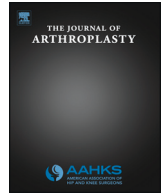




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Increased Complications in Obese Patients Undergoing Direct Anterior Total Hip Arthroplasty

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ABSTRACT

The direct anterior (DA) approach for total hip arthroplasty (THA) has demonstrated successful short term outcomes in several studies. However, there is no consensus about which patients are appropriate candidates for DA total hip arthroplasty. It is also unclear if short term outcomes in obese patients undergoing THA through a DA approach are elevated in comparison to non-obese patients. The purpose of this study was to evaluate complication rates and short term outcomes of obese, pre-obese, and normal body mass index (BMI) patients undergoing THA with a DA approach in a consecutive group of patients. This study was a retrospective review of 210 consecutive patients who underwent unilateral THA through a DA approach for osteoarthritis or avascular necrosis during the early peri-operative period. The study included 61 patients with normal BMI, 70 pre-obese patients, and 79 obese patients according to World Health Organization (WHO) classification (49 class I obese, 22 class II obese, and 8 class III obese patients). Patient charts were reviewed to determine differences in surgical time, length of stay, disposition, major complications, wound complications, and short term outcome measures. When comparing normal and pre-obese patients (BMI <30) to a combined group of WHO class I, II, and III obese patients (BMI >30), the obese group demonstrated increased surgical times by 12.7 minutes ($P < 0.0001$), as well as increased length of stay ($P = 0.0303$), narcotic use ($P = 0.0037$), and assistive device use at two weeks ($P < 0.0030$). In addition, major complications and wound complications were both significantly increased in the obese group (odds ratio [OR], 8.8; $P = 0.0493$ and OR, 3.6; $P = 0.0431$, respectively). There was also a trend toward increased use of rehabilitation facilities in the obese group at disposition, 15.4% vs 7.6% ($P = 0.0774$). This study demonstrates that obese patients undergoing a DA approach have a 8.8 and 3.6 times increase in major and wound complications, respectively, compared to patients with a BMI <30. Obese patients also demonstrated significant increases in operative time, use of narcotics, use of assistive devices, and length of stay. There was a trend toward higher use of rehabilitation placement. While significant, these findings are similar to complication rates in the literature for other THA operative approaches. This study further defines the risks associated with performing THA on obese patients regardless of approach.

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Although total hip arthroplasty through a direct anterior approach was first described in 1947 by Judet and Judet [1], it has gained recent attention and popularity with both patients and surgeons due to its potential for faster recovery, increased stability, and decreased pain when compared with other surgical approaches [2]. What is often underestimated however is the high degree of difficulty associated with exposure in the obese patient and the direct correlation between surgeon experience and complication rates in this patient population [3].

There are numerous advantages of the direct anterior approach published in the orthopedic literature, with most owing to its intermuscular exposure and soft tissue preservation rather than the more traditional muscle-splitting approaches [4]. Muscle-splitting

approaches require the release of tendinous attachments in order to gain adequate exposure, thereby inhibiting normal hip function until those structures have healed. In contrast, a muscle sparing exposure requires no additional time for soft tissue attachment healing, potentially resulting in improved peri-operative recovery and mobility.

Outcomes and comparison studies have demonstrated a clinically significant reduction in post-operative pain and recovery time for the direct anterior approach. In a comparison study between the direct anterior and mini-posterior approach, Nakata et al [5] found a more rapid recovery of normal gait and hip function with the direct anterior approach. This study also found improved acetabular component placement with the direct anterior approach, citing 98.99% of components placed in the “safe zone” for anteversion and abduction angles, compared with 90.63% in the mini-posterior approach. In addition to a faster recovery, the DA approach offers the potential benefit of increased stability and less risk for dislocation, although this has not yet been shown to be statistically significant compared with other approaches [6].

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The high early complication rates during the learning curve period associated with a direct anterior approach can be attributed to difficulty in obtaining adequate exposure, especially for the preparation and implantation of the femoral component [7]. There are many specific anatomic features of the hip and pelvis that contribute to the difficulty of exposure and femoral preparation including a wide iliac wing, high femoral neck shaft angle, as well as a large muscular patient. When combined with obesity, these features can present a substantial challenge for the surgeon in terms of retractor placement, proper bone preparation, and accurate component positioning [8].

