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Original Research

Acute Surgical Site Complications in Direct Anterior Total Hip Arthroplasty: Impact of Local Subcutaneous Tissue Depth and Body Mass Index

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ABSTRACT

Background: Body mass index (BMI) is an imperfect measure of patients' adiposity and operative risk. Radiographic and direct subcutaneous measurements have been utilized in attempts to more accurately characterize the risk of postoperative complications, including surgical site infection. This study aims to evaluate whether direct tissue depth measurement is a more accurate predictor of skin complication following direct anterior total hip arthroplasty (THA).
Methods: A retrospective chart review of patients who underwent elective THA between April 30, 2020, and January 31, 2023, was performed. Baseline demographics, antibiotics, anticoagulation, and intraoperatively measured tissue depths at proximal, middle, and distal portions of the incision were recorded. Patient follow-up was reviewed to assess the development of skin complication in the acute postoperative period.
Results: Data were collected from 280 patients who underwent THA via direct anterior approach by a single surgeon. The mean age was 66.0 years, and 52.1% were female. A total of 18/280 (6.4%) patients developed an abrasion (5/18) or superficial surgical site infection (13/18) within the first 60 days postoperatively. Patients who developed skin complications had a significantly higher BMI (33.7 kg/m^2 vs 29.9 kg/m^2; $P = .0021$). Patients with a BMI >30 kg/m^2 had more than 5 times increased odds of developing a superficial skin complication in the acute 60-day postoperative period compared to those with a BMI <30 kg/m^2 (Odds ratio = 5.318, $P = .0059$). None of the measured tissue depths, nor their average together, were shown to be significant predictors of skin complications.
Conclusions: This study showed that BMI is a significant predictor of acute skin complications in direct anterior THA patients. No other significant predictors were found to be associated with increased risk, including proximal, middle, and distal tissue depths.

Introduction

The increasing prevalence of obesity in countries around the world has been described as a global pandemic. [1] Morbidly obese patients will require total hip arthroplasty (THA) 10 years earlier than normal weighted individuals, with a relative risk of approximately 8.5 times for a THA relative to normal weight individuals in Class III (morbidly) obese patients. [2] Furthermore, the need for total joint arthroplasty (TJA) is projected to increase in the next decade as the population continues to age. Studies estimate the total number of hip and knee replacements will exceed 4 million by 2030, an increase of 174%. [3] Despite preventative efforts, patients

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continue to struggle through the plethora of metabolic and physiologic complications that come with an increased body habitus. In the realm of arthroplasty, these issues often manifest as increased postoperative complications. [4]

Several studies have evaluated the effect of body mass index (BMI) on the risk of postoperative complications following TJA. Zusmanovich et al demonstrated that patients with a BMI >30 kg/m^2 had increased infectious and medical complications compared with nonobese patients. [5] Furthermore, there was a stepwise increase in complications as BMI categories increased from <30 kg/m^2 to 30-35 kg/m^2 to greater than 40 kg/m^2 including operating time, length of stay, rate of readmission, reoperation, deep vein thrombosis, renal insufficiency, superficial infection, deep infection, and wound dehiscence. [5] As a result, many institutions around the country have implemented BMI cut-offs of less than 40 kg/m^2 for elective total joint replacement due to the increased hospital length of stay [6] and increased risk of complications and revision surgery. [7] However, BMI is often an imperfect measure of a patient's adiposity as it does not account for age, gender, muscle mass, and fat distribution. [8] Some patients may have an acceptable BMI, however, with a larger proportion of their body mass distributed within the surgical site. Consequently, these patients may have a surgical area with a greater local BMI equivalent, thereby putting them at increased risk of postoperative complications such as surgical site infection (SSI).

