SHORT-TERM OUTCOMES IN OBESE PATIENTS UNDERGOING ANTERIOR MINIMALLY INVASIVE TOTAL HIP ARTHROPLASTY

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ABSTRACT

Background: Obesity affects over 774 million individuals worldwide. It is associated with an accelerated onset and progression of osteoarthritis, resulting in an increased need for Total Hip Arthroplasty (THA). Obese patients have a higher risk of perioperative complications. The Direct Anterior Approach (DAA) for THA is gaining popularity globally, however, there are concerns over its suitability for obese individuals.

Objective: This study compares short-term clinical, functional, and radiological outcomes of obese and non-obese patients undergoing THA via the DAA.

Methods: We conducted a retrospective study of 356 consecutive patients who underwent elective primary THA via the DAA using a specialised leg positioner (Medacta International, Switzerland) and intraoperative fluoroscopy. Obese patients (BMI ≥ 30 kg/m^2) were compared to the control group using baseline patient information, perioperative data and postoperative outcomes at minimum one-year follow-up.

Results: The study included 107 (30%) obese patients. Cohorts were well-matched for age, sex, preoperative diagnosis and baseline PROMs. In the obese cohort, surgical time and blood loss increased by a mean of 8.32 ± 6.9 minutes (p = 0.03) and 58.19 ± 25.37 ml (p = 0.0003) respectively. There were no significant differences in intraoperative radiation (mGys), time to discharge and discharge destination between the groups. Obese patients had a higher incidence of wound-related complications (5.6% versus 2.4%), however overall complication rates were similar (9.3% versus 6.8%, p = 0.67). Functional outcomes were equivalent with a mean postoperative mHHS of 97.57 ± 4.86 and 98.05 ± 5.59 in the obese and non-obese cohorts respectively (p = 0.54). PROMs including the Forgotten Joint Score (p = 0.34), patient joint perception score (p = 0.2) and patient satisfaction rates (p = 0.085) were comparable.

Conclusion: The AMIS® DAA is a safe and effective approach for obese patients with excellent short-term outcomes, however an increased risk of wound-related complications remains.

Key words: Total hip arthroplasty, Direct anterior approach, Obesity, Anterior minimally invasive total hip arthroplasty, AMIS

INTRODUCTION

The worldwide prevalence of obesity has risen exponentially over the last few decades with obesity affecting over 774 million individuals (1). Within South Africa, 41% of women and 11% of men are classified as obese (2). Obesity is associated with an earlier onset of osteoarthritis due to physiological and biomechanical mechanisms (3,4). Obesity results in a state of chronic inflammation, which contributes to the severity, and progression of osteoarthritis by reducing pain tolerance, accelerating cartilage degradation, and stimulating osteophyte formation (3–5). Affected individuals typically have altered gait patterns and abnormal joint loading (4,5). The relative risk of undergoing Total Joint Arthroplasty (TJA) correlates with increasing Body Mass Index (BMI) (3,4). Morbidly obese patients are 8.5 times more likely to require Total Hip Arthroplasty (THA) than

non-obese individuals (3,4). Obese and morbidly obese individuals respectively are likely to require THA two and nine years earlier than their non-obese counterparts (3,4).

Obesity is associated with a cluster of comorbidities, which contribute to increased perioperative risk (4). Obese individuals typically have increased surgical duration, Length of Stay (LOS) and analgesic requirements (3,6–9). Obesity is an independent risk factor for complications during TJA including combined complications; systemic complications; hip dislocation; re-intubation; re-operation; surgical site and deep infections (3,4,6–8,10–13). A 2019, meta-analysis by Onggo *et al.* (8) of over two million patients found an increased risk of all complications in obese patients undergoing THA (OR = 1.53, 95% CI:1.30 – 1.80, p< 0.001).