Demographic trends point toward an increasing need for THA in the obese patient population. Many studies suggest that this group has a higher risk for perioperative complications [9–12]. Since our patient demographic population includes a large percentage of obese patients, we decided to retrospectively examine this challenging group of patients in our DA approach cohort, and to evaluate how these results compare to published complication rates for other operative approaches. Therefore, the purpose of this study was to evaluate complication rates and short term outcomes of obese, pre-obese, and normal BMI patients undergoing THA with a DA approach in a consecutive group of patients.

Materials and Methods

This study was approved by the institutional review board and conducted entirely at the authors' institution. All adult patients undergoing primary total hip arthroplasty by the senior author (MZ) were eligible for inclusion. A retrospective chart review of 210 consecutive patients who underwent unilateral primary THA through a DA approach was conducted. All patients scheduled for THA during this time period had a DA approach unless they had prior surgery or required hardware removal. Intraoperative and early (first 6 weeks) postoperative complications were evaluated. The study included 61 patients with a normal BMI, 70 pre-obese patients, and 79 obese patients according to World Health Organization (WHO) classification (Table 1). The WHO classification of obesity is as follows: normal: <25 kg/m², pre-obese: 25–29.9 kg/m², class I: 30–34.9 kg/m², class II: 35–39.9 kg/m², class III: >40.0 kg/m².

All 210 cases used the same implants, a Pinnacle uncemented acetabular component, a highly cross-linked polyethylene liner, a Trilock BPS uncemented femoral stem, and either cobalt–chromium or Biolox Delta ceramic femoral head of 32 or 36 mm in size (Depuy, Warsaw, IN).

The direct anterior approach utilized a modified Smith–Peterson interval as described by Berend et al [3]. The approach is between the tensor fascia lata muscle and the sartorius, with deep dissection extending lateral to the rectus femoris. A standard operating table was used along with a femoral elevator allowing for proper femoral exposure (Omni-Tract Surgical, St. Paul, MN), as well as dual-offset broach handles to help with femoral canal preparation. Routine use of

Table 1
Patient Characteristics by BMI and Age.

BMI Group	Mean	Std Dev	Min	Max
Normal (n = 7)				
BMI	22.68	1.679	18.36	24.93
Age	61.37	11.444	34.00	89.00
Pre-obese (n = 70)				
BMI	27.52	1.394	25.01	29.92
Age	63.67	10.755	44.00	87.00
Obese class I (n = 49)				
BMI	32.38	1.537	30.00	34.96
Age	59.34	10.239	23.00	74.00
Obese class II (n = 22)				
BMI	37.44	1.619	35.08	39.97
Age	57.81	8.284	43.00	78.00
Obese class III (n = 8)				
BMI	44.77	3.428	40.00	49.11
Age	55.25	15.285	34.00	83.00

Table 2
Odds Ratio Estimates: Normal and Pre-Obese (Combined) vs Obese.

	Odds Ratio	95% Wald Confidence Limits		P Value
Wound complications	3.578	1.041	12.299	0.0431
Major complications	8.783	1.007	76.612	0.0493

fluoroscopy was not used. Unless contraindicated, patients were treated with a standardized pain protocol in combination with regional anesthesia at the discretion of the anesthesia team. A local tissue pain injection was administered as well as intravenous tranexamic acid. The same closure technique was utilized for all patients, which included a #1 barbed suture to close the deep fascia and subcutaneous tissue, and a running 0 barbed suture for the skin. Dermabond was applied topically and an occlusive foam dressing was applied (Mepilex, Gothenberg, Sweden).

Physical therapy followed a standardized protocol and began on postoperative day 0 with mobilization out of bed, followed by twice daily treatments thereafter, progressing from a walker to a cane to no assistive devices as tolerated by the patient. Patients were discharged when able to safely mobilize for daily activities, pain controlled on oral medications, and were medically stable. Standard post-discharge follow-up was at two and six weeks. All patients were placed on aspirin 325 mg twice daily for DVT prophylaxis.

Electronic and paper medical records were reviewed to determine surgical time, length of stay, discharge disposition, major and minor complications, and short-term outcome measures. All patient charts were available and no patients were lost to follow up in the immediate post-operative period. Major complications were defined as venous thromboembolism (VTE), wound infection or periprosthetic fracture requiring return to the operating room, hip dislocation, medical complications, or any adverse event requiring return to the operating room in the six weeks following surgery. Minor complications (wound complications) included wound drainage or delayed healing requiring dressing changes or oral antibiotics without a return to the operating room.

