



Morbid obesity is not a contraindication to lower limb arthroplasty

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There are concerns that increased BMI is associated with a greater length of stay (LOS) and perioperative complications following total knee (TKR) and total hip replacements (THR).

We analysed data from a six-month period to see if there was a correlation between BMI and LOS. We performed a subgroup analysis for patients with morbid obesity (BMI >40) looking at perioperative complications.

285 TKRs and 195 THRs were analysed. For TKRs, the average length of stay was 2.7 days. The average BMI was 32.4. There was no significant correlation between BMI and LOS ($r=-0.0447$, $p=0.2267$). The morbidly obese category ($n=33$) had the shortest LOS (2.5 days) compared to other BMI categories. 30-day readmission rate was 6%. 90-day re-admission rate was 12%. Six patients had minor wound issues requiring no intervention or antibiotics only. There was one prosthetic joint infection, one stitch abscess, one DVT and one patellar tendon injury.

For THRs, the average LOS was 2.9 days. The average BMI was 29.9. There was no significant correlation between BMI and LOS ($r=0.007$, $p=0.4613$). The morbid obese category ($n=9$) had the shortest LOS (1.9 days) compared to other BMI categories. No patients were readmitted within 90 days or had documented complications.

We have shown that for TKRs and THRs, increased BMI is not associated with increased LOS. The morbidly obese were found to have the shortest LOS. Re-admission rates and complications were commendable for patients with morbid obesity. BMI >40 is not a contraindication to TKR or THR.

Keywords : arthroplasty ; hip ; knee ; replacement ; morbid obesity ; body mass index ; BMI.

INTRODUCTION

Obesity is a significant risk factor for the development of osteoarthritis (1). We are seeing a rise in the proportion of lower limb arthroplasty procedures performed on patients with a high body mass index (BMI). The National Joint Registry's (NJR) 2019 annual report states that the average person undergoing a total knee replacement (TKR) has a BMI of 30.7 (obese), and the average BMI of a patient undergoing a total hip replacement (THR) is 28.7 (overweight) (2).

Obesity is a multi-systemic disease, often linked with diabetes, cardiovascular and pulmonary comorbidities. As such there are concerns that an increased

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BMI is associated with perioperative complications including venous thromboembolism (VTE), post-operative deep and superficial infections, airway difficulty, dislocations, revisions, and mortality (3,4). The increased risk of complications, together with the functional challenges involved with rehabilitating obese patients, raises concerns that increased BMI is associated with a longer length of stay (LOS) following lower limb arthroplasty (5,6).

Data from the NJR states that for patients undergoing total hip and knee replacements at our trust, the BMI is higher than the national average (2). Our objective was to test the hypothesis that increased BMI was associated with increased length of stay and perioperative complications. The primary aim of this paper is to assess the effect BMI has on length of stay following primary hip and knee replacements. The secondary aim of this paper was to perform a subgroup analysis for patients with a BMI greater than 40 to analyse whether this category of patient is at risk of perioperative complications.

METHODS

Data was collected retrospectively on all patients who had a primary total hip or knee replacement within our trust over a six-month period (February 2019 to August 2019). Our trust serves a population of 820,000 in the North-East sector of Greater Manchester. We collected data from 12 lower limb arthroplasty surgeons. Data was available via our online patient records.

We performed a qualitative subgroup analysis on patients with a BMI of greater than 40. We looked at patient age, operation time, haemoglobin drop, 30-day and 90-day readmission rate, range of motion at final clinical review and postoperative complications. Patients were followed up for at least one year.

Statistical analysis was performed using GraphPad Prism 8.4.2. Normality was assessed by the Shapiro-Wilk test. Correlations between BMI and LOS were computed using Spearman's rank correlation. Comparisons between mean LOS for each BMI category was calculated using one-way ANOVA (Kruskal-Wallis) with multiple

comparisons. Statistical significance was set at $p < 0.05$.

RESULTS

Over the six-month period 495 patients underwent total hip or knee arthroplasty at our unit. Six patients had no recorded BMI and were excluded. One patient had bilateral total knee replacements and was excluded. Eight patients had a LOS of over 10 days which were considered extreme outliers and henceforth excluded from the main analysis. This left 195 THRs and 285 TKRs for analysis.