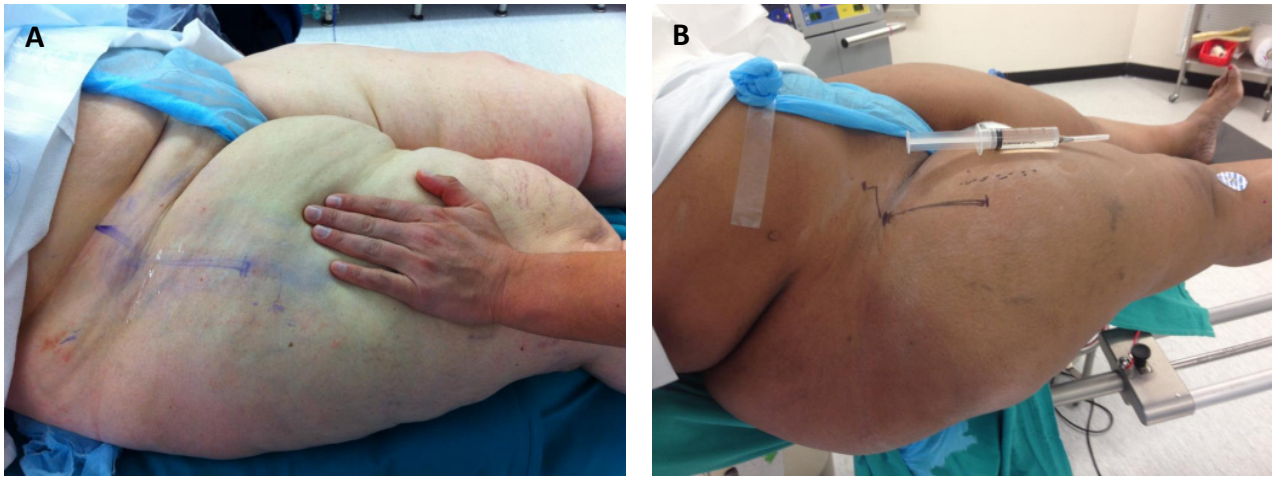
THA is a highly regarded and cost-effective surgical intervention with reported survivorship of up to 95% at 10 years, > 80% at 25 years and patient satisfaction of > 96% at 10 years (10,14–16). Utilisation of THA continues to grow and current projections suggest a perpetuation of this trend as demand, eligibility, technology, and skills evolve, however there is still no consensus on the optimal surgical approach (14,17).

The DAA has seen a recent surge in popularity with DAA utilisation for primary THA amongst American Association of Hip and Knee Surgeons' members increasing from 12% in 2009 to 45% in 2020 (18,19). The DAA is an anterior-based minimally invasive surgical approach that accesses the hip via intermuscular and internervous planes, potentially limiting muscle damage (20–22). Reported advantages include reduced postoperative pain, LOS and dislocation risk; improved mobility; and superior HHS during the early postoperative period (20,21,23–26). Despite these benefits, the DAA is not the panacea as it has been associated with a steep learning curve, longer surgical duration, and a higher rate of certain complications, most notably Surgical Site Infections (SSI) and intraoperative fractures (7,10,12,13,19–21,24–27). Fifty-three percent of DAA surgeons consider obesity to be a relative contraindication for DAA use (19).

While common, the use of specialised leg positioners for the DAA remains controversial (28,29). The AMIS® mobile leg positioner (Medacta International, Switzerland) was developed for use with the AMIS® DAA technique to allow controlled intraoperative manipulation of the hip (30). A potential benefit of this device in obese patients, is that the suspended thigh allows some of the excess adipose tissue to fall away from the surgical site compared to a conventional table on which the excess adiposity is supported by the table and pushes up towards the surgical site thus making exposure more challenging (28) (Figure 1).

Figure 1

A. Obese patient positioned on conventional table
B. Obese patient positioned on AMIS® Mobile Leg Positioner



Considering the trifactor of THA demand, DAA utilisation and the global obesity epidemic outlined above, we sought to compare short-term outcomes of obese and non-obese patients undergoing THA via the AMIS® DAA.

MATERIALS AND METHODS

Study design: This was a retrospective analysis using prospectively collected data from a single-surgeon, evaluating 356 consecutive, adult patients who underwent elective, unilateral primary THA via the AMIS® DAA, between 01 January 2018 and 31 December 2020. Exclusion criteria included patients who declined or were incapable of giving informed consent, and/or did not complete a minimum one-year follow-up. Ethics clearance was obtained from the Human Research Ethics Committee, University of the Witwatersrand.

Surgical protocol: A standardised protocol was utilised with all patients undergoing preoperative medical evaluation and optimisation by a single physician. All patients were operated on in a single laminar-flow theatre under general anaesthesia and a lumbar plexus block, administered by a fellowship-trained anaesthetist. Patients were positioned supine with padded perineal support. The affected leg was placed in the AMIS® Mobile Leg Positioner, controlled by an experienced table-operator. A weight-adjusted dose of intravenous antibiotic prophylaxis (Cefazolin or Clindamycin in cases of a known allergy) was administered preoperatively and for 24 hours postoperatively.

