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# Does peritrochanteric fat thickness increase the risk of early reoperation for infection or wound complications following total hip arthroplasty?

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ABSTRACT

*Background:* Radiographically measured subcutaneous peri-incisional tissue depth has been correlated with post-operative surgical site infection after cardiac, cervical spine, and total knee surgery. Its impact following primary total hip arthroplasty (THA) has not been studied. We compare the interobserver reliability of measuring peritrochanteric fat thickness on pre-operative radiographs and hypothesize that these measurements are a reproducible way to predict acute post-operative wound complications and infection in patients undergoing THA.

*Methods:* A retrospective case-control analysis was performed at a single institution. Patients taken to the operating room within 90 days of their primary THA for a wound complication or deep infection between 2008 and 2016 were identified. Patients < 18 years old, those with history of open surgery on the affected hip, or with inadequate radiographs were excluded. Patients were matched 1:1 for gender, age, BMI, and ASA score to THA patients without early wound complications.

*Results:* All radiographic measurements performed were found to have excellent inter-rater reliabilities (range 0.96–0.98). There was no difference in peritrochanteric fat thickness measurements between the two groups including the sourcil to skin surface (89.5 mm vs. 91.9 mm, p = 0.5), tip of greater trochanter to skin surface (52.9 mm vs. 53.7 mm, p = 0.8), and lateral greater trochanter to skin surface (36.0 mm vs. 37.8 mm, p = 0.6) measurements.

*Conclusion:* Contrary to other previously reported surgical procedures, radiographic measurement of subcutaneous depth is not a valid tool for predicting a return to the OR for wound complications in the early postoperative period following primary total hip arthroplasty.

## 1. Introduction

An estimated 1% of the 285,000 total hip arthroplasties (THAs) performed annually in the United States result in readmission due to infection or wound complications in the early post-operative period.[1] These complications can drastically increase the challenge of post-operative management, sometimes even requiring revision surgery to eliminate infection and reconstruct a functional hip.[2] Revision surgery places an immense clinical burden on patients and physicians, but also comes at a direct financial cost exceeding $1 billion per year in the United States alone.[1] Identifying strong correlative risk factors for postoperative wound complications is a critical tool for anticipating the perioperative course of patients undergoing primary THA.

Several risk factors for acute postoperative wound complication and infection following THA have previously been identified. These include younger age (≤75 years old), greater height, and higher body mass index (BMI).[1,3] Recently, increased anterior knee subcutaneous fat thickness has been associated with a significantly increased risk of early reoperation for wound complication following primary TKA, and had a greater predictive value than BMI.[4] However, no studies have investigated the potential association between increased peritrochanteric fat thickness and acute postoperative infection and wound complications following primary THA.

The purposes of this study were to (1) compare the interobserver reliability of measuring peritrochanteric fat thickness on postoperative radiographs, and (2) determine if peritrochanteric fat thickness is associated with increased wound complications and infection in the early postoperative period following primary THA. We hypothesized that

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increased depth of peritrochanteric tissue would predict an increased risk of early reoperation for wound complication and infection following primary THA.

## 2. Material and methods

A retrospective matched case-control study was conducted of patients undergoing an elective, primary THA via a posterolateral surgical approach at a single institution. Patients who returned to the operating room within 90 days of their index THA for infection or wound complication between 2008 and 2016 were identified. Exclusion criteria were patients < 18 years of age, previous history of open surgery on the affected hip, or inadequate radiographs for measurement (i.e. radiograph missing a calibration marker or the entire soft tissue envelope was not captured on film). Study patients who fit this initial inclusion criteria were then matched 1:1 to THA patients without a reported history of deep infection or wound complication according to gender (same), age ( ± 3 years), BMI ( ± 5 kg/m$^2$), and American Academy of Anesthesiologists (ASA) Score (same). Deep infection was defined using Musculoskeletal Infection Society criteria.[5] Radiographic measurements were performed on the pre-operative anteroposterior (AP) hip or pelvis radiographs and calibrated using a standard 25 mm metal marker. Measurements included the distance between (1) the sourcil to skin surface (SS), (2) the tip of the greater trochanter to skin surface (TGTS), and (3) the most prominent lateral aspect of the greater trochanter to skin surface (LPGTS- Fig. 1). Each of the three measurements were made by two independent observers for each patient.

