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Total hip arthroplasty outcomes in morbidly obese patients: a systematic review

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- The increasing prevalence of obesity has resulted in a marked increase in the number of total hip arthroplasties (THAs) carried out in patients with a high body mass index (BMI).
- THA in morbidly obese patients is often technically challenging owing to the associated co-morbidities and anatomical factors. Furthermore, the long-term clinical and functional outcomes of the procedure in these patients are not clear.
- The aim of this systematic review was to compare the long-term failure rate and functional outcomes of THA in morbidly obese versus non-obese patients.
- A literature search of PubMed, EMBASE and PubMed Central was conducted to identify studies that compared the outcomes of THA in patients defined as morbidly obese (BMI ≥ 35) to a control group (BMI < 30). The primary and secondary outcome measures were rate of revision and functional outcome, respectively, in the long term.
- Eight studies were included in this review. There were 66,238 THAs in morbidly obese patients and 705,619 THAs in patients with a BMI < 30. The overall revision rate was 7.99% in the morbidly obese patients versus 2.75% in the non-obese controls. The functional outcome was at least comparable to non-obese patients.
- This review suggests that morbidly obese patients have a slightly increased revision rate following THA. Importantly, these patients have a functional recovery at least comparable to those with a BMI < 30. Morbidly obese patients should be fully informed of these issues prior to undergoing surgery.

Keywords: THA; morbidly obese; outcomes

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Introduction

Total hip arthroplasty (THA) is one of the most successful and common surgical procedures, with a total of 98,211 THAs performed in England and Wales in 2015.[1] Current trends show a universal rise in the demand for THA; in the US, demand is projected to increase by 173% from 2005, to 572,000 in 2030;[2] Swedish projections show an increase from 16,000 THA operations in 2010 to 20,000 in 2030 whilst Australian figures predict a 219% increase in primary THA from 2013 to 2046.[3,4]

Likewise, the prevalence of obesity is increasing, with a projected 11 million additional obese people in the UK by 2030.[5] Obesity is a primary modifiable risk factor for the development of osteoarthritis.[6] This is due in part to increased joint reaction forces and altered biomechanics that create abnormal impact loading and alter gait. In addition, the increased accumulation of body fat and adipokines contributes to low-grade systemic inflammation which negatively affects cartilage biology.[7] As such, orthopaedic arthroplasty surgeons are likely to face a greater number of obese patients who warrant THA over the coming years. Obesity is significantly associated with a greater need for joint arthroplasty compared to age-matched controls,[8] and studies have shown that patients with a high body mass index (BMI) may require a hip replacement up to ten years earlier than patients with a normal BMI.[9,10] Despite this, some orthopaedic surgeons hold reservations about performing THA in obese patients,[11] and some Clinical Commissioning Groups in England have started to refuse funding for THA in people with a BMI of more than 35.[12]

Body mass index is an anthropological measurement that estimates adiposity in adults. It is calculated by dividing a patient’s body mass in kilograms by the square of

Table 1. BMI classification of obesity

Classification	BMI (kg/m²)
Underweight	< 18.5
Normal	18.5–24.9
Overweight	25.0–29.9
Obese:	
Class I	30.0–34.9
Class II	35.0–39.9*
Class III	≥ 40.0

Notes. BMI, body mass index; WHO, World Health Organization.
*Morbid obesity can be defined as a BMI ≥ 40, or class II with significant comorbidities.
Source: adapted from WHO.[14]

their height, in metres.[13] The World Health Organization has used BMI values to classify people as underweight, overweight or obese (see Table 1).[14] Morbid obesity is defined as a BMI ≥ 40, or a BMI ≥ 35 with associated obesity-related health conditions.[15] The term 'super-obese' has been used to describe those with a BMI ≥ 50 kg/m^2.[16]

Some studies have shown that obese patients have higher perioperative complications, longer hospital stays, poorer wound healing and more anaesthetic complications.[17] Furthermore, obesity is associated with poor short-term outcomes after undergoing THA, with reported complications of increased rates of periprosthetic infections, dislocations and instability.[18–20] However, the clinical and functional outcomes of morbidly obese patients following primary THA remain unclear. Some studies have reported no significant difference in post-operative outcomes between obese and non-obese patients.[21,22] Despite this, it is common practice for patients with a BMI ≥ 40 kg/m^2 to be asked to provide evidence of weight loss pre-operatively.[20]

We performed a comprehensive systematic review of the literature to answer the following two primary questions: (i) Is the revision rate of THA higher in morbidly obese patients? (ii) Do morbidly obese patients experience poorer functional results following THA?