A longitudinal skin incision of 6 – 10cm was made 2 – 3cm lateral and parallel to a line between the anterior superior iliac spine and Gerdy's tubercle. The underlying perimysium was divided to allow access to the interval between tensor fascia lata and sartorius. The lateral aspect of the rectus femoris was retracted medially to expose the joint capsule. An anterior capsulotomy was used to enter the joint. The femoral neck was osteotomised under traction while protecting the posterior capsule. The acetabular labrum was preserved where possible, and the acetabulum prepared as per conventional THA. Preparation of the femur was done in a position of extension and external rotation, optimising access to the proximal femur. Soft tissues were released as necessary to allow adequate access to the femoral canal while protecting the ligaments. Femoral broaching was performed using AMIS® broaches via conventional broaching techniques. Uncemented implants with 36mm ceramic femoral heads and highly cross-linked polyethylene cups were used preferentially as allowed by patient anatomy.

Intraoperative fluoroscopy (Philips, BV Pulsera) was performed by a single radiographer at three different time points: (i) to assess optimal positioning of the acetabular cup; (ii) to assess optimal sizing and position of the femoral component during broaching; and (iii) after reduction of the implants, prior to soft tissue closure. An intra-articular negative-pressure drain was placed intraoperatively and removed within 24 hours. Intermittent pneumatic compression devices were employed postoperatively until discharge and inpatient physiotherapy provided twice daily. Patients were required to be ambulatory on crutches before discharge. Patients were discharged on oral thromboprophylaxis (Rivaroxaban 10mg daily) for two weeks.

The surgical site was assessed by a clinical associate 10 days postoperatively and all suspicious wounds reviewed by the primary surgeon. A routine duplex Doppler was performed three weeks postoperatively to assess for occult Deep Vein Thrombosis (DVT). The surgeon conducted follow-up assessments at six weeks, six months and one year postoperatively.

Variables and outcome measures: Preoperatively, the following baseline patient information was captured for all patients: age (years), sex, primary diagnosis, comorbidities, and BMI. Limb Length Discrepancy (LLD) was measured radiographically using Woolson's technique (31). Patients' preoperative functional status were evaluated using the modified Harris Hip Score (mHHS) – a validated tool that factors in pain, gait and activities (32). Pain was quantified using the Universal Pain Assessment Tool (UPAT); a combination tool comprising the verbal numeric rating scale, the verbal descriptor scale and the Wong-Baker FACES® pain rating scale (33,34).

Intraoperatively, the following data was collected: surgical duration in minutes from incision to completion of the last suture; estimated blood loss in millilitres and fluoroscopy use (radiation exposure in milligrays and duration of exposure in seconds). Perioperative data included: the use of blood products; LOS in days measured from date of admission to date of discharge and discharge destination; home or step-down facility.

Postoperatively, at minimum one year, clinical, functional and radiographic outcomes were assessed using the following tools: mHHS, UPAT, Forgotten Joint Score (FJS), joint functionality, Patient Joint Perception (PJP) and a Likert-type patient satisfaction scale. The FJS is a validated Patient Reported Outcome Measure (PROM), designed to determine patient awareness of the artificial joint (35). The PJP is a single-question PROM that correlates moderately with FJS (36).

Standard radiographic imaging was used to assess LLD, component position and component loosening. Radiographic measurements were made using Medicad® software version 6.0.0.10, integrated into the Agfa HealthCare Enterprise Imaging system.

Complications were classified as intraoperative or postoperative; medical (related to the patients' baseline and physiological effect of the surgery) or surgical (directly related to the surgery); and temporal (early ≤ 4 weeks, late > 4 weeks).

Data analysis: The study compared the outcomes of obese (BMI ≥ 30) and non-obese (BMI < 30) patients, based on a series of parameters (1). The means of these parameters were compared using t-tests with statistical significance at $p < 0.05$. Confidence intervals were calculated at 95%, and used in conjunction with the p-values to determine clinical significance. Groups were tested for linear model assumptions: normality and homogeneity of variances. In the event of a violation of the linear model assumptions, the Wilcoxon rank-sum alternative was used to hypothesis test between the two cohorts. The statistical package used was the R version 4.0.4 (2021-02-15); University of Auckland, New Zealand.

RESULTS

Demographics: In total, there were 356 patients of which 107 (30%) were obese and 205 (57.6%) were female ($p = 0.05$). The mean age of the obese group was 60.19 years versus 60.82 years in non-obese patients. The most common diagnosis was primary osteoarthritis, affecting 67.1% of non-obese and 74.8% of obese patients ($p = 0.7$). For further demographic details see Table 1.