Recent studies have attempted to characterize this risk based on radiographic or direct measurements of patient's local subcutaneous tissue depths in lieu of BMI. In spine surgery, researchers used sagittal view computerized tomography imaging to measure subcutaneous fat from the spinous process to the posterior skin. [9] Similarly, in total knee arthroplasty, lateral x-ray radiographic measurements of prepatellar thickness and pretibial tubercle thickness have been used to characterize the risk of surgical site infection. [10] The current literature on THA is more conflicting. Using anteroposterior hip radiographic measurements of peritrochanteric fat, no differences were observed between the postoperative skin complication cohort and the no-complication cohort in patients undergoing elective THA via posterolateral approach. [11] However, another retrospective case control study in patients following hip fragility fracture fixation found significant differences in tissue measurements between those who developed SSI and those who did not. [12]

It is possible that there is a measurable difference in subcutaneous fat thickness and risk of surgical site infection following THA; however, this measurement may not be radiographically quantifiable due to the difference in surgical approach and method of tissue depth measurement. Therefore, a study utilizing direct, intraoperative surgical site subcutaneous tissue depth measurements may help better understand the relationship between local tissue thickness and risk of surgical site infection following THA. The direct anterior approach (DAA) has had increasing attraction due to preservation of the surrounding soft tissues and rapid rehabilitation, with similar postoperative complications to other approaches (direct lateral, posterior). [13,14] However, concern for increased wound complications due to proximity of the anterior skin incision to the inguinal skin crease has been reported. [15] As the population requiring total joint arthroplasty becomes older and more obese, surgeons will be faced with increasing rates of postoperative complications. Therefore, it is imperative to accurately identify risk factors for surgical site infection following THA as well as potential areas for patient optimization. This manuscript aims to evaluate whether differences in patient BMI, local tissue depth, perioperative antibiotics, baseline comorbidities, or anticoagulation are associated with an increased risk of skin complication following elective direct anterior THA.

Material and methods

A retrospective chart review of adult patients aged 18 years or older who underwent elective THA (identified by Current Procedural Terminology codes) at Springfield Memorial Hospital, St. John's Hospital, or Orthopedic Center of Illinois was performed from April 30, 2020, through January 31, 2023. Patient baseline demographics including age, sex, height, weight, BMI, smoking status, and comorbidities were recorded. Operative records were reviewed to document intraoperatively measured subcutaneous tissue depths, intraoperative antibiotics, and perioperative antibiotics. Anticoagulant use was also recorded. The depth of local subcutaneous tissue was measured at the time of surgery using a disposable sterile ruler. The subcutaneous tissue depth was measured from the skin incision down to the tensor fasciae latae at a perpendicular angle to the fascia using a standard incision length of approximately 8-10 cm. Depths were recorded at the proximal, middle, and distal portions of the incision.

Patients were followed from the date of surgery through the last available postoperative follow-up within the data collection period. All patients had a minimum of 60 days of postoperative follow-up. The presence or absence of a surgical site skin complication was recorded within the first 60 days postoperatively. Inclusion criteria for this study were all patients aged 18 years or older who received primary elective THA via DAA. Patients were excluded from primary elective THA if they had prior ipsilateral hip surgery, recent corticosteroid injection in the ipsilateral hip within the previous 3 months, arthroplasty performed for fracture or any other emergent basis, or if no intraoperative subcutaneous tissue depths were documented. The surgeon's indications for elective surgery include hemoglobin A1c (HbA1c) < 7%, abstinence from nicotine and tobacco for 30 days preceding surgery, and BMI <40 kg/m^2. There were no excluded patients, as the surgeon did not perform an elective THA on patients who did not meet the inclusion and exclusion criteria. One patient did have a BMI of 40.75 kg/m^2.