Methods

Search strategy

Our search strategy was conducted according to the recommendations of the Cochrane group. We completed an electronic database search of PubMed, EMBASE and PubMed Central to identify any studies reporting the revision rate of primary THA in morbidly obese (or super-obese) patients, compared to a non-obese control group. The following text was used to maximize sensitivity and specificity: "(hip replacement OR hip arthroplasty OR THR OR THA) AND (obesity OR obese)". The search included studies published from the date of inception of the databases until 30 June 2017.

Eligibility criteria

Eligibility criteria were agreed by all authors prior to performing the search. Studies included were published in the English literature and reported data on the revision rate of THA in obese patients (stratified by BMI) versus a non-obese group. Studies with a minimum mean follow-up of less than two years were excluded.

The titles and abstracts were screened, and the full articles were accessed for relevant studies that satisfied all of the inclusion criteria. Relevant articles were independently analysed by authors MB and AP; articles which did not fit the eligibility criteria were discarded. The reference lists of the remaining articles were manually assessed in an attempt to identify any additional relevant articles that had not been found in the initial database search. Any uncertainties about whether an article should be included were resolved by SAH.

Data extraction

Data extraction was independently performed by MB and AP and reviewed by SAH. The guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were followed. Our primary outcome measure was the revision rate of primary THA; the secondary outcome measure was functional outcome. We attempted to contact the authors of all studies when further information was required.

Results

Search results

The PRISMA flowchart of the study selection process is shown in Fig. 1. The initial search of the database yielded 899 potentially relevant articles, of which 883 were excluded with a reason after screening the titles and abstracts. The remaining 16 articles were reviewed. Nine of these failed to meet the inclusion criteria and were excluded. An additional study[23] was found in the references of these studies. A total of eight studies were included in this review.[23–30]

Cohort characteristics

All of the studies reported the revision rate of THA in morbidly obese versus non-obese patients and were published between 2006 and 2016. Demographic data are presented in Table 2 and the number of hips per study in Table 3. Overall, there were 66,238 THAs in the morbidly obese group versus 705,619 THAs in the non-obese group. The most common diagnosis in included patients was osteoarthritis. The mean follow-up time for each group was reported in five of the studies, with an average of 4.8 years (SE ±0.35) in the morbidly obese group and 5.3 years (SE ±0.23) in the non-obese group.

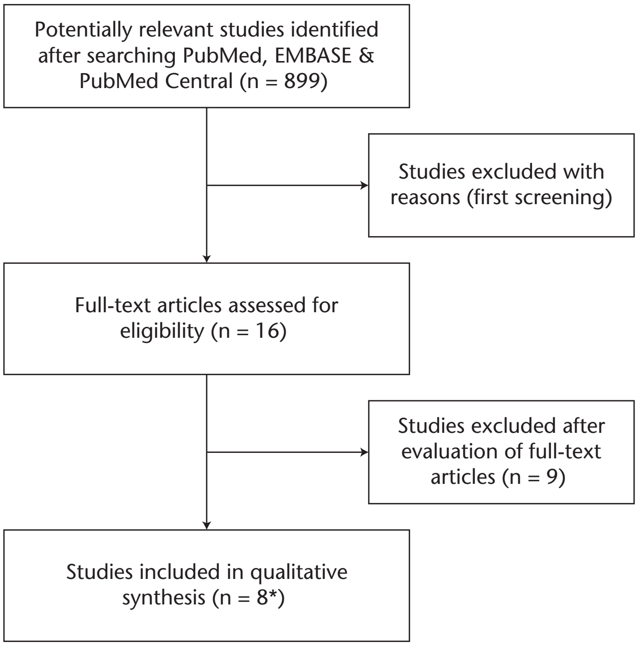

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart for study selection.

*One additional study was included after manually searching the reference lists of all relevant studies.