Table 1
Patient demographics

	Total n = 356 (%)	Obese n = 107 (%)	Non-obese n = 249 (%)	P-value
Sex (n; %)				0.05
Male	151 (42.4%)	56 (52.3%)	95 (38.2%)	
Female	205 (57.6%)	51 (47.7%)	154 (61.8%)	
BMI (kg/m^2) (± SD)	27.95 ± 5.37	35.34 ± 3.7	25.21 ± 3.2	< 0.000
Age, years (± SD)	60.33 ± 12.75	60.19 ± 11.65	60.82 ± 13.23	0.73
Diagnosis (n; %)				
Primary osteoarthritis	247 (69.4%)	80 (74.8%)	167 (67.1%)	0.7
Congenital hip dysplasia	37 (10.4%)	12 (11.2%)	25 (10.0%)	
Avascular necrosis	22 (6.2%)	5 (4.7%)	17 (6.8%)	0.66
Inflammatory arthritis	16 (4.5%)	5 (4.7%)	11 (4.4%)	
FAI	16 (4.5%)	3 (2.8%)	13 (5.2%)	0.84
Previous trauma	4 (1.1%)	1 (0.9%)	3 (1.2%)	
Other	12 (3.4%)	1 (0.9%)	11 (4.4%)	
Comorbidities (n; %)				
Hypertension	69 (19.4%)	23 (21.5%)	46 (18.5%)	0.48
Asthma/COPD	34 (9.6%)	9 (8.4%)	15 (6.0%)	
Diabetes	33 (9.3%)	12 (11.2%)	21(8.4%)	0.21
Cardiac	26 (7.3%)	11(10.2%)	15 (6.0%)	1
Epilepsy	19 (5.3%)	6 (5.6%)	13 (5.2%)	
Thyroid	19 (5.3%)	4 (3.7%)	15 (6.0%)	0.51
Previous DVT/PE	12 (3.4%)	3 (2.8%)	9 (3.6%)	
Cancer	7 (2%)	2 (1.9%)	5 (2.0%)	0.21
Other	25 (7.0%)	7 (6.5%)	18 (7.6%)	

	Total n = 356 (%)	Obese n = 107 (%)	Non-obese n = 249 (%)	P-value
ASA grade (n; %)				
1	132 (37.1%)	34 (31.8%)	98 (39.4%)	
2	204 (57.3%)	66 (61.7%)	138 (55.4%)	
3	20 (5.6%)	7 (6.5%)	13 (5.2%)	

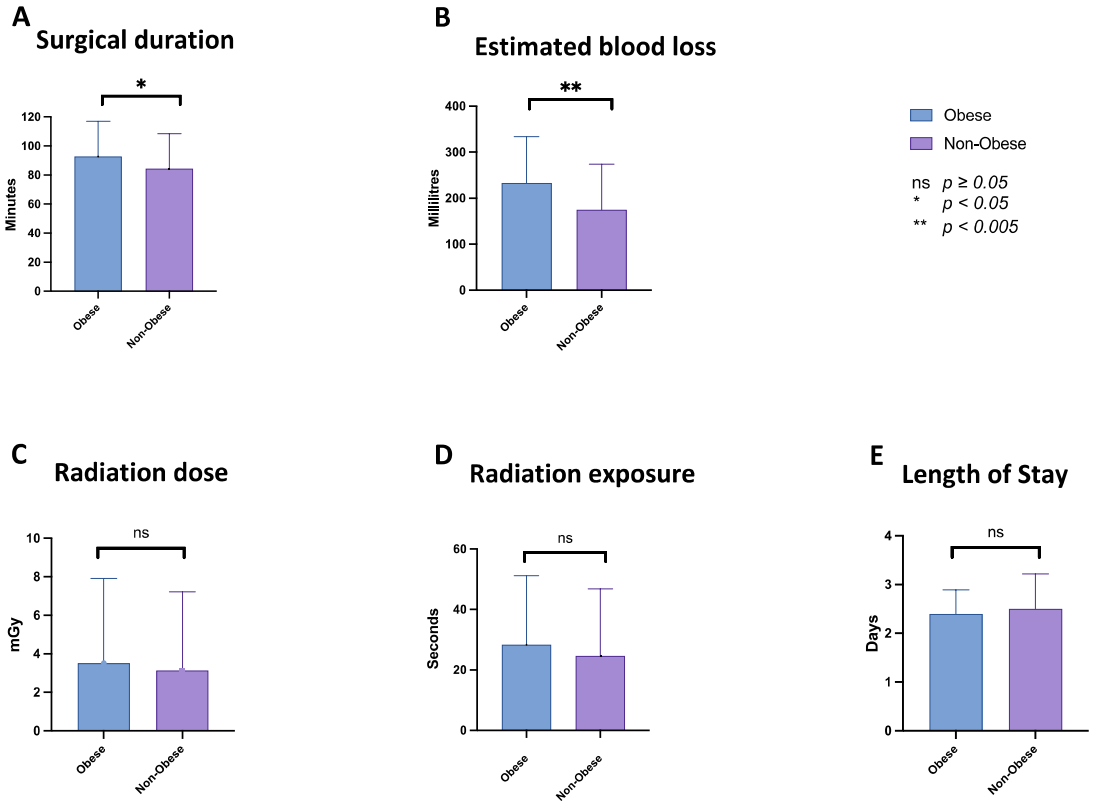
BMI: Body Mass Index; FAI: Femoroacetabular Impingement; COPD: Chronic Obstructive Pulmonary Disease; DVT: Deep Vein Thrombosis; PE: Pulmonary Embolus; ASA: American Society of Anaesthesiologists

