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The Radiographic Prepatellar Fat Thickness Ratio Correlates With Infection Risk After Total Knee Arthroplasty

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ABSTRACT

Background: Obesity has been associated with complications after a total knee arthroplasty (TKA). Surgical site infection (SSI) after TKA is one of the feared complications as it increases revision rates, costs, and stress to the patient. There is conflicting evidence in the literature regarding body mass index (BMI) and risk of infection after TKA, and some studies have suggested that site-specific fat distribution may be a better metric for determining risk of postoperative infections. Here, we investigate the correlation of soft tissue distribution about the knee to SSI after TKA.
Methods: We retrospectively review 572 patients who underwent primary TKA at a single institution from 2006 to 2010. We introduce the prepatellar fat thickness ratio (PFTR) as a radiographic means to quantitatively assess fat distribution about the knee and evaluate this measurement's ability to assess the risk of developing an SSI after TKA.
Results: The PFTR was shown to be a better predictor of SSI than BMI in both the univariate ($P = .05$) and multivariate ($P = .01$) analyses.
Conclusion: Although BMI cannot fully account for variations in adipose distribution, the PFTR may account for this variability and may be a helpful tool for assessing a patient's preoperative risk of SSI after TKA.

The prevalence of obesity in the United States has more than doubled since 1970 and is projected to continue to increase [1]. Obesity is a known risk factor for development of knee osteoarthrosis [2]. As the population continues to grow, the number of patients with symptomatic knee arthritis presenting for consideration of total knee arthroplasty (TKA) increases as well. One of the most dreaded complications of knee arthroplasty is development of surgical site infection (SSI). Several studies have shown increased odds of infection after TKA in the obese [3-6], whereas other studies fail to demonstrate such an increase [1,7]. Body mass index (BMI) does not precisely gauge a patient's local obesity about the knee and this may explain the variation in SSI vs BMI results in the literature. To help understand this discrepancy, we hypothesized that there may be value in isolating and evaluating the soft tissue thickness about the knee when evaluating a patient's preoperative risk of an SSI.

In this study, we retrospectively review a series