Statistical analyses were conducted using Stata version 13.1 (StataCorp LLC, College Station, TX, USA). The level of significance was set at $p < 0.05$. First, demographics were compared between cohorts using paired T-tests (continuous variables) or McNemar exact tests (categorical variables). Second, inter-rater agreement between the two raters was determined using Pearson's correlation coefficient. Finally, the average of the two rater's measurements was tested for association with the increased complications between the two cohorts using paired T-tests.

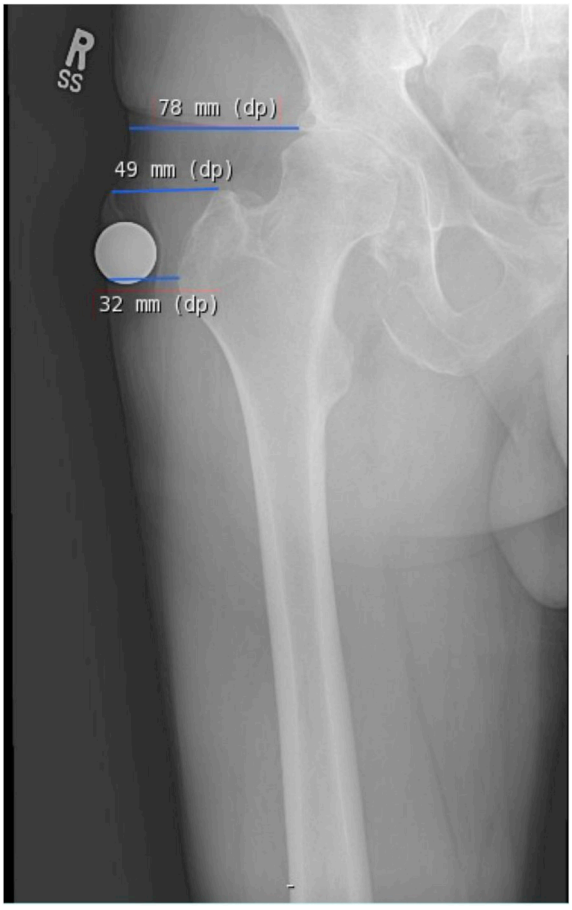


**Fig. 1.** Example of the three different measurements made to assess peritrochanteric fat thickness. 78 mm = sourcil to skin surface; 49 mm = tip of greater trochanter to skin surface; 32 mm = lateral greater trochanter to skin surface.

**Table 1**
Baseline characteristics of the matched cohorts.

| | No complication | Complication | P-value |
|---|---|---|---|
| Age[a] | 59.7 ± 7.0 | 59.4 ± 9.1 | 0.767 |
| Male sex[a] | 19 (48.7%) | 19 (48.7%) | – |
| BMI[a] | 32.1 ± 6.1 | 31.6 ± 6.3 | 0.036 |
| ASA score[a] | | | – |
| 1 | 2 (5.1%) | 2 (5.1%) | |
| 2 | 25 (64.1%) | 25 (64.1%) | |
| 3 | 12 (30.8%) | 12 (30.8%) | |
| Diabetes | 4 (10.5%) | 3 (7.9%) | 1.000 |
| Rheumatoid | 0 (0.0%) | 1 (2.6%) | 1.000 |
| Smoker | 5 (13.2%) | 4 (10.5%) | 1.000 |
| DVT prophylaxis | | | |
| Aspirin | 6 (15.8%) | 18 (47.4%) | 0.004 |
| Warfarin | 24 (63.2%) | 13 (34.2%) | 0.019 |
| Enoxaparin | 1 (2.6%) | 1 (2.6%) | 1.000 |
| Rivaroxaban | 7 (18.4%) | 6 (15.8%) | 1.000 |

BMI = body mass index; ASA = American Society of Anesthesiologists. DVT = deep vein thrombosis.

[a] Patients were matched on these characteristics. For age, matching within 3 years was required. For BMI, matching within 5 kg/m$^2$ was required. For ASA score and sex, perfect matching was required.