The average length of stay for patients undergoing TKR was 2.7 days. The average BMI was 32.4. There was no significant correlation between BMI and LOS ($r = -0.0447$, $p = 0.2267$) as seen on figure 1. A non-significant reduction in LOS can be seen as BMI increases. When comparing BMI categories there was no significant difference ($p = 0.7116$) as seen on figure 2 and table 2. Patients with a BMI greater than 40 had the shortest LOS.

The average length of stay for patients undergoing THR was 2.9 days. The average BMI was 29.9. There was no significant correlation between BMI and LOS ($r = 0.007$, $p = 0.4613$) as seen on figure 1. A non-significant increase in LOS can be seen as BMI increases. When comparing BMI categories there was no significant difference ($p = 0.4613$) as seen on figure 2 and table 1. Patients with a BMI greater than 40 had the shortest LOS.

33 patients had a BMI greater than 40. Two of these had a LOS over 10 days and were excluded from the prior analysis but are included here as part of the descriptive analysis. The average age was 65 years. The average operative time was 78 minutes (data only available for 24 patients). The average haemoglobin drop was 2.4 g/dL and no patients required blood transfusion.

Two patients (6%) were readmitted within 30 days. Four patients (12%) were readmitted within 90 days. One patient was admitted on post-operative day five with cellulitis and treated with antibiotics for five days. Another patient was admitted six weeks post-operatively with a stitch abscess that required incision and drainage. Two patients had suspected deep vein thrombosis ; one was excluded

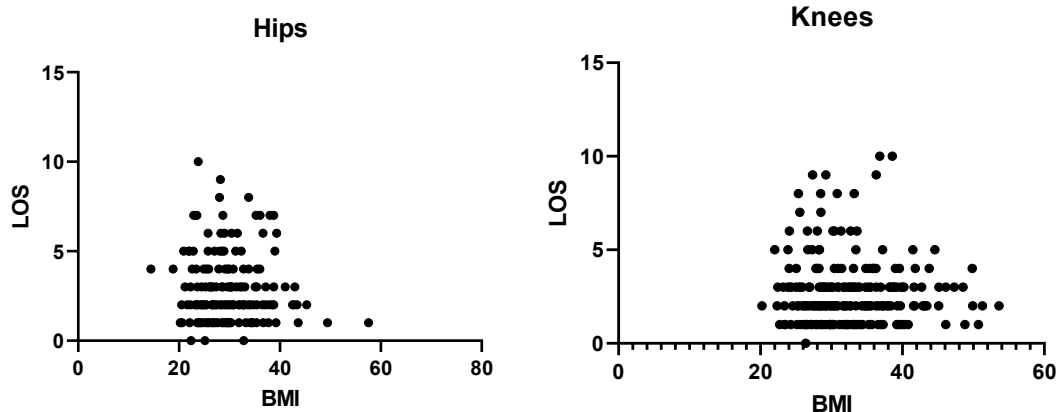


Figure 1. — Scatter graphs showing correlation between BMI and LOS for total hip and knee replacements.

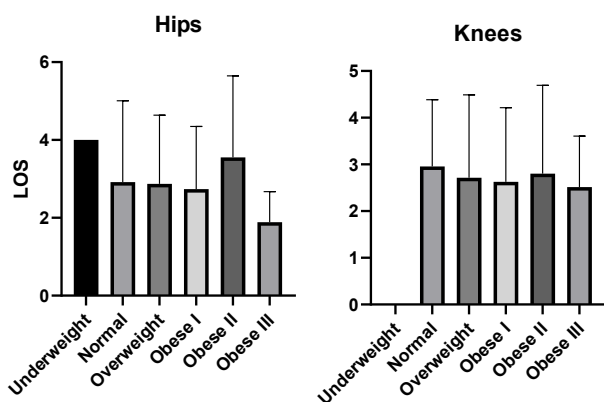


Figure 2. — Bar charts showing mean (and standard deviation) LOS for each BMI category. Underweight, BMI <18.5. Normal, BMI 18.5-24.9. Overweight, BMI 25-29.9. Obese I, BMI 30-34.9. Obese II, BMI 35-39.9. Obese III, BMI >40.