Statistical analysis

Descriptive statistics were computed for all study variables. Categorical variables, including smoking status, comorbidities, antibiotic use, and complications, were summarized as frequencies and percents and compared between groups with a chi-square or Fisher's exact test. Continuous variables, including age, BMI, and tissue depths, were summarized with measures of central tendency and analyzed between groups via *t*-test. BMI was analyzed as both a continuous and dichotomized predictive measure (BMI <30 vs BMI 30+ = obese). Univariate logistic regression with Firth's penalized likelihood approach was used to assess the effect of BMI on the short-term outcome of skin complication within 60 days. Odds ratios and 95% confidence intervals are presented. Statistical significance was determined as *P*-value < .05. All analyses were performed on SAS version 9.4 (SAS Institute Inc, SAS Campus Drive, Cary, NC 27513, USA). The study was approved as an exempt project by the local institutional review board. Power analyses showed that n = 274 patients would give >80% power in a 2-tailed, logistic regression model of predicting skin complications for each of the independent predictors, based on various published literature. [16]

Surgical approach

The surgeon's incision and approach are performed according to the standard modified Heuter approach. An incision is made 2 cm lateral and 2 cm distal to the anterior superior iliac spine, with a length of approximately 6-8 cm. The incision is made with a 10-blade scalpel until subcutaneous fat is identified. Gelpi retractors are placed at the proximal and distal ends of the incision. No forceps are used to grasp skin edges during the approach. The anteromedial aspect of the tensor fascia lata is identified; the fascia is incised and detached from the muscle fibers superiorly and medially to access the intermuscular plane with care to avoid damaging the lateral femoral cutaneous nerve (LCFN). The surgeon does not routinely use a soft tissue protector.

Results

Data were collected from 280 patients who underwent primary THA by a single surgeon. The mean age was 66.0 years, approximately half (52.1%) of patients were female, and 38.9% were former or current smokers. All cases were performed via DAA. Mean duration of procedure was 72.9 minutes. Baseline demographics, comorbidities, procedure location, laterality, and operative approach are summarized in Table 1. There were no differences in age, sex, comorbidities, deep venous thrombosis (DVT) prophylaxis, smoking status, or alcohol use between patients who developed a skin complication and those who did not.

A total of 19/280 (6.8%) patients developed superficial skin complication over the collected data period, with 18/280 (6.4%) developing skin complication within 60 days postoperatively. Superficial skin complication was defined as either an abrasion (5/19) or superficial surgical site infection (14/19). All but one case was identified within the first 60 days postoperatively, with a mean of 28.5 days (5 range 2-115 days). One patient had skin complication identified on postoperative day (POD) 115. Excluding this patient, the latest skin complication occurred on POD 49. Sixteen patients (14 SSI and 2 abrasion) received oral antibiotics (2-week course of trimethoprim-sulfamethoxazole) for their incision complications, and all cases resolved. One patient required an irrigation and debridement; however, the infection was not deemed to have infiltrated the fascial layer, so no hardware removal or explantation was required.

Overall, patients who developed skin complications had a significantly higher BMI (33.7 kg/m^2) vs those who did not (BMI 29.9 kg/m^2; $P = .0021$). When stratified, those with a BMI >30 kg/m^2 had more than 5 times increased odds of developing a superficial skin complication in the acute 60-day postoperative period compared to those with a BMI <30 kg/m^2 (Odds ratio = 5.318, $P = .0059$). None of the measured tissue depths, nor their average together, was shown to be a significant predictor of skin complications. In fact, all measures of tissue depth, including the overall average tissue depth, were lower (although not significantly) in those who developed a superficial skin complication compared to those that did not. (Tables 2-4).

Most patients received cefazolin 2g intraoperatively (91.4%) and were discharged on cephalexin 1000 mg (82.1%) to be taken at 10:00 PM on the day of surgery and at 6:00 AM on POD 1. The majority of patients (87.1%) received aspirin 81 mg BID for 30 days for DVT prophylaxis, while 4.6% restarted their previously prescribed factor X inhibitor and 3.6% restarted their warfarin with an enoxaparin bridge. The full list of intraoperative and perioperative antibiotics is summarized in Table 5.

Table 1
Baseline demographics, procedure location, surgical approach, and laterality of primary THA.