## 3. Results

Thirty-nine patients met our inclusion criteria **with** 30 patients (77%) treated for a deep periprosthetic joint infection, 4 patients underwent a hematoma evacuation (10%), 4 treated for superficial wound infection (10%) and 1 for wound revision (3%). After matching, the complication cohort had a slightly lower BMI than the no complication cohort (31.6 ± 6.3 versus 32.1 ± 6.1, p = 0.036; Table 1). Additionally, the complication cohort was more likely to have been given aspirin for venous thromboembolism prophylaxis (47.4% versus 15.8%, p = 0.004), while the no complication cohort was more likely to have been given warfarin for prophylaxis (63.2% versus 34.2%, p = 0.019). However, there were no differences between cohorts in age or in the percentage with diabetes mellitus, rheumatoid arthritis, or who were currently smoking ($p > 0.05$ for each). BMI was not independently studied in this investigation as a risk factor for post-operative wound complications as it was initially matched for when forming the control cohort.

The skin to sourcil distance, tip of the greater trochanter to skin, and lateral prominence of the greater trochanter to skin measurements were found to have excellent inter-rater reliabilities (0.966, 0.958, and 0.981, respectively). Mean skin-to-sourcil distance did not differ between the complication and no complication cohorts. Similarly, distance from the tip of the greater trochanter to skin did not differ between complication and no complication cohorts (53.7 ± 30.4 mm versus 52.9 ± 24.4 mm, p = 0.838). Finally, the mean distance from the lateral most prominence of the greater trochanter to the skin shadow distance did not differ between complication and no complication cohorts (37.8 ± 30.3 mm versus 36.0 ± 23.3 mm, p = 0. 623 (Table 2). Fat thickness values at the 50th, 75th, and 90th percentile were investigated as an independent risk factor for post-operative wound complications, but these values were not found to be associated with the development of complication in any case (Table 3).

**Table 2**
Differences in thickness measurements between cohorts.

| Distance | No complication (mean ± SD) | Complication (mean ± SD) | P-value |
|---|---|---|---|
| Skin to sourcil | 89.5 ± 23.1 (range 53.7–157.7) | 91.9 ± 28.1 (range 61.3–195.2) | 0.467 |
| Tip of GT to skin | 52.9 ± 24.4 (range 7.2–118.2) | 53.7 ± 30.4 (range 21.5–166.0) | 0.838 |
| Lateral prominence of GT to skin | 36.0 ± 23.3 (range 2.6–95.4) | 37.8 ± 30.3 (range 1.2–150.3) | 0.623 |

SD = standard deviation; GT = greater trochanter.

**Table 3**
Use of thickness measurement cutoffs to predict complication.

| Cutoff | OR | 95% CI | P-value |
|---|---|---|---|
| Skin to sourcil | | | |
| Median (90.7) | 0.8 | 0.3–2.0 | 0.642 |
| 75$^{th}$ percentile (101.0) | 1.0 | 0.4–2.8 | 1.000 |
| 90$^{th}$ percentile (122.3) | 1.0 | 0.4–4.3 | 1.000 |
| Tip of GT to skin | | | |
| Median (53.3) | 1.2 | 0.5–3.1 | 0.642 |
| 75$^{th}$ percentile (63.9) | 1.3 | 0.5–3.6 | 0.604 |
| 90$^{th}$ percentile (82.2) | 0.6 | 0.1–2.6 | 0.460 |
| Lateral prominence of GT to skin | | | |
| Median (36.9) | 1.4 | 0.6–3.3 | 0.495 |
| 75$^{th}$ percentile (51.0) | 1.1 | 0.4–3.2 | 0.792 |
| 90$^{th}$ percentile (61.1) | 0.8 | 0.2–2.9 | 0.745 |

OR = odds ratio; CI = confidence interval; GT = greater trochanter.