Perioperative findings: Mean surgical duration was 92.71 ± 24.24 minutes for obese and 84.39 ± 23.92 minutes for non-obese patients (p = 0.03). Blood loss averaged 233.05 ± 100.93ml and 174.86 ± 99.11ml for obese and non-obese individuals respectively (p = 0.0003). One obese patient required a transfusion. Intraoperatively, the mean radiation dose was 3.51 ± 1.16mGy in the obese cohort (range 1.87 – 7.91 mGy) with an average exposure time of 28.31 seconds (range 17.61 – 51.17 seconds). The mean radiation dose in the non-obese cohort was 3.13 ± 1.81mGy (range 1.58 – 7.21mGy) and average exposure time was 24.56 seconds (range 14.9 – 46.75 seconds). The average LOS of obese patients was 2.4 ± 0.49 days and non-obese patients 2.5 ± 0.72 days (p = 0.16). Two obese and four non-obese patients required discharge to a step-down facility (p = 1) (Figure 2).

Figure 2

Perioperative findings

A. Surgical duration (p=0.03). B. Estimated blood loss (p=0.0003). C. Radiation dose (p=0.2). D. Radiation exposure (p=0.17). E. Length of stay (p=0.16)

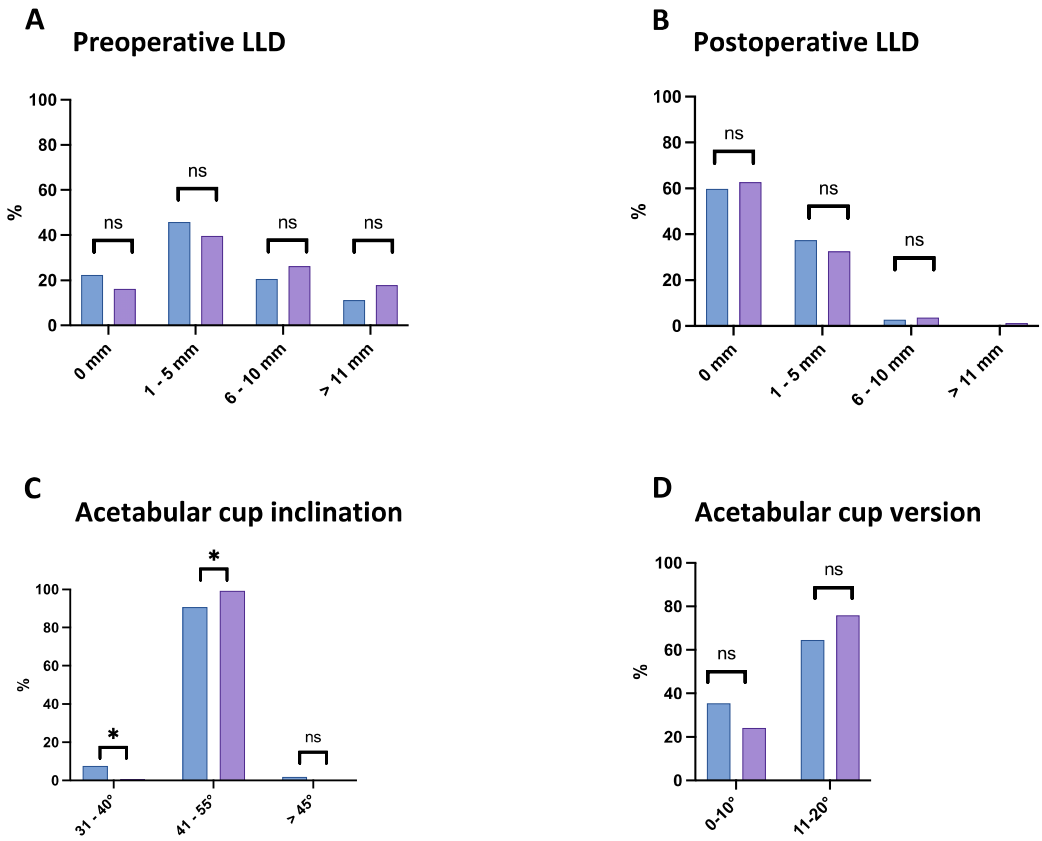


Radiographic outcomes: Eight (7.5%) obese patients and two (0.8%) non-obese patients had acetabular cup inclination of 31°– 40° (p = 0.01). Cup inclination of 41° –55° was achieved in 99.2% of the non-obese cohort versus 90.7% of the obese cohort (p = 0.02). LLD and other aspects of the implant placement demonstrated no statistical difference (Figure 3).