Age (y) at time of surgery, mean (standard deviation [SD])	66.0 (11.1)
BMI (kg/m^2), mean (SD)	30.1 (5.1)
Sex, n (%)	
Male	134 (47.9)
Female	146 (52.1)
Comorbidities, n (%)	
Pulmonary disease	60 (21.4)
Coronary artery disease	64 (22.9)
Peripheral vascular disease	23 (8.2)
Chronic kidney disease	16 (5.7)
Diabetes	36 (12.9)
Liver disease (missing = 1)	6 (2.1)
Methicillin resistant Staph aureus (missing = 27)	8 (2.9)
Anticoagulation	43 (15.4)
Alcohol use	38 (13.6)
Tobacco (including chewing)	8 (2.9)
Smoking status, n (%)	
Current	4 (1.4)
Former	105 (37.5)
Never	171 (61.1)
Surgical approach, n (%)	
Direct anterior	280 (100.0)
Laterality, n (%)	
Right	160 (57.1)
Left	120 (42.9)

Discussion

In total, 18/280 (6.4%) of primary THA patients developed an acute skin complication within 60 days postoperatively. Of these, 16 patients received a course of antibiotics, and all skin complications resolved. One patient required irrigation and debridement. BMI is a significant predictor of acute skin complications in direct anterior THA patients. No other significant predictors were found to be associated with increased risk, including proximal, middle, and distal tissue depths. (Table 2)

The link between subcutaneous tissue depth and risk of surgical site infection has been studied across surgical specialties. In obstetrics-gynecology, a prospective study on 150 women undergoing abdominal hysterectomy revealed that the maximum vertical subcutaneous tissue measurement from their incisions was the only variable that maintained a significant association with SSI after logistic regression. [17] Similar findings were published in a study on 140 women undergoing caesarean delivery, where multiple logistic regression again revealed that subcutaneous tissue thickness was the only significant risk factor for SSI. [18]

In orthopaedic spine literature, a retrospective review of 366 patients undergoing posterior lumbar fusion documented skin-to-spinous process soft tissue measurements on lateral x-ray radiographs. They found BMI and soft tissue depth to be significantly associated with SSI. [19] In another study on patients undergoing lumbar spine procedures through a midline posterior approach, there was a 6% increased risk of infection for every 1 mm thickness of subcutaneous fat (measured on magnetic resonance imaging), as well as a 4-fold increase in risk of infection with greater than 50 mm of posterior lumbar back fat thickness. [9] This has also been proven in patients who underwent posterior cervical spine fusion. The study showed that obesity (BMI $\geq$30 kg/m^2) was not a significant risk factor for surgical site infection; however, the thickness of subcutaneous fat and the ratio of the fat thickness to the lamina-to-skin distance were both significant risk factors for infection. [20]

More relevant are the studies on TJA. In total knee arthroplasty, lateral radiographic measurements of subcutaneous tissue showed that prepatellar thickness $\geq$15 mm and pretibial tubercle thickness $\geq$25 mm increased the 90-day risk for surgical site infection, increased risk of early reoperation (by 2.0× and 1.6×, respectively), and had a greater predictive value than BMI. [10] The studies in THA patients are more conflicting. Using anteroposterior hip radiographic measurements of peritrochanteric fat, including sourcil to lateral skin surface, tip of greater trochanter to skin surface, and lateral greater trochanter to skin surface, no differences were observed between the postoperative skin complication cohort and the no complication cohort in patients who underwent THA via posterolateral surgical approach. [11] However, another

Table 2
Subcutaneous tissue depths and surgical site complication within 60 days postoperatively in primary THA.

Variable	Skin complication (abrasion or infection)	N	Mean	Standard error	Standard deviation	Median	Minimum	Maximum	P-value
BMI	No	262	29.86	0.32	29.47	5.12	18.99	40.75	.0021
	Yes	18	33.69	0.84	34.10	3.57	25.07	38.28	
Procedure duration (min)	No	222	72.93	0.88	71.00	13.12	51.00	138.00	.8828
	Yes	16	72.44	2.57	71.50	10.26	55.00	91.00	
Subcutaneous tissue depths (cm)									
Proximal	No	262	1.77	0.05	1.70	0.89	0.30	7.50	.6498
	Yes	18	1.68	0.17	1.65	0.72	0.90	3.80	
Middle	No	262	2.08	0.06	2.00	0.93	0.20	7.00	.8079
	Yes	18	2.02	0.18	2.00	0.78	1.00	4.30	
Distal	No	262	2.17	0.06	2.00	1.03	0.40	9.00	.2757
	Yes	18	1.89	0.19	1.90	0.81	0.80	4.10	
Average	No	262	2.01	0.05	1.87	0.88	0.30	6.83	.5044
	Yes	18	1.86	0.18	1.92	0.75	0.90	4.07	