## 4. Discussion

Wound complications following THA are a common cause for readmission and can drastically alter the a patient's postoperative course. BMI is known to be a predictive factor for wound complications following both THA and total knee arthroplasty. However, in a series of morbidly obese patients undergoing primary TKA, Watts et al. found increased anterior knee subcutaneous fat thickness to be a more predictive measurement of wound complication than body mass index. They found a prepatellar thickness of ≥15 mm and pretubercular thickness of ≥25 mm, to increase the risk of early reoperation by 2.0x and 1.6x, respectively. The impact of increased peritrochanteric fat thickness on the risk of early reoperation secondary to infection and wound complications in patients undergoing total hip arthroplasty has not been investigated. Therefore, the purpose of this study was to determine if peritrochanteric fat thickness is associated with increased wound complications and infection in the early postoperative period following primary THA. In the present study—a case-control study matched on age, sex, and BMI—we were unable to demonstrate any association between peritrochanteric fat thickness and infectious and wound complications following THA. Peritrochanteric fat thickness was reliably measured, with Pearson's correlation coefficients > 0.90 in all cases. Thus, peritrochanteric fat thickness is unlikely to be a helpful tool in the prediction of postoperative infectious and wound complications.

The present study has several limitations that must be recognized prior to interpretation of our results. First, with only 39 patients in each cohort, the study may be underpowered to show an association between peritrochanteric fat measurements and wound complications. However, it was difficult to identify patients following primary THA who met our inclusion criteria as fortunately a return to the operating room within 90 days is relatively rare. Second, a several patients had to be excluded because of a lack of calibration markers on their radiographs allowing an accurate measurement. While most of these radiographs allow for full measurements to be made of the patient's skin edge, the calibration marker was not included on the films, thus limiting the ability to accurately measure peritrochanteric fat thickness preoperatively. However, the mean tip of GT to skin distance in both cohorts was greater than 5 cm, with a maximum of 16.6 cm in the complication cohort, indicating that relatively larger individuals were included in this investigation for analysis. Lastly, although matching was performed, patients in the "complication" cohort did have a lower mean BMI and also were more likely to receive aspirin for venous thromboembolism prophylaxis versus the control group. Prior literature would suggest that these factors would actually make patients in the "complication" cohort to be less likely to experience an early reoperation.

Watts et al. previously investigated the soft tissue envelope in total knee arthroplasty patients using plain radiographs and found that prepatellar fat thickness was associated with significant increase in infection and wound complications. However, it's important to note that their investigation only included morbidly obese patients (BMI > 40 kg/m$^2$) while the current investigation included patients with any presenting BMI.[4] Subcutaneous fat thickness has also been reported as a risk factor for infection in posterior cervical spine fusions. In a series of 213 adult patients undergoing posterior cervical spine fusion, Mehta et al. found the depth of subcutaneous fat thickness and the ratio of fat to full depth of exposure at the C5 level to be a more predictive measurement of post-operative infection than body mass index. They found that patients who developed surgical site infections had an average fat thickness of 27.0 ± 2.5 mm versus 21.4 ± 0.88 in those who did not. They concluded that thickness of the subcutaneous fat is a factor in the development of surgical site infections and deserves pre-operative consideration.[6] This association has also been described in other surgical fields such as general and cardiac surgery.[4,6–8] Larger dissections, tissue necrosis, more aggressive retraction, longer case times, and poor immunity in obese patients are among the reasons reported for such outcomes.[4,9–11]

There are a number of reasons that findings for THA may differ from those after TKA. First, the typical posterior hip incision is made parallel to Langer's lines and thus potentially has improved healing capacity versus an anterior knee or posterior cervical incision which are perpendicular to Langer's lines. This could affect the impact of subcutaneous fat thickness on the risk of wound complications. Additionally, range of motion of the knee changes the soft tissue tension across the wound, while a posterior hip incision is subjected to relatively less tension. Finally, the capsule in a TKA is nearly subcutaneous, while the capsule in a THA is buried deeply under the soft tissues. As a result, it may simply be that wound complications are less common and not associated with fat thickness in THA versus TKA.

In conclusion, the present study surprisingly did not demonstrate an association between peritrochanteric fat and infectious and wound complications following THA. The difference between these findings and those of the parallel study of the knee conducted by Watts et al. likely lies in biomechanical and vascular differences between the hip and knee approaches. Therefore, peritrochanteric fat thickness is unlikely to be helpful in predicting risk for infectious and wound complications following THA performed via posterior surgical approach.

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## Author declaration

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all

named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jor.2019.03.025.

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