Figure 3

Radiographic outcomes

A. Preoperative limb length discrepancy. B. Postoperative limb length discrepancy. C. Acetabular cup inclination. D. Acetabular cup version. E. Femoral stem version. F. Femoral offset differential



Clinical and functional outcomes: Postoperative mHHS scores were 97.57 ± 4.86 and 98.05 ± 5.49 in the obese and non-obese cohorts, respectively (p = 0.54). The mean FJS in obese patients was 77.81 ± 22.19 versus 71.43 ± 28.56 in the non-obese (p = 0.34). Satisfaction was > 92% in both cohorts (p = 0.085). For details on other PROMS see Table 2.

Table 2

Clinical and functional outcomes

	Total n = 356 (%)	Obese n = 107 (%)	Non-obese n = 249 (%)	P -value
mHHS				
Preoperative ± SD	51.74 ± 12.02	49.92 ± 13.44	52.51 ± 11.22	0.19
Postoperative ± SD	97.91 ± 5.3	97.57 ± 4.86	98.05 ± 5.49	0.54
Change in mHHS	46.17	47.65	45.54	
FJS ± SD	73.34 ± 25.67	77.81 ± 22.19	71.43 ± 28.56	0.34
Satisfaction rate (n; %)				
Overall satisfaction	333 (93.5%)	99 (92.6%)	234 (94%)	0.085
Very dissatisfied	7 (2.0%)	2 (1.9%)	5 (2.0%)	
Dissatisfied	6 (1.7%)	2 (1.9%)	4 (1.6%)	
Neutral	10 (2.8%)	4 (3.7%)	6 (2.4%)	

	Total n = 356 (%)	Obese n = 107 (%)	Non-obese n = 249 (%)	P -value
Satisfied	66 (18.5%)	22 (20.6%)	44 (17.7%)	
Very satisfied	267 (75%)	77 (72.0%)	190 (76.3%)	
PJP (n; %)				0.2
Natural joint	216 (60.7%)	62 (57.9%)	154 (61.8%)	
Artificial joint, no restriction	71 (19.9%)	22 (20.6%)	49 (19.7%)	
Artificial joint, minimal restriction	61 (17.1%)	19 (17.8%)	42 (16.9%)	
Artificial joint, major restriction	5 (1.4%)	2 (1.9%)	3 (1.2%)	
Non-functional joint	3 (0.8%)	2 (1.9%)	1 (0.4%)	
Joint functionality (n; %)				0.53
Severely limited	8 (2.2%)	2 (1.9%)	6 (2.4%)	
Limited	17 (4.8%)	4 (3.7%)	13 (5.2%)	
Can do most things	136 (38.2%)	40 (37.4%)	96 (38.6%)	
Can do anything	195 (54.8%	61 (57.0%)	134 (53.8%)	
UPAT ± SD				
Preoperative day	5.81 ± 1.98	5.99 ± 1.79	5.44 ± 2.3	0.13
Postoperative day	0.4 ± 1.28	0.45 ± 1.43	0.28 ± 0.82	0.29
Change day	5.39 ± 2.31	5.49 ± 2.24	5.2 ± 2.47	
Preoperative night	5.15 ± 2.62	4.92 ± 2.54	5.28 ± 2.65	0.42
Postoperative night	0.35 ± 1.33	0.23 ± 0.96	0.41 ± 1.46	0.32
Change night	4.82 ± 2.64	4.91 ± 2.32	4.78 ± 2.79	
Preoperative sport/activity	7.16 ± 2.21	7.13 ± 2.75	7.17 ± 2.06	0.97
Postoperative sport/activity	1.31 ± 3.19	0.43 ± 1.33	1.59 ± 3.58	0.2
Change sport/activity	5.64 ± 4.01	5.33 ± 4.73	5.72 ± 4.05	

mHSS: modified Harris Hip Score; FJS: Forgotten Joint Score; PJP: Patient Joint Perception; UPAT: Universal Pain Assessment tool