Outcome analysis

Revision rate

The rate of THA revision was directly reported in four studies.[23,25,27,29] In the remaining four studies, this was recorded by calculating the percentage of hips that underwent revision by follow-up (see Table 3).[24,26,28,30] The median revision rate was 7.99% in the morbidly obese group versus 2.75% in the non-obese group. Statistical significance was reached in two studies.[25,29]

Functional outcome

Harris Hip Score (HHS) was reported in four studies.[24,25,28,29] HHS improved after THA in all studies. The median pre-operative HHS was 36.5 vs 45.5, the median post-operative HHS was 82.1 vs 90.2, and the median difference in pre- vs post-operative HHS was 45.6 vs 44.8, in the morbidly obese and non-obese groups respectively (see Table 4 and Fig. 2). All studies reported that the difference in pre- vs post-operative HHS in the morbidly obese group was at least comparable to HHS improvement in the non-obese controls.

A similar trend was found in other functional outcome scores. Issa et al reported that Short Form-36 questionnaires (SF-36) and University of California, Los Angeles (UCLA) scores were significantly lower ($p = .001$) in the morbidly obese group.[29] McCalden et al found that morbidly obese patients had the lowest post-operative Western Ontario and McMaster Universities (WOMAC) osteoarthritis scores but comparable post-operative scores ($p = .86$). They also found that morbidly obese patients had lower Short Form-12 questionnaires (SF-12) scores, with a difference that failed to reach statistical significance ($p = .233$) when compared to non-obese patients.[25] Andrew et al found that the mean change in pre- and post-operative Oxford Hip Scores (OHS) was similar to non-obese controls ($p = .473$).[23]

Discussion

The evidence for longer-term outcomes in morbidly obese patients following primary THA is unclear, with some studies reporting similar outcomes to patients with a normal BMI,[31–33] and some reporting inferior outcomes.[34–36] Surgical management of morbidly obese patients can be challenging in terms of getting patients into theatre and providing specialized operating tables, beds and wheelchairs, as well as surgical access. As a result, some orthopaedic surgeons tend to be reluctant in operating on morbidly obese patients; it has been shown that these patients visit significantly more orthopaedic surgeons (mean 2.5, $p = .01$) than patients with a normal BMI before being accepted as a candidate for THA.[29]

To our knowledge, this is the first systematic review to evaluate the medium- to long-term revision rate and functional outcome in patients with a high BMI (≥ 35) who

Table 2. Demographics of the morbidly obese (MO) and control (C) groups for each study

	Mean BMI (*SD*/range)		Mean age (range)		Mean follow-up (years, range)	
Study authors	**MO**	**C**	**MO**	**C**	**MO**	**C**
Arsoy et al[24]	53.2 (3.9)	26.0 (3.0)	56.4 (19.0–77.0)	56.7 (27.0–77.0)	4.0 (0.3–10.5)	5.4 (1.0–13.0)
Rajgopal et al[26]	NR but ≥ 50	NR but < 30	53.0 (31.0–72.0)	53.0 (29.0–72.0)	4.2 (2.0–11.7)	5.0 (2.0–12.3)
Issa et al[29]	55.0 (50.0–65.0)	NR but < 30	54.0 (36.0–71.0)	55.0 (48.0–75.0)	6.0 (4.0–12.0)	6.2 (4.0–13.0)
McCalden et al[25]	NR but ≥ 40	NR but < 30	59.7 (27.0–82.0)	NR	NR (> 2)	
Werner et al[27]	NR but ≥ 40	NR but < 30	NR	NR	NR (1.0–8.0)	
McLaughlin et al[30]	NR but ≥ 35	26.0 (20.0–29.0)	NR	57.0 (20.0–82.0)	NR (10.0–18.9)	
Chee et al[28]	37.9 (35.1–47.2)	25.5 (18.7–29.8)	63.6 (45.0–83.0)	63.7 (45.0–83.0)	5.0 (NR)	5.0 (NR)
Andrew et al[23]	44.8 (40.0–53.3)	25.1 (15.2-29.9)	60.0 (29.0–78.0)	69.1 (21.0–94.0)	5.0 (NR)	5.0 (NR)

Note. NR, not reported.

