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## Periarticular Soft Tissue Envelope Size and Postoperative Wound Complications Following Total Knee Arthroplasty

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### ABSTRACT

**Background:** Periprosthetic joint infection following total knee arthroplasty (TKA) is a serious complication often related to obesity which leads to poor patient outcomes and increased resource utilization. A periarticular soft tissue index (PASTI) may help predict postoperative wound complications than BMI alone.

**Methods:** Three hundred seventy-six TKA patients with a preoperative, lateral knee X-ray radiograph and 1 year of follow up were analyzed. We used 2 pairs of soft tissue and bony measurements, one referencing the femur and the other the tibia. A high PASTI was defined as a ratio >3.0. Minor complications involved clinical interventions related to the surgical wound. Major complications involved return to the operating room.

**Results:** More minor complications occurred in high PASTI for both tibial (20.9% vs 6.4%; odds ratio 3.89, 95% confidence interval 1.94-7.79,  $P < .001$ ) and femoral measurements (15.3% vs 7.2%; odds ratio 2.09, 95% confidence interval 1.06-4.15,  $P = .013$ ). Major complications were also more frequent in high PASTI, though not statistically significant. The proportion of obesity (BMI > 30) in both minor (12.4% vs 7.7%,  $P = .140$ ) and major complications (2.8% vs 3.3%,  $P = .788$ ) was not statistically different.

**Conclusion:** More wound complications occurred in patients with high PASTI, while no difference was seen using BMI. BMI has traditionally approximated patient size, but does not describe variations in body habitus. PASTI is a more reliable and direct way to assess the periarticular soft tissue envelope size, which is associated with postoperative wound complications in the knee.

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Total knee arthroplasty (TKA) is more prevalent due to changing population demographics. Specifically, patients are living longer [1–3], and there is an increasing prevalence of obesity in the United States [4,5]. These risk factors predispose patients to osteoarthritis, which often necessitates TKA in its later stages [6,7].

Periprosthetic joint infection (PJI) following TKA is a serious complication leading to poor patient outcomes and increased hospital resource utilization [8,9]. Studies have implicated a variety

of risk factors for developing PJI, including low white blood cell count [10], poor nutrition, tobacco use, skin flora, previous operation, comorbid rheumatoid arthritis, skin ulcers, previous knee surgery [11], obesity, recurrent urinary tract infections, oral corticosteroids, diabetes, and hypertension [12,13].

The impact of obesity in relation to postoperative infection has been well studied [9,10,12–14]. One study found the odds ratio (OR) relating a body mass index (BMI, kg/m<sup>2</sup>) greater than 30 and PJI to be 2.53 [12]. Another retrospective study found that BMI greater than 35 increases incidence of surgical site infections for TKA by 6.7 times and total hip arthroplasty by 4.2 times [15]. TKA performed on morbidly obese patients is associated with ORs of 3.3 and 21 for BMI over 40 and 50, respectively [16]. Obese patients are also likely to suffer from other comorbid conditions, such as hypertension, hyperlipidemia, diabetes, and heart disease, all of which contribute to delayed postoperative recovery times and increase the risk of perioperative complications [17–19]. For example, obesity combined with

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hyperglycemia experience a decreased innate immune response intraoperatively, which can contribute to PJI [20,21].

Prior studies have used BMI as an index for patients' obesity. However, this measure is imperfect, as it does not take into account variations in body habitus. Some patients may have more soft tissue surrounding the knee, while others may have their adiposity more centrally located. Therefore, there is a wide range in the amount of tissue exposed in the operating room, even though patients may present with similar BMIs. This is important for assessing infection risk since the increased surface tension at the incision site results in higher risk of wound dehiscence and wound complications [22]. Furthermore, because subcutaneous fat has suboptimal vascularization, there is lower oxygen tension around the incision, leading to prolonged wound healing [23]. Increased soft tissue around the knee may also increase operative time due to technical difficulties, which in turn predisposes patients to an elevated risk of PJI [24].

Although the relationship of soft tissue envelope size and risk of postoperative wound complications has been discussed [25], it is not yet well studied. We aim to develop a reliable radiologic measurement to assess the periarticular soft tissue index (PASTI). We hypothesize that a high PASTI will be associated with increased risk of developing postoperative wound complications following TKA.