Table 3
Comparison of Normal and Pre-Obese (Combined) vs Obese.

Characteristics	Normal and Pre-Obese (Combined; n = 131)	Obese (Classes I, II, III) Combined; n = 79	P Value
OR time (min)	75.9 ± 14.5	88.6 ± 20.0	<0.0001
Wound complications			0.0607
Yes	4 (3.0%)	8 (10.1%)	
No	127 (97.0%)	71 (89.9%)	
Major complications			0.0291
Yes	1 (0.8%)	5 (6.3%)	
No	130 (99.2%)	74 (93.7%)	
ASA score	2.2 ± 0.5	2.5 ± 0.5	0.0002
Pain—pre	6.8 ± 2.1	7.6 ± 1.9	0.0115
Pain—2 weeks	2.2 ± 2.3	2.8 ± 2.8	0.1976
Pain—6 weeks	1.3 ± 2.1	1.9 ± 2.4	0.0651
Narcotics (2 weeks)			0.0037
Yes	33 (25.4%)	35 (44.9%)	
No	97 (74.6%)	43 (55.1%)	
Narcotics (6 weeks)			0.1810
Yes	4 (3.1%)	6 (7.7%)	
No	126 (96.9%)	72 (92.3%)	
Assistive device (2 weeks)			0.0030
Yes	84 (64.1%)	65 (83.3%)	
No	47 (35.9%)	13 (16.7%)	
Assistive device (6 weeks)			0.1513
Yes	24 (18.5%)	21 (26.9%)	
No	106 (81.5%)	57 (73.1%)	
Length of stay	2.4 ± 1.0	2.6 ± 0.9	0.0303
Discharge disposition			0.0774
Home	121 (92.4%)	66 (84.6%)	
Rehab	10 (7.6%)	12 (15.4%)	

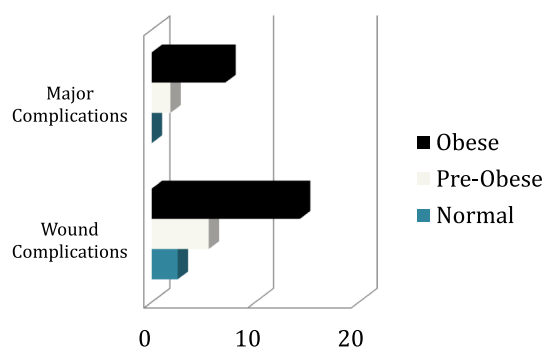


Fig. 1. Major and Wound Complications between Obese, Pre-Obese and Normal BMI Subjects.

The means and standard deviations for continuous variables and the frequencies and percentages for categorical variables were calculated. For the continuous variables differences in the averages between two groups were tested by the non-parametric Wilcoxon rank sum test since normality assumption was not satisfied. For the continuous variables differences in the averages between the three groups were examined by the non-parametric Kruskal–Wallis test since normality assumption was not satisfied. Chi-square and Fisher exact (when cells have counts less than 5) tests as appropriate were used to investigate differences for categorical variables. A P -value of <0.05 was considered to indicate a statistically significant difference.

Results

Two hundred ten consecutive patients, undergoing total hip arthroplasty through a direct anterior approach by a single experienced surgeon, were evaluated (Table 1). Comparing normal and pre-obese patients (BMI <30) to a combined group of WHO class I, II, and III obese patients, wound complication rates were 3.0% in the BMI <30 group, and 10% in the combined group ($P = 0.0431$). Major complications were 0.8% for the normal and pre-obese group, compared to 6.3% for the obese group ($P = 0.0291$; Table 2). The odds ratio showed an 8.8 fold increase for major complications and a 3.6 fold increase for wound complications in the obese group when compared to the normal and pre-obese group combined.

There were a total of six major complications (Table 3). Five major complications occurred in the obese group, with three requiring a return to the operating room. Two patients required a two-stage revision procedure for infection, one required stem revision for aseptic loosening, and one with intra-operative medial femoral perforation and greater trochanteric fracture. One patient in the obese group was diagnosed with a pulmonary embolism and treated with anticoagulation. The one major complication in the pre-obese group required a return to the operating room for infection (Fig. 1).