retrospective case-control study evaluating subcutaneous radiographic hip fat measurement in patients following fragility hip fracture fixation found significant differences in tissue measurements (all higher in the study group) between those who developed SSI and those who did not. [12]

Direct intraoperative subcutaneous tissue measurement has been used in an attempt to bypass the potential limitations of measuring tissue depths via radiographs or advanced imaging. A study by Mayne et al analyzed prospectively collected data on 1220 primary THA patients. The vertical soft tissue depth from the most prominent part of the greater trochanter to the skin was measured intraoperatively using a sterile ruler and recorded to the nearest millimeter. They found patients with the greatest subcutaneous fat depth (upper quartile) were at no greater risk of complications compared with patients with the lowest fat depth (lower quartile); 7/311 (2.3%) vs 9/439 (2.1%); $P = .820$. [21] The study presented in this manuscript also used direct intraoperative subcutaneous tissue measurements, however, at 3 different hip locations: proximal, middle, and distal, as compared to a single maximum tissue depth measurement. The results show a higher BMI was significantly associated with an increased risk of infection 29.8 kg/m^2 vs 33.8 kg/m^2 ($P = .0021$), while no significant differences between proximal, middle, or distal tissue depths were observed between the 2 groups. (Table 2)

Central obesity is often associated with the development of a panniculus, a sheet of redundant subcutaneous tissue and skin that is present in the lower abdominal region. [22] In a study on pregnant women with class III obesity, next-generation sequencing found significant differences in the bacterial diversity between sample-pairing of the dry anterior panniculus compared to the moist, anaerobic sub-pannicular (intertriginous) fold. [23] Bacterial diversity may play a role in the association between BMI and postoperative skin complications. Other mechanisms that may account for the association between obesity and acute postoperative skin complications in DAA THA may include local vascular and inflammatory effects of excess adipose tissue. [24,25] Increased adiposity has been shown to cause chronic low-grade inflammation as well as trigger inflammatory cascades, which ultimately affect angiogenesis and impair microvascular blood supply. [24] Additionally, venous insufficiency is associated with obesity and has also been shown to play an important role in delayed wound healing. [25]

Direct anterior THA through the traditional longitudinal incision does not follow the anatomic skin creases, which can cause scar widening, injury to the LCFN, and subjective discomfort. [26] The “bikini incision” is a short oblique incision that follows the groin crease. In a systematic review comparing bikini incision with the traditional longitudinal incision, the bikini incision had better scar cosmesis and patient satisfaction [27], but increased the risk of early LCFN palsy [27,28]. The longitudinal incision delayed wound healing in obese patients [29]. The benefits of the bikini incision must be balanced with the risk of contamination from unique microbiota found near the groin crease. As a result, some surgeons have moved their incisions closer to the anterior superior iliac spine and away from the groin crease to decrease damage to the proximal medial aspect of the incision while minimizing skin complications.

Morbidly obese patients were not included in this study, as THA is not recommended for these patients at the current medical institutions due to the increased risk of complications. Studies have shown the possibility of and change in the relative contraindication to DAA THA in morbidly obese patients. [30] Given that morbidly obese patients have shown an increased risk of complications after DAA THA and the possibility of increased subcutaneous tissue depth, the data may have shown a correlation should they have been included. [31] Other limitations to this study include the exclusively anterior surgical approach, as differences in subcutaneous tissue depth through other approaches may show differences in infection rate. The patient’s overall skin condition and body habitus were not considered, such as overlying panniculus, distribution of pubic hair, and status of intertrigo in the inguinal crease. While a power analysis showed an adequate number of participants in the study, given the low incidence of infection and skin complications, larger studies with multiple surgical approaches may be needed to find a true soft tissue depth cut-off for the risk of infection. The rate of superficial SSI in this study is relatively high compared to prior literature, with some studies documenting rates as low as 1%-2% [32], while others report rates as high as 18.3% in high-risk individuals. [33] A possible explanation

Table 3
Rate of acute superficial skin complication by BMI following elective DAA THA.