Table 3. The number of hips and revision rates of the morbidly obese (MO) and control (C) groups for each study

		Patients (hips)		Revision rate (no. hips)		
Study authors	**Date**	**MO**	**C**	**MO**	**C**	**Difference**
Arsoy et al[22]	2014	40 (42)	81 (84)	10% (4)	6% (5)	NR
Rajgopal et al[24]	2013	30 (39)	39 (39)	5.1% (2)	0% (0)	NR
Issa et al[27]	2016	45 (48)	135 (144)	10.4% (5)	2.2% (3)	p = 0.02*
McCalden et al[23]	2011	NR (206)	NR (1859)	5.3% (11)	3.3% (62)	p = 0.147
Werner et al[25]	2016	NR (65800)	NR (702360)	6.88% (4527)	3.4% (23880)	p <0.0001*
McLaughlin et al[28]	2006	26 (30)	99 (109)	50% (15)	71.6% (71)	NR
Chee et al[26]	2010	53 (55)	53 (55)	9.1% (5)	0% (0)	NR
Andrew et al[21]	2008	NR (18)	NR (1069)	0% (0)	1.3% (14)	p = 0.851

Notes. NR, not reported. p-values < .05 were considered significant.

Table 4. Mean pre- and post-operative Harris Hip Scores (HHS) between morbidly obese and non-obese controls, for each study

	Morbidly obese mean HHS			Non-obese control mean HHS		
Study authors	**Pre-op**	**Post-op**	**Difference**	**Pre-op**	**Post-op**	**Difference**
Arsoy et al[24]	33.9	74.9	39.7	55.1	89.6	34.6
Issa et al[29]	39.0	82.0	43.0	41.0	91.0	50.0
McCalden et al[25]	35.7	86.4	49.2	45.8	88.4	41.8
Chee et al[28]	37.3	85.4	48.1	39.8	91.8	52.0

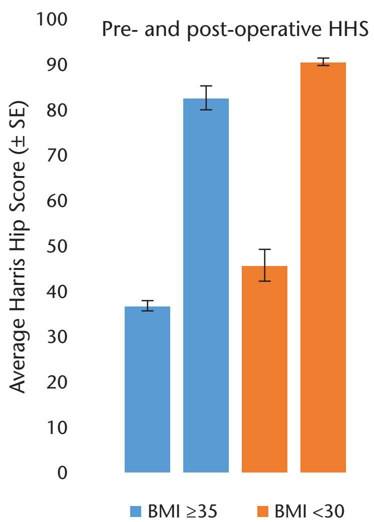

Fig. 2 Pre- and post-operative mean Harris Hip Scores (HHS) for patients with a BMI ≥ 35 vs. non-obese patients (BMI < 30).

Note. BMI, body mass index.

have undergone a primary THA. Our systematic review suggests that there is an increased rate of THA revision in these patients. The average reported revision rate was 7.99% in the morbidly obese versus 2.75% in non-obese patients. The study with the highest number of patients[27] reported the strongest relationship (6.88% in morbidly obese vs 3.40% in non-obese, $p < .0001$) having compared 65,800 patients with a BMI ≥ 40 with 702,360 non-obese patients. Andrew et al and McLaughlin et al reported higher revision rates, but these studies failed to report a significant difference which may be due to small sample sizes of morbidly obese patients (n = 18 vs 30).[23,30] The authors of these studies suggested that even though a higher BMI is associated with increased loading of hip prostheses, the lack of a large difference in failure rates may arise from a more sedentary lifestyle in morbidly obese patients, resulting in reduced mobility and less prosthetic wear.[23,28,30]

A consistent finding throughout our review is the advantage of improved functional outcomes following primary THA in morbidly obese patients, though these patients tend to have lower pre- and post-operative functional scores. All of the studies reporting HHS, OHS, WOMAC and SF-12 have reported that the mean difference is at least comparable between morbidly obese and non-obese controls.[24,25,28,29] Similar findings have been reported in the literature for obese patients.[21,37]

Limitations to this review are that studies lacked homogeneity in the types of prosthesis used, the approach to the hip and the definition of morbid obesity; though this may be representative of the differing practice between hospitals. Most studies reported a follow-up of approximately five years. Although McLaughlin et al did not directly report the mean follow-up for each group, the whole study had a range of 10–18.9 years, two to four times longer than the average of the other studies.[30] This could explain the higher revision rates in both groups, making it difficult to compare the findings to other studies. Further limitations are the retrospective nature of six of the studies and the varying experience in treating severely obese patients between institutions. Conducting prospective cohort studies with longer follow-up periods is necessary to better evaluate the long-term outcomes of morbidly obese patients following THA.