Direct comparison among class I, II, and III obese groups also failed to reveal any significant differences in wound or major complications, operative time, narcotic use, or assistive device use (Table 4). Length of stay was significantly different in this comparison with longer lengths of stay associated with class III obese patients ($P = 0.0438$).

Utilizing analysis of variance and again comparing normal and pre-obese patients combined to obese patients, the obese group demonstrated increased surgical times by 12.7 minutes ($P < 0.0001$), as well as increased length of stay ($P = 0.0303$), narcotic use ($P = 0.0037$), and assistive device use at two weeks ($P < 0.0030$) (Table 3). By six weeks, there was no longer a significant difference with the use of narcotics or reliance on assistive devices for ambulation. There was a trend toward increased use of rehabilitation facilities in the obese group at disposition, 15.4% vs 7.6% ($P = 0.0774$).

Table 4

Comparison of Class I vs Class II vs Class III Obese Subjects.

Characteristics	Class I (n = 49)	Class II (n = 22)	Class III (n = 8)	P Value
OR time	88.1 ± 20.8	85.1 ± 14.0	101.3 ± 26.1	0.2908
Wound complications				0.0557
Yes	4 (8.2%)	1 (4.6%)	3 (37.5%)	
No	45 (91.8%)	21 (95.5%)	5 (62.5%)	
Major complications				0.6043
Yes	3 (6.1%)	1 (4.6%)	1 (12.5%)	
No	46 (93.9%)	21 (95.5%)	7 (87.5%)	
ASA score	2.4 ± 0.5	2.5 ± 0.5	2.6 ± 0.5	0.4254
Pain—pre	7.4 ± 1.8	8.0 ± 2.0	8.0 ± 2.3	0.3039
Pain—2 weeks	2.8 ± 2.9	2.4 ± 2.5	3.9 ± 2.9	0.3217
Pain—6 weeks	1.6 ± 2.3	2.1 ± 2.3	3.1 ± 2.9	0.1898
Narcotics (2 weeks)				0.1829
Yes	21 (43.8%)	8 (36.4%)	6 (75.0%)	
No	27 (56.3%)	14 (63.6%)	2 (25.0%)	
Narcotics (6 weeks)				0.5450
Yes	3 (6.3%)	2 (9.1%)	1 (12.5%)	
No	45 (93.8%)	20 (90.9%)	7 (87.5%)	
Assistive device (2 weeks)				0.5936
Yes	39 (81.3%)	18 (81.8%)	8 (100.0%)	
No	9 (18.8%)	4 (18.2%)	0 (0.0%)	
Assistive device (6 weeks)				0.3421
Yes	12 (25.0%)	5 (22.7%)	4 (50.0%)	
No	36 (75.0%)	17 (77.3%)	4 (50.0%)	
Length of stay	2.6 ± 0.9	2.4 ± 0.8	3.1 ± 0.4	0.0438
Discharge disposition				0.1933
Home	39 (81.3%)	21 (95.5%)	6 (75.0%)	
Rehab	9 (18.8%)	1 (4.6%)	2 (25.0%)	

Discussion

The direct anterior approach utilizing a muscle-sparing technique has gained popularity in recent years for primary THA due its potential for improved post-operative pain, recovery and strengthening [5,6]. Few studies, however, have been performed analyzing if these benefits remain significant in the obese population.

Obese patients present a significant challenge for THA surgeons due to their large body habitus. We have noted that in many obese patients there is a relatively small amount of subcutaneous adipose tissue along the anterior aspect of the proximal thigh where the incision and dissection is located for the DA approach which can actually allow for a relatively routine operative procedure. Even in large patients it is often possible to mobilize and reposition the abdominal pannus away from the incision and operative field allowing for an easier exposure.

Despite the many potential benefits of the direct anterior approach, there remains a real concern regarding total complication rates and the learning curve associated with its use in routine practice. Jewett *et al* [13] reviewed 800 primary total hip arthroplasty patients performed over 5 years with a direct anterior approach and discovered a high rate of early complications of trochanteric fractures, perforations, and wound-healing problems. After the first 400 cases, however, there was a significant reduction in intra-operative complications such as fracture. Bhandari *et al* [14] attempted to quantify the learning curve of the direct anterior approach by demonstrating that surgeons who had performed fewer than 100 cases had total complication rates more than double that of surgeons who had performed more than 100 cases. For these reasons, it is recommended that surgeons in the learning curve period avoid obese patients until they are more experienced with the technique. In the current study, the performing surgeon (MZ) is well beyond the learning curve, allowing for an accurate and reliable comparison of complication rates associated with other approaches.