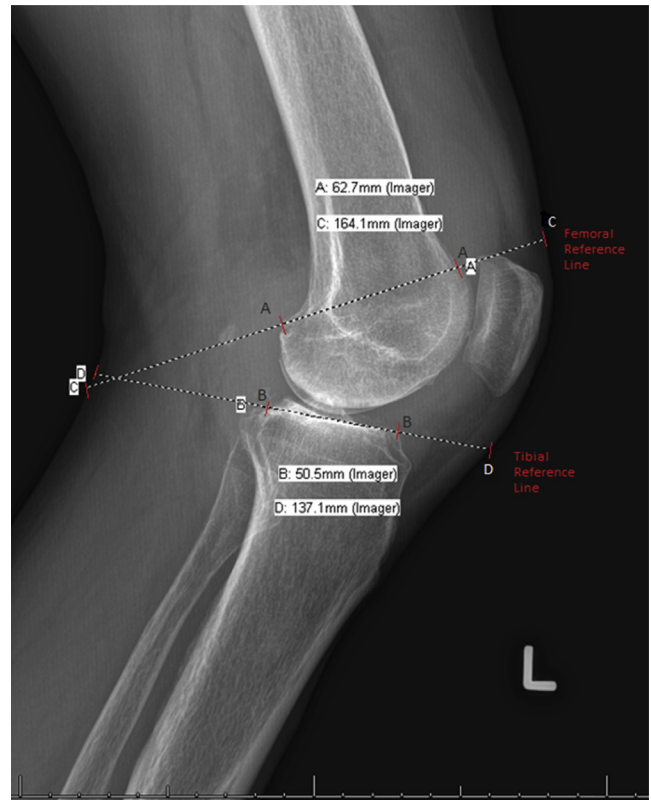
## Methods

Institutional Review Board approval was obtained to perform a retrospective review at a single academic institution. The electronic medical record system was reviewed for patients who underwent primary, unilateral TKA from September 2013 to October 2014. Our inclusion criteria for this study were any patients who underwent a primary, unilateral TKA, had an acceptable preoperative lateral knee X-ray radiograph, and had at least 1 year of clinical follow-up. The lateral radiograph was deemed acceptable when the rotation was a true lateral and the knee was flexed between  $35^\circ \pm 10^\circ$ .

Three hundred seventy-four of 477 patients met our inclusion criteria. Seventy-six of 477 (16%) patients were excluded due to poor X-ray technique or lack of a standard lateral in the electronic picture archiving computer system. Twenty-seven of 477 (6%) patients were excluded due to lack of 1-year follow up. Demographic data including age, gender, body mass index, and ASA score were collected. The PASTI was defined as a ratio between the extent of the soft tissue envelope and the size of the bone on the lateral projection of the knee. This ratio was derived in order to control for magnification variance and allow for universal applicability. Two pairs of soft tissue and bony measurements, one referencing the femur and the other the tibia, were established using anatomical landmarks for standardization and repeatability.

The femur measurement was measured by drawing a reference line, using the top of the patella to the most proximal portion of the posterior condyles (Fig. 1; label: femoral reference line). The femoral PASTI is C:C divided by A:A. The extent of the width of the soft tissue in line with the reference line was measured. The bony measurement was recorded as the anterior and posterior most aspect of the femur along the reference line. The tibia measurement was made establishing a reference line in line with the tibial plateau (Fig. 1; label: tibial reference line). The tibial PASTI is D:D divided by B:B. Similarly, the extent of the soft tissue margin and the bony margins were recorded. All measurements were verified by 2 independent observers. A high PASTI index was arbitrarily defined as a soft tissue:bone ratio  $>3.0$ , while a low PASTI was defined as a soft tissue:bone ratio  $<3.0$ .

The electronic medical records up to 1 year following surgery were reviewed to identify wound complications. Complications were defined as minor vs major complications: minor complications



**Fig. 1.** An example of a PASTI method for using the femoral and tibial measurement. In this particular knee, the femoral PASTI is 2.62 (164.1/62.7) and the tibial PASTI is 2.71 (137.1/50.5).

involved the need for any clinical intervention that was directly related to the surgical wound, including office debridement and course of antibiotics without operative intervention. A major complication was defined as return to the operating theatre for the surgical knee for any wound-related cause, specifically periprosthetic infection and wound dehiscence. Unrelated complications such as readmissions for periprosthetic fracture or medical complications were excluded from analysis.

## Statistical Analysis

All the patient demographics were summarized using descriptive statistics. Univariate analysis was conducted to determine the relationship between minor/major wound complications and low/high PASTI, and linear regression was conducted to evaluate the association of PASTI as a continuous variable and minor/major complications. Results were deemed to be significant at a *P* value of less than .05. Intraobserver and interobserver reliability was calculated using 2 blinded independent observers and was statistically evaluated using Pearson coefficients and internal reliability was calculated using a Cronbach's alpha coefficient. Statistical analyses were performed with SPSS version 20 software (IBM Corporation, Armonk, NY).

## Results

There were 374 patients in this study. The average age was  $66.2 \pm 9.9$  years, with 63% (234/374) of the population being female. The average BMI was  $30.9 \pm 5.9$ . Obesity was defined as  $\text{BMI} \geq 30$ . A subgroup analysis was conducted for obese vs nonobese patients. For minor complication rates, there was no statistically significant difference, with 12.4% (22/178) in the obese patient cohort vs 7.7%

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