This review found an increase in overall complication rate, particularly for those who were super-obese.[24,27–29] Overall, morbidly obese patients should benefit from discussion with orthopaedic surgeons on their risks of perioperative complications and early revision, and should be selected for THA with this in mind. It is our opinion that patients with a high BMI should still be encouraged to lose weight, not only to reduce complication risk but to also improve overall health. However, a high BMI alone should not preclude morbidly obese patients from THA; future studies are needed to investigate the effect of pre-operative weight loss on the rate of post-operative complications in morbidly obese patients undergoing primary THA.

Conclusion

There is evidence from the literature to suggest that morbidly obese patients have a higher revision rate following primary THA than non-obese patients. The improvement in pain and quality of life conferred by this treatment is comparable to patients with a normal BMI.

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ICMJE CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. **National Joint Registry.** National Joint Registry 13th annual report, 2016. http://www.njrcentre.org.uk/njrcentre/Portals/0/Documents/England/Reports/13th%20Annual%20Report/07950%20NJR%20Annual%20Report%202016%20ONLINE%20REPORT.pdf (date last accessed 16 August 2018).

2. **Kurtz S, Ong K, Lau E, Mowat F, Halpern M.** Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am* 2007;89:780–785.

3. **Inacio MCS, Graves SE, Pratt NL, Roughead EE, Nemes S.** Increase in total joint arthroplasty projected from 2014 to 2046 in Australia: a conservative local model with international implications. *Clin Orthop Relat Res* 2017;475:2130–2137.

4. **Nemes S, Gordon M, Rogmark C, Rolfson O.** Projections of total hip replacement in Sweden from 2013 to 2030. *Acta Orthop* 2014;85:238–243.

5. **Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M.** Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 2011;378:815–825.

6. **Marks R, Allegrante JP.** Body mass indices in patients with disabling hip osteoarthritis. *Arthritis Res* 2002;4:112–116.

7. **Guilak F.** Biomechanical factors in osteoarthritis. *Best Pract Res Clin Rheumatol* 2011;25:815–823.

8. **Harms S, Larson R, Sahmoun AE, Beal JR.** Obesity increases the likelihood of total joint replacement surgery among younger adults. *Int Orthop* 2007;31:23–26.

9. **Changulani M, Kalairajah Y, Peel T, Field RE.** The relationship between obesity and the age at which hip and knee replacement is undertaken. *J Bone Joint Surg Br* 2008;90:360–363.

10. **Haynes J, Nam D, Barrack RL.** Obesity in total hip arthroplasty: does it make a difference? *Bone Joint J* 2017;99–B(suppl A):31–36.

11. **Fehring TK, Odum SM, Griffin WL, Mason JB, McCoy TH.** The obesity epidemic: its effect on total joint arthroplasty. *J Arthroplasty* 2007;22:71–76.

12. **The Royal College of Surgeons of England.** Smokers and overweight patients soft targets for NHS savings. https://www.rcseng.ac.uk/library-and-publications/rcs-publications/docs/smokers-soft-targets/ (date last accessed 16 August 2018).

13. **Deurenberg P, Weststrate JA, Seidell JC.** Body mass index as a measure of body fatness: age- and sex-specific prediction formulas. *Br J Nutr* 1991;65:105.

14. **WHO.** Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser* 2000;894:1–253.

15. **National Institute for Health and Care Excellence.** Obesity: identification, assessment and management (CG189), 2014. nice.org.uk/guidance/cg189 (date last accessed 25 August 2018).

16. **Sturm R.** Increases in clinically severe obesity in the United States, 1986–2000. *Arch Intern Med* 2003;163:2146–2148.

17. **Huschak G, Busch T, Kaisers UX.** Obesity in anesthesia and intensive care. *Best Pract Res Clin Endocrinol Metab* 2013;27:247–260.

18. **Bozic KJ, Lau E, Kurtz S, et al.** Patient-related risk factors for periprosthetic joint infection and postoperative mortality following total hip arthroplasty in Medicare patients. *J Bone Joint Surg Am* 2012;94:794–800.