Complications: Overall, the complication rate was 7.6% (n = 27), 9.3% and 6.8% of the obese and non-obese groups respectively (p = 0.67). Twenty-six of the complications were surgical and resulted in eight re-admissions (two obese (1.8%) and six (2.4%) non-obese). Three cases were revised at a mean follow-up of 29.45 months (one obese and two non-obese). Twelve patients presented with wound complications, six (5.6%) obese and six (2.4%) non-obese patients. In the obese cohort, one Prosthetic Joint Infection (PJI) and one intraoperative fracture were diagnosed. Three postoperative periprosthetic fractures (1.2%), two dislocations (0.8%) and one confirmed DVT were documented in the non-obese cohort. Aseptic loosening occurred in two obese (1.9%) and five (2.0%) non-obese patients (2%) (Table 3).

Table 3
Complications

	Total n = 356	Obese n = 107	Non-obese n = 249	P-value
Total	27 (7.6%)	10 (9.3%)	17 (6.8%)	0.67
Early (<4 weeks)	15 (4.2%)	4 (3.7%)	11 (4.4%)	0.4
Late (>4 weeks)	12 (3.4%)	6 (5.6%)	6 (2.4%)	
Medical	1 (0.3%)	0	1 (0.4%)	
DVT	1 (0.3%)	0	1 (0.4%)	
Surgical	26 (7.3%)	10 (9.3%)	16 (6.4%)	0.8
Wound problems	12 (3.4%)	6 (5.6%)	6 (2.4%)	
Wound dehiscence	11 (3.1%)	5 (4.7%)	6 (2.4%)	
Surgical site infections	1 (0.3%)	1 (0.9%)	0	
Deep PJI	1 (0.3%)	1 (0.9%)	0	
Aseptic loosening	7 (2.0%)	2 (1.9%)	5 (2.0%)	
Acetabular loosening	1 (0.3%)	0	1 (0.4%)	
Femoral component loosening	6 (1.7%)	2 (1.9%)	4 (1.6%)	
Dislocation	2 (0.6%)	0	2 (0.8%)	
Periprosthetic fractures	4 (1.1%)	1 (0.9%)	3 (1.2%)	
Intraoperative fractures	1 (0.3%)	1 (0.9%)	0	
Postoperative fractures	3 (0.8%)	0	3 (1.2%)	
Vancouver B2	2 (0.6%)	0	2 (0.8%)	
Vancouver C	1 (0.3%)	0	1 (0.4%)	
Re-admissions	8	2 (1.9%)	6 (2.4%)	
<30 days	3 (0.8%)	1 (0.9%)	2 (0.8%)	
31 – 60 days	2 (0.6%)	0	2 (0.8%)	
61 – 90 days	3 (0.8%)	1 (0.9%)	2 (0.8%)	
Re-operations	3 (0.8%)	1 (0.9%)	2 (0.8%)	
< 4 weeks	2 (0.6%)	0	2 (0.8%)	
> 4 weeks	1 (0.3%)	1 (0.9%)	0	

DVT: Deep Vein Thrombosis; PJI: Prosthetic Joint Infection

DISCUSSION

To our knowledge, this is the first study in South Africa to compare outcomes between obese and non-obese patients undergoing THA via the AMIS®DAA. Cohorts were well-matched in terms of age, gender, primary diagnosis, and comorbidities. No differences were found in LOS, discharge destination, intraoperative fluoroscopy use, functional outcomes, PROMS and overall complication rates however increases in surgical duration, blood loss and risk of wound complications were noted in the obese group.

In this study mean surgical duration was longer in the obese cohort by 8.32 minutes. Obesity adversely affects surgical time regardless of approach (6–8,10,28,37,38). Onggo *et al.* (8) calculated a difference in the mean surgical duration of 8.71 minutes between obese and non-obese patients, which widened further with increasing BMI, without assessing specific approaches. In the DAA, Russo *et al.* (7) reported an increased surgical duration of 12.7 minutes in obese patients. Prolonged surgical duration is associated with increased perioperative risks including: prolonged admission; re-admission and re-operation; surgical site complications; systemic complications; and the need for blood transfusion (9,39).

Despite the increased intraoperative blood loss noted in the obese cohort, only one patient

required a transfusion implying limited clinical impact. Blood transfusions in THA are associated with a higher risk of PJI, increased LOS and cost (40). Neither Argyrou *et al.* (28) nor Hartford *et al.* (37) found a relationship between BMI and blood loss in the DAA, however, Antoniadis *et al.* (10) noted increased blood loss in severely obese patients (BMI ≥ 35kg/m^2) undergoing the DAA. Onggo *et al.* (8) did not find a significant difference in blood loss between obese and non-obese patients regardless of approach.