BMI	Skin complication at 60 days				Fisher's exact	Chi-square P-value
	No	Yes	% Yes	Total		
Not obese (<30)	143	3	2.1%	146	0.0025	.0018
Obese (30+)	119	15	11.9%	134		
Total	262	18	6.8%	280		

Table 4
Odds ratio of acute superficial skin complication by BMI following elective DAA THA.

Odds ratio estimates and profile-likelihood confidence intervals of developing superficial skin complication within 60 d postoperatively in elective DAA THA				
Effect	Estimate	95% Confidence limits		Logistic regression P-value
BMI: 30+ vs BMI <30	5.318	1.805	20.758	.0059

Table 5
Intraoperative antibiotics, perioperative antibiotics, and surgical site complication in primary THA.

Type of intraoperative antibiotic, n (%)	Skin complication (abrasion or infection)		
	No	Yes	Total
Cefazolin 2g	207 (92.8)	16 (7.2)	223
Cefazolin 3g	13 (100.0)	0 (0.0)	13
Cefazolin + Clindamycin	1 (100.0)	0 (0.0)	1
Cefazolin + Vancomycin	6 (85.7)	1 (14.3)	7
Total	227 (93.0)	17 (7.0)	244
Frequency missing = 36			
Type of perioperative antibiotic, n (%)			
TMP-SMX × 10 days	12 (92.3)	1 (7.7)	13
TMP-SMX × 7 days	11 (91.7)	1 (8.3)	12
Cephalexin 1000 mg DOS + POD1	176 (93.6)	12 (6.4)	188
Cephalexin 500 mg BID × 3 d	1 (100.0)	0 (0.0)	1
Cephalexin 500 mg TID × 7 d	2 (100.0)	0 (0.0)	2
Cephalexin 500 mg TID × 7 d	1 (100.0)	0 (0.0	1
Cephalexin 500 mg QID × 7 d	5 (83.3)	1 (16.7)	6
Cephalexin 500 mg QID × 10 d	2 (100.0)	0 (0.0)	2
Ciprofloxacin	1 (100.0)	0 (0.0)	1
Clindamycin 300 mg × 7 d	2 (100.0)	0 (0.0)	2
Clindamycin 600 mg DOS + POD1	1 (100.0)	0 (0.0)	1
Total	214 (93.4)	15 (6.6)	229
Frequency missing = 51			

Type of perioperative antibiotic, n (%)	Skin complication (abrasion or infection)			Fisher's *P*-value
	No	Yes	Total	
TMP-SMX × 7 or 10 d	23 (92.0)	2 (8.0)	25	.6718
Cephalexin 1000 mg DOS and POD1	176 (93.6)	12 (6.4)	188	

TMP-SMX, trimethoprim-sulfamethoxazole; DOS, day of surgery; POD1, postoperative day 1; BID, twice daily or once every 12 h; TID, 3 times daily or once every 8 h; QID, 4 times daily or once every 6 hours.

for this discrepancy is the performing surgeon's conservative approach to diagnose and treat any abrasion or superficial SSI. The surgeon was quick to address any defect, abrasion, delayed healing, or any other possible sign of superficial infection with antibiotics. As a result, this may have skewed the number of superficial SSIs and abrasions reported in this study. We cannot definitively comment on the presence or absence of LCFN nerve palsy or its possible association with obesity or tissue depth in DAA THA, as this was not a collected outcome in this study. Lastly, this study is limited in the inability to address the association between increased BMI or local subcutaneous tissue depth and subsequent development of deep surgical site infection, as it is unknown if any patients developed deep infection after 60 days.