19. **Lübbeke A, Stern R, Garavaglia G, Zurcher L, Hoffmeyer P.** Differences in outcomes of obese women and men undergoing primary total hip arthroplasty. *Arthritis Rheum* 2007;57:327–334.

20. **Liu W, Wahafu T, Cheng M, Cheng T, Zhang Y, Zhang X.** The influence of obesity on primary total hip arthroplasty outcomes: a meta-analysis of prospective cohort studies. *Orthop Traumatol Surg Res* 2015;101:289–296.

21. **Chan CL, Villar RN.** Obesity and quality of life after primary hip arthroplasty. *J Bone Joint Surg Br* 1996;78:78–81.

22. **Moran M, Walmsley P, Gray A, Brenkel IJ.** Does body mass index affect the early outcome of primary total hip arthroplasty? *J Arthroplasty* 2005;20:866–869.

23. **Andrew JG, Palan J, Kurup HV, Gibson P, Murray DW, Beard DJ.** Obesity in total hip replacement. *J Bone Joint Surg Br* 2008;90:424–429.

24. **Arsoy D, Woodcock JA, Lewallen DG, Trousdale RT.** Outcomes and complications following total hip arthroplasty in the super-obese patient, BMI < 50. *J Arthroplasty* 2014;29:1899–1905.

25. **McCalden RW, Charron KD, MacDonald SJ, Bourne RB, Naudie DD.** Does morbid obesity affect the outcome of total hip replacement? An analysis of 3290 THRs. *Bone Joint J* 2011;93–B:321–325.

26. **Rajgopal R, Martin R, Howard JL, Somerville L, Macdonald SJ, Bourne R.** Outcomes and complications of total hip replacement in super-obese patients. *Bone Joint J* 2013;95–B:758–764.

27. **Werner BC, Higgins MD, Pehlivan HC, Carothers JT, Browne JA.** Super obesity is an independent risk factor for complications after primary total hip arthroplasty. *J Arthroplasty* 2017;32:402–406.

28. **Chee YH, Teoh KH, Sabnis BM, Ballantyne JA, Brenkel IJ.** Total hip replacement in morbidly obese patients with osteoarthritis: results of a prospectively matched study. *J Bone Joint Surg [Br]* 2010;92:1066–1071.

29. **Issa K, Harwin SF, Malkani AL, Bonutti PM, Scillia A, Mont MA.** Bariatric orthopaedics: total hip arthroplasty in super-obese patients (those with a BMI of ≥ 50 kg/m2). *J Bone Jt Surg, Am Vol (CD-ROM Ed)* 2016;98:180–185.

30. **McLaughlin JR, Lee KR.** The outcome of total hip replacement in obese and non-obese patients at 10- to 18-years. *J Bone Jt Surgery-British Vol* 2006;88B:1286–1292.

31. **Lowe GDO, Haverkate F, Thompson SG, et al.** Prediction of deep vein thrombosis after elective hip replacement surgery by preoperative clinical and haemostatic variables: the ECAT DVT Study. *Thromb Haemost* 1999;81:879–886.

32. **Haverkamp D, Klinkenbijl MN, Somford MP, Albers GHR, Van Der Vis HM.** Obesity in total hip arthroplasty: does it really matter? *Acta Orthop* 2011;82:417–422.

33. **Lehman DE, Capello WN, Feinberg JR.** Total hip arthroplasty without cement in obese patients. A minimum two-year clinical and radiographic follow-up study. *J Bone Joint Surg Am* 1994;76[6]:854–862.

34. **Jackson MP, Sexton SA, Yeung E, Walter WL, Walter WK, Zicat BA.** The effect of obesity on the mid-term survival and clinical outcome of cementless total hip replacement. *J Bone Joint Surg Br* 2009;91:1296–1301.

35. **Ibrahim T, Hobson S, Beiri A, Esler CN.** No influence of body mass index on early outcome following total hip arthroplasty. *Int Orthop* 2005;29:359–361.

36. **Sadr Azodi O, Adami J, Lindstrom D, et al.** High body mass index is associated with increased risk of implant dislocation following primary total hip replacement: 2,106 patients followed for up to 8 years. *Acta Orthop* 2008;79:141–147.

37. **Stickles B, Phillips L, Brox WT, Owens B, Lanzer WL.** Defining the relationship between obesity and total joint arthroplasty. *Obes Res* 2001;9:219–223.