Table 1. — Mean LOS for each BMI category for total hip replacements

BMI	Category	Number of patients	Mean LOS
< 18.5	Underweight	1	4.0
18.5-24.9	Normal	36	2.9
25-29.9	Overweight	78	2.9
30-34.9	Obese I	42	2.7
35-39.9	Obese II	29	3.6
> 40	Obese III	9	1.9

on Doppler, the other had an equivocal Doppler and was discharged on apixaban for three months. Median follow up was 17 months (range 12-19)

Range of motion was measured at the final clinical follow up. 30 (91%) patients could flex

Table 2. — Mean LOS for each BMI category for total knee replacements

BMI	Category	Number of patients	Mean LOS
< 18.5	Underweight	0	n/a
18.5-24.9	Normal	22	3.0
25-29.9	Overweight	98	2.7
30-34.9	Obese I	78	2.6
35-39.9	Obese II	56	2.8
> 40	Obese III	31	2.5

Table 3. — Complication rates for patients with a BMI greater than 40 undergoing total knee replacement

Complication	Number
Minor wound issue (required antibiotics or no intervention)	6
Urine retention	2
Prosthetic joint infection (diagnosed at 5 months)	1
Stitch abscess requiring incision and drainage	1
Deep vein thrombosis	1
Unsatisfactory range of motion	1
Intraoperative patellar tendon injury	1

beyond 90 degrees. Only four patients couldn't reach full extension. One patient had a range of motion of 0-70 and underwent manipulation under anaesthesia and arthrolysis. Complications can be seen on table 3.

9 patients had a BMI greater than 40. The average age was 63 years. The average operative time was 118 minutes. The average haemoglobin drop was 2.2 g/dL and no patients required blood transfusion. No patients were readmitted within 90 days. No patients

had any documented complications. Median follow up was 16 months (range 12-18).

DISCUSSION

The results from our primary analysis show that increased BMI is not associated with increased LOS following primary total hip or knee replacements. For TKRs there was a non-significant weak negative correlation between BMI and LOS. For THRs there was a non-significant weak positive correlation between BMI and LOS. For both TKRs and THRs, patients with a BMI of greater than 40 had the shortest length of stay compared to other BMI categories (2.5 days for knees, 1.9 days for hips).

Previous research looking at the effect of BMI on LOS following TKR has yielded conflicting results. Prohaska et al. (2017) analysed 716 primary TKRs performed at a single institute in the United States of America and concluded that increased BMI was correlated with increased LOS and that BMI over 40 was associated with discharge to institution (6). Keeney et al. (2019) supported this by showing that, in patients with a BMI greater than 40, losing 9 kilograms preoperatively lead to reduced LOS and reduced discharge to institution following TKR (7). On the contrary, Husted et al. (2016) and Al-Azzani et al. (2017) showed that BMI is not associated with increased LOS (8,9). Chen et al. (2016) demonstrated that although patients undergoing TKR with a BMI of greater than 40 has a longer LOS and 30-day readmission rate, they had a greater improvement in functional outcomes at two year follow up (10).

With regards to THR, again the literature is conflicting. Hung et al. (2019) showed that increased age, operative time and presence of cardiovascular comorbidities were associated with greater 30-day complications, but failed to demonstrate a link between BMI and LOS or 30-day complications (11). Richard et al. (2018) and Iqbal et al. (2016) both showed that BMI does not affect LOS following THR (12,13). On the other hand, Bradley et al. (2014) and Kremers et al. (2014) found a correlation between increased BMI and both LOS and cost (5,14). Husted et al. (2016) found that BMI greater than 35 was associated with LOS over four days (8).

There are concerns that operating on the morbidly obese may lead to inferior outcomes. Barrett et al. (2018) performed a systematic review of THRs comparing BMI greater than 35 with BMI less than 35, finding increased revision rates with a higher BMI (7.99% versus 2.75%, respectively) (15). Nevertheless they also demonstrated a comparable improvement in functional outcomes scores between morbidly obese and non-obese patients (15). Contrary to this however, Chee et al. (2010) identified that functional outcomes improved more if the patient was non-obese (16). Chee et al. (2010) also noted increased complications and reduced five-year survivorship in the morbidly obese (16). With respect to TKRs, Amin et al. (2006) showed that BMI greater than 40 was associated with lower Knee Society Scores, increased complications and inferior survivorship (17). Halawi et al. (2019) showed that patient-reported outcomes were only inferior in the six months immediately postoperative for patients with a BMI of greater than 40 ; beyond six months there was no difference (18). They also found no difference in patient-reported outcomes following THR when comparing BMI greater than 40 with BMI less than 40 (18).