In the setting of total hip arthroplasty, obesity has been shown in multiple recent studies independent of surgical approach to prolong the length of stay, increase direct medical costs [9], and attribute to component malpositioning [10]. Furthermore, obesity has also been

found to be an independent risk factor for an increase in 30-day readmission rates [11] as well as periprosthetic joint infection [12]. This study is consistent with these reports as our data demonstrates that obese patients have statistically significant increases in operative time, dependence on narcotics and assistive devices post-operatively, and require a longer length of stay, with a trend toward higher use of rehabilitation placement.

Specifically with the anterior approach, obese patients with a large pannus or abdominal fold risk contamination of the surgical incision near the inguinal crease. Christensen et al [15] quantified this risk of wound complications requiring re-operation from a DA approach at 1.4% compared with the posterior approach at 0.2% in 1288 primary THA patients. Bozic et al [16] further demonstrated that obesity is an independent predictor of periprosthetic infection in a large cohort of Medicare patients undergoing THA. Similarly, Namba et al [17] reviewed over 1000 patients after THA and also concluded that obesity was associated with a higher local and deep infection rate. To the authors' knowledge, the influence of obesity on complications and early outcomes specifically utilizing a direct anterior approach by an experienced surgeon has yet to be directly analyzed prior to this study.

While this study reveals a significant increase in complication rates for obese patients in comparison to non-obese patients using the DA approach, these rates are similar to the rates in the literature for other operative approaches. In a prospective matched cohort study using an anterolateral approach Chee et al [18] reported a 9% major complication rate and a 13% minor wound complication rate for their obese patients which had an average BMI of 37.9. In comparison, our complication rates were 6.3% for major, and 10% for minor wound complications. Michalka et al [19] found a 14% major complication rate and a 12.3% minor complication rate in their study of obese patients undergoing THA using a posterior approach. A study by Dowsey and Choong [20] of obese patients using a posterior approach reported a 4.4% acute infection rate in comparison to our rate of 2.5%. Overall our experience demonstrates an increased complication rate for the DA approach in obese patients that is comparable to the published data for other operative approaches, which does not appear to be directly attributable to the DA approach itself.

Limitations of this study include a retrospective design and relatively short-term follow-up with no specific outcomes instruments; however, the focus of the study was designed to analyze early complications in a specific obese population rather than long-term functional outcomes. In addition, pre-operative ASA scores were also found to be higher among the obese group indicating higher comorbidities which may contribute to wound healing problems, length of stay, and use of rehabilitation facilities. This study only provides data as to whether wound complications may be an independent risk factor for the DA approach by comparing our complication rates to the published complication rates for other approaches available in the literature. A prospective study comparing the three common operative approaches, as well as one analyzing wound closure techniques would be a valuable addition to the literature.

This study further provides data regarding the appropriate candidate for THA and the risks associated with performing this procedure on obese patients. The results may help to stratify intraoperative and immediate postoperative risk according to BMI. Further studies are warranted for improved risk stratification among the obese population. A recent analysis by a workgroup of the American Association of Hip and Knee Surgeons (AAHKS) evidence based committee recommends a BMI threshold of <40, especially when combined with other comorbid conditions for total knee arthroplasty but further studies are needed to specifically apply this threshold to THA [21]. The recommendation

stems from multiple studies demonstrating a sharp increase in perioperative complications, including infection and revision rates above the threshold, which may outweigh the benefits of total joint arthroplasty. This study supports the conclusions of the workgroup and adds to the increasing body of literature regarding the elevated risks of performing a THA in the obese patient.

In summary, current demographic trends predict an increased need for THA in the obese population, with class III obese patients having an 8.5 times increase in need for THA compared to matched non-obese individuals [22]. This study demonstrates that the complication rate for patients undergoing THA utilizing a DA approach is significantly increased in comparison to normal and pre-obese patients. The increased complication rates for the DA approach are similar to those cited for other THA operative approaches. These important points as well as the benefits of weight loss on the patient's health and surgical risk should be taken into consideration and addressed in detail prior to elective total hip surgery.

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