Conclusions

This study indicates that BMI is a significant predictor of acute superficial skin complications in direct anterior THA patients in the acute postoperative period. No other significant predictors were found to be associated with increased risk, including proximal, middle, and distal tissue depths. There were no differences in age, sex, comorbidities, anticoagulation, duration of procedure, intraoperative antibiotics, perioperative antibiotics, or DVT prophylaxis between the 2 groups.

Conflicts of interest

K. Delfino is a reviewer and member of the board of statisticians for the Journal of Urology. All other authors declare no potential conflicts of interest.

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References

[1] Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012;70:3–21.
[2] 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;90:360–3.
[3] Froemke C, Wang L, DeHart ML, Williamson RK, Ko LM, Duwelius PJ. Standardizing care and improving quality under a bundled payment initiative for total joint arthroplasty. J Arthroplasty 2015;30:1676–82.
[4] George J, Klika AK, Navale SM, Newman JM, Barsoum WK, Higuera CA. Obesity epidemic: is its impact on total joint arthroplasty underestimated? An analysis of national trends. Clin Orthop Relat Res 2017;475:1798–806.
[5] Zusmanovich M, Kester BS, Schwarzkopf R. Postoperative complications of total joint arthroplasty in obese patients stratified by BMI. J Arthroplasty 2018;33:856–64.
[6] Liabaud B, Patrick Jr DA, Geller JA. Higher body mass index leads to longer operative time in total knee arthroplasty. J Arthroplasty 2013;28:563–5.
[7] Wagner ER, Kamath AF, Fruth KM, Harmsen WS, Berry DJ. Effect of body mass index on complications and reoperations after total hip arthroplasty. J Bone Joint Surg Am 2016;98:169–79.
[8] Rothman KJ. BMI-related errors in the measurement of obesity. Int J Obes 2008;32:S56–9.
[9] Lee JJ, Odeh KI, Holcombe SA, Patel RD, Wang SC, Goulet JA, et al. Fat thickness as a risk factor for infection in lumbar spine surgery. Orthopedics 2016;39:e1124–8.
[10] Watts CD, Houdek MT, Wagner ER, Taunton MJ. Subcutaneous fat thickness is associated with early reoperation and infection after total knee arthroplasty in morbidly obese patients. J Arthroplasty 2016;31:1788–91.
[11] Bell JA, Jeong A, Bohl DD, Levine B, Della Valle C, Nam D. Does peritrochanteric fat thickness increase the risk of early reoperation for infection or wound complications following total hip arthroplasty? J Orthop 2019;16:359–62.
[12] Frenkel Rutenberg T, Markman R, Rutenberg R, Daglan E, Rubin T, Shemesh S. Thickness of the subcutaneous fat as a risk factor for surgical site infection following fragility hip fracture surgery. Geriatr Orthop Surg Rehabil 2022;13:21514593221080272.
[13] Huang XT, Liu DG, Jia B, Xu YX. Comparisons between direct anterior approach and lateral approach for primary total hip arthroplasty in postoperative orthopaedic complications: a systematic review and meta-analysis. Orthop Surg 2021;13:1707–20.
[14] Flevas DA, Tsantes AG, Mavrogenis AF. Direct anterior approach total hip arthroplasty revisited. JBJS Rev 2020;8:e0144.
[15] Jahng KH, Bas MA, Rodriguez JA, Cooper HJ. Risk factors for wound complications after direct anterior approach hip arthroplasty. J Arthroplasty 2016;31:2583–7.
[16] Alvi HM, Mednick RE, Krishnan V, Kwasny MJ, Beal MD, Manning DW. The effect of BMI on 30 Day outcomes following total joint arthroplasty. J Arthroplasty 2015;30:1113–7.
[17] Soper DE, Bump RC, Hurt WG. Wound infection after abdominal hysterectomy: effect of the depth of subcutaneous tissue. Am J Obstet Gynecol 1995;173:465–9.
[18] Vermillion ST, Lamoutte C, Soper DE, Verdeja A. Wound infection after cesarean: effect of subcutaneous tissue thickness. Obstet Gynecol 2000;95:923–6.