30-day readmission rates following TKR (for all BMI categories combined) have been quoted at 3.3-4.7%, and 90-day readmissions quoted at 8.2-9.7% (19,20). Top reasons for readmission include post-operative infection, cellulitis, periprosthetic fracture, wound disruption, cardiac events, VTE and pneumonia (19). It has been noted in the literature that morbid obesity has been associated with higher readmission rates (21,22). In our series of patients with a BMI of greater than 40, we identified a 30-day readmission rate of 6% and a 90-day re-admission rate of 12%. We do note that one of our readmissions was for a suspected DVT that was ruled out and could therefore be seen as an inappropriate admission. Although readmissions for the morbidly obese in our series were slightly higher than other BMI categories quoted in the literature, we feel that the relatively low readmission rate in this 'high-risk' category should be commended.

30-day readmission rates following THR (for all BMI categories combined) have been quoted at 3.4%-5.6%, and 90-day readmissions quoted

at 7.2%-7.7% (19,20). Common reasons for readmission are similar to TKR, but also include dislocation (19). In our series of morbidly obese patients we had no readmissions within 90 days, although we do note our sample size of nine is limited.

Lübbecke et al. (2016) analysed 9,061 TKRs and THRs and noted prosthetic joint infection rates to be 1.1% if BMI was less than 35, 2.1% if BMI was 35-40, and 3.7% if BMI was greater than 40 (23). In the current study we identified one prosthetic joint infection out of 42 lower limb arthroplasties (2.4%) performed in the patients with a BMI greater than 40. In our series we found that prosthetic joint infection rates in the morbidly obese are roughly double that of a 'typical' arthroplasty patient, which is lower than quoted in the literature.

The most frequency complication we found with patients with a BMI of greater than 40 was issues with the wound, all in TKRs. We identified six (14.3%) minor wound issues (two oozing wounds, two issues with skin clips, one superficial wound infection and one cellulitis). One patient required incision and drainage of a stitch abscess at two months post-TKR. Wound issues have been noted to be more frequent with increasing BMI elsewhere in the literature (24,25). Given the increased risk of deep and superficial infections in patients with a BMI of greater than 40, it is essential that when consenting these patients we make it clear they are fully informed of their higher complication risk.

The literature is conflicting regarding the effect of BMI on development of postoperative VTE. Anecdotally obesity is associated with greater risk of VTE, however there are several large studies that show obese patients are at no greater risk than non-obese patients (25-27). In the general population, it has been suggested that 1.3% of patients undergoing a THR and 2.8% of patients undergoing a TKR will develop VTE (28). It is important to point out that these figures vary throughout the literature, with Sadeghi et al. (2012) identifying that 21% of patients undergoing TKR in their series developed VTE (26). The rate of VTE was low (2.4%) in our analysis of patients with a BMI of greater than 40, suggesting that increased BMI doesn't affect VTE risk.

The results from our subgroup analysis of patients with a BMI greater than 40 show that surgical complications are similar to those quoted in the literature for all patients undergoing lower limb arthroplasty.

A limitation of our study is that we lack long term follow up. Our median follow up for morbidly obese patients is 16 months and therefore we cannot provide long term data on revision rates or implant survivorship ; for which there are concerns about in this BMI category (15-17).

Another limitation of our data is the relatively small number of patients with a BMI of greater than 40 (33 knees, 9 hips) however we do note that our average BMI is higher than the average quoted in the NJR's 2019 annual report (2). For TKRs, the NJR average BMI is 30.7, however our trust average BMI is 32.4 (2). For THRs, the NJR average BMI is 28.7, whereas ours is 29.9 (2). It could be hypothesised that the short LOS and reasonable complication rates for patients with a BMI of greater than 40 in our series is due to our increased exposure to patients with a high BMI. If surgeons are regularly performing arthroplasty in patients with a higher than average BMI then this could lead to improved outcomes in this cohort of patients. One of the key findings of the Getting It Right First Time report was that a high number of surgeons were performing fewer than ten revision cases per year, and a potential solution for this is to set up revision centres for surgeons to subspecialise solely in revision arthroplasty (29). Given that the incidence of obesity related arthritis is increasing, would it be unreasonable to suggest in future years we see surgeons subspecialising in arthroplasty in the morbidly obese?

CONCLUSION

We have shown that for primary TKRs and THRs, increased BMI is not associated with increased LOS. The morbidly obese category was found to have the shortest LOS, although this difference wasn't statistically significant. Re-admission rates and complications for the morbidly obese were comparable to the literature for non-obese

patients. We feel that BMI greater than 40 is not a contraindication to TKR or THR.

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