There were no statistically significant differences in average fluoroscopy duration or dosage between the obese and non-obese cohorts. Previous research by Curtin *et al.* (41) identified a relationship between radiation dose and BMI based on the energy required to create the image. While the average fluoroscopy duration and dosage was greater than elsewhere in the literature, with Baksh *et al.* (42) noting a mean fluoroscopy time of 21.4 seconds and a mean patient radiation dose of 1.8 mGy; the radiation dose across both cohorts remained within safe limits (41,42). Intraoperative fluoroscopy improves the accuracy of component positioning at the expense of radiation exposure to patient and staff (42).

The authors found no difference in LOS or need for step-down facilities. Antoniadis *et al.* (10) reported a longer LOS in both cohorts than found in this study and further noted a higher LOS in the severely obese cohort (7.3 versus 5.3 days). In obese patients, Russo *et al.* (7) noted an increased LOS (2.4 versus 2.6 days) and need for step-down care (7.6% versus 15.4%). Hartford *et al.* (37) noted equivalent outcomes regardless of BMI in terms of LOS (p = 0.70) and discharge destination (p = 1.7).

There was a significant improvement in UPAT score in both cohorts (p< 0.000). Postoperatively, obese patients reported higher levels of day pain (0.45 ± 1.43 versus 0.28 ± 0.82, p = 0.29) and lower night (0.23 ± 0.96 versus 0.41 ± 1.46, p = 0.32) and activity-related pain (0.43 ± 1.59, p = 0.2) however this trend existed preoperatively and differences were statistically insignificant. Macheras *et al.* (43) found equivalent postoperative pain scores for the obese and non-obese cohorts who underwent the DAA with both groups scoring significantly better than matched candidates who underwent the Hardinge approach. Though statistically insignificant, we found a greater improvement in mHHS scores in the obese cohort, despite the mean postoperative mHHS remaining lower than those of the non-obese. This was similar to the findings in other studies (10,28,43). In an RCT, Macheras *et al.* (43) noted better mHHS in DAA patients than Hardinge patients regardless of BMI. FJS in both of our cohorts reflected successful surgery but contrary to Singh *et al.* (44) who noted a trend of higher scores in non-obese patients, (68.11 versus 62.45; p = 0.349), our study demonstrated higher scores in the obese cohort (77.81 ± 22.19 versus 71.43 ± 28.57) however these findings were statistically insignificant (p = 0.34). Other PROMS were similar indicating equivalent functional outcomes between obese and non-obese patients.

There were no statistically significant differences in overall complication rates, re-admissions or re-operations. These have all been associated with increased risk in obese patients, regardless of approach (7,8,10,13,28,37,38). In our study, obese patients were more likely to have late complications and more likely to have wound complications (5.6% versus 2.4%, OR 2.4). An increased risk of wound complications and PJI in the obese cohort is in keeping with previous literature (7,10,13,28,37). Russo *et al.* (7) noted a 3.6 times risk for wound complications in obese patients with an 8.8 times risk of major complications. Purcell *et al. (*13) noted an incidence of 2.5% for PJI and 2% for SSI in patients with a BMI of ≥ 35kg/m^2; Argyrou *et al.* (28) noted an SSI rate of 8.1% in the obese versus 1.2% in the non-obese and Antoniadis *et al.* (10) documented a 2.3% incidence of deep infection and 4.7% incidence of SSI in the obese compared to 0.8% of each respective complication in the non-obese cohort. In our study, non-obese patients were more likely to have early complications, including fractures and dislocations. There were no dislocations in the obese cohort. Onggo *et al.* (8) and Lui *et al.* (45) both noted an increased dislocation risk for obese patients undergoing THA however Verhaegen *et al.* (46) who only assessed patients undergoing the DAA did not find a difference. In our population, potentially protective factors include the tendency towards a more closed acetabular cup in the obese cohort and the intermuscular nature of the approach.

There were several limitations to this study. As the data set was limited to a single, high-volume hip surgeon at a single institution, results may not be replicable in settings without equivalent expertise or resources. BMI was used to classify obesity due to widespread use and convenience however it is often considered to be a crude measure of obesity. While we used broad categories of obese and non-obese patients, the further grading of BMI would have allowed for a more refined analysis of the data and comparison to other literature.

CONCLUSION

This study shows that AMIS® DAA is a safe option for obese patients with equivalent outcomes to non-obese patients. As in other THA approaches, obese patients have a higher risk of wound-related complications, longer duration of surgery and increased volume of blood loss. This should be discussed during preoperative counselling and surgical planning.

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