[19] AlSaleh K, Aldowesh A, Alqhtani M, Alageel M, AlZakri A, Alrehaili O, et al. Subcutaneous fat thickness on erect radiographs is a predictor of infection following elective posterior lumbar fusion. Int J Spine Surg 2022;16:660−5.
[20] Mehta AI, Babu R, Sharma R, Karikari IO, Grunch BH, Owens TR, et al. Thickness of subcutaneous fat as a risk factor for infection in cervical spine fusion surgery. J Bone Joint Surg Am 2013;95:323−8.
[21] Mayne AIW, Cassidy RS, Magill P, Diamond OJ, Beverland DE. Increased fat depth is not associated with increased risk of surgical complications following total hip arthroplasty. Bone Joint J 2020;102-b:1146−50.
[22] Igwe Jr D, Stanczyk M, Lee H, Felahy B, Tambi J, Fobi MA. Panniculectomy adjuvant to obesity surgery. Obes Surg 2000;10:530−9.
[23] Edwards RK, Kumar R, Zhi D, Szychowski J, Subramaniam A, Lefkowitz EJ, et al. Gravidas with class III obesity: evaluating the abdominal skin microbiota above and below the panniculus. J Matern Fetal Neonatal Med 2016;29:3312−6.
[24] de Jongh RT, Serné EH, IJzerman RG, de Vries G, Stehouwer CD. Impaired microvascular function in obesity: implications for obesity-associated microangiopathy, hypertension, and insulin resistance. Circulation 2004;109: 2529−35.
[25] Pierpont YN, Dinh TP, Salas RE, Johnson EL, Wright TG, Robson MC, et al. Obesity and surgical wound healing: a current review. ISRN Obes 2014;2014: 638936. http://dx.doi.org/10.1155/2014/638936.
[26] Leunig M, Faas M, von Knoch F, Naal FD. Skin crease 'bikini' incision for anterior approach total hip arthroplasty: surgical technique and preliminary results. Clin Orthop Relat Res 2013;471:2245−52.
[27] Butler J, Singleton A, Miller R, Morse B, Naylor B, DeCook C. Bikini incision vs longitudinal incision for anterior total hip arthroplasty: a systematic review. Arthroplasty today 2022;17:1−8.
[28] Sang W, Xue S, Xu Y, Liu Y, Zhu L, Ma J. Bikini incision increases the incidence of lateral femoral cutaneous nerve injury in direct anterior approach hip arthroplasty: a prospective ultrasonic, electrophysiological, and clinical study. J Arthroplasty 2021;36:3463−70.
[29] Manrique J, Paskey T, Tarabichi M, Restrepo C, Foltz C, Hozack WJ. Total hip arthroplasty through the direct anterior approach using a bikini incision can be safely performed in obese patients. J Arthroplasty 2019;34:1723−30.
[30] Argyrou C, Tzefronis D, Sarantis M, Kateros K, Poultsides L, Macheras GA. Total hip arthroplasty through the direct anterior approach in morbidly obese patients. Bone Jt Open 2022;3:4−11.
[31] Antoniadis A, Dimitriou D, Flury A, Wiedmer G, Hasler J, Helmy N. Is direct anterior approach a credible option for severely obese patients undergoing total hip arthroplasty? A matched-control, retrospective, clinical study. J Arthroplasty 2018;33:2535−40.
[32] Purcell RL, Parks NL, Gargiulo JM, Hamilton WG. Severely obese patients have a higher risk of infection after direct anterior approach total hip arthroplasty. J Arthroplasty 2016;31:162−5.
[33] Cooper HJ, Santos WM, Neuwirth AL, Geller JA, Rodriguez JA, Rodriguez-Elizalde S, et al. Randomized controlled trial of incisional negative pressure following high-risk direct anterior total hip arthroplasty. J Arthroplasty 2022;37:S931−6.