (8.9)§	0.03
At 12 months	80.8 (16.9)	79.8 (17.0)	70.5 (18.8)§	0.03
Change	+ 44.1 (18.0)	+ 44.1 (16.8)	+ 40.3 (18.3)	0.63
PCS¶				
Preadmission	25.7 (5.6)	25.3 (4.5)	22.9 (3.6)	0.05
At 12 months	40.0 (11.4)	37.5 (11.0)§	33.6 (10.2)§	0.01
Change	+ 14.3 (11.2)	+ 12.2 (11.8)	+ 10.7 (10.3)	0.09
MCS¶				
Preadmission	50.8 (9.8)	46.9 (10.4)§	47.2 (10.3)	< 0.01
At 12 months	50.7 (11.8)	50.5 (10.5)	50.9 (9.7)	0.98
Change	− 0.1 (11.7)	+ 3.6 (12.2)§	+ 3.7 (9.4)	0.01

MCS = Mental Component Summary. PCS = Physical Component Summary. * Data are mean score (SD). † Reference group. ‡ Pain score (maximum 44 points) and function score (maximum 47 points) are components of the Harris Hip Score (HHS). The maximum HHS score (100 points) indicates no functional impairment. § Denotes which comparison group(s) differed significantly from reference group. ¶ PCS and MCS are components of the 12-item Short Form Health Survey (SF-12). Population norms are 56.58 for PCS and 60.76 for MCS (a person can score higher than the population norm). A lower SF-12 score indicates poorer physical and/or mental health. ◆

DISCUSSION

Our study of a consecutive series of patients undergoing primary THA over a 2-year period found that the majority of obese patients did not lose weight in the first 12 months after surgery. Indeed, one in four patients gained weight. No individual patient characteristic predicted weight loss. However, weight gain was associated with poorer preoperative mental health scores. Improvements in function and QOL after surgery were comparable between non-obese and obese groups, but obese and morbidly obese patients incurred a significantly greater risk of complications. The risk of complications in the first 12 months after THA increased by 7% for each unit increase in BMI, after adjusting for age and sex.

4 Risk of complications in the first 12 months after primary total hip arthroplasty

Variable	OR (95% CI)	*P*
BMI*†	1.07 (1.03–1.12)	< 0.01
Obese	1.81 (1.05–3.11)	0.03
Morbidly obese	5.77 (2.10–15.86)	< 0.01
Age‡	1.05 (1.01–1.08)	< 0.01
Comorbidities§	1.23 (1.05–1.44)	0.01

BMI = body mass index. OR = odds ratio. * Adjusted for age and sex. † OR is for each unit increase in BMI. ‡ OR is for each 1-year increase in age. § OR is for each additional comorbidity. ◆

Although a number of small studies have reported that patients tend to gain an average of 2%–3% of their preoperative weight after THA,[15,17,26] only one provided data on the number of patients who *lost* weight after surgery.[13] However, weight loss was not quantified and predictive patient characteristics were not investigated.

Despite significant reduction in pain and improvement in function reported in obese and morbidly obese patients after surgery, the incidence of weight loss was relatively low. Functional ability is only one of a number of factors that affect a person's willingness to participate in physical activity (and thus aid weight loss) after surgery. Several variables not recorded in our study have been found to be associated with motivation to participate in physical activity, including cost, accessibility, knowledge, cultural influences, socioeconomic status and self-efficacy.[27-29] Poorer mental health may present another barrier to participation in physical activity, given the association with weight gain demonstrated in our study.

Previous cohort studies investigating functional and QOL outcomes in obese patients have been limited by the use of datasets that have excluded up to three-quarters of patients because of incomplete data.[12] The level of patient follow-up has also been identified as a limiting factor.[9] Despite this, the findings of such studies have been similar to our findings, in that comparable gains in function and QOL were experienced in non-obese and obese groups after THA. There have also been a number of studies, in contrast to ours,[11,30,31] reporting poorer functional and QOL outcomes in obese groups. However, inconsistency between studies in the health questionnaires that were used limits the validity of comparing their results.[21,32]

No single complication was significantly associated with obesity, but the risk of incurring any type of complication rose significantly as BMI increased. Despite the small number of morbidly obese patients in our study, a significantly higher complication rate (nearly sixfold that of non-obese patients) was detected in this group. As in our study, others have reported relatively small numbers of morbidly obese patients, yet still demonstrated an association with higher rates of complications, such as prolonged wound drainage,[33] higher dislocation rates[34] and higher rates of prosthetic infection.[35]

Major strengths of our study were its overall sample size and the completeness of recruitment and follow-up. However, the sourcing of patients from a single centre was a potential source of selection bias. Although there are very few studies with which ours can be compared, we note that the proportion of obese patients in our study was double that of another large Australian study of patients undergoing THA.[36] The age and sex ratios of our cohort were similar to those of major arthroplasty centres throughout Australia.[37]

Two other limitations also warrant mention. First, because our study did not include a non-THA control group, we were unable to compare weight change in our patients with weight change in untreated patients. Secondly, our study was limited by the relatively small number of morbidly obese patients ($n = 21$). Although analyses of

complication outcomes were adequately powered, analyses of health scores may not have been. The small subgroup of morbidly obese patients may have also affected our weight change analysis. Using percentage weight change rather than absolute weight may disadvantage morbidly obese patients, who would need to shed more weight after surgery in order to demonstrate a 5% shift. However, our study was concerned with clinically significant weight loss and providing a meaningful definition for clinicians. As such, we were guided by the US Food and Drug Administration,[23] the Dietitians Association of Australia[24] and other experts,[38] who report that 5%–10% weight loss can produce significant improvement in cardiovascular and metabolic health.

Despite the low level of weight loss after THA and a significantly greater risk of complications among obese and morbidly obese patients, clinicians can inform their patients that they are likely to experience significant reduction in pain and improvement in function after surgery. Before consenting to surgery, obese patients should be counselled about the high risk of adverse events. But given the disabling effects of end-stage osteoarthritis — continued functional decline, worsening health and loss of independence — many patients are likely to opt for surgery despite the risk. Interventions targeting weight loss and health improvement in obese patients undergoing THA are yet to be tested, and this should be the focus of future research.

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COMPETING INTERESTS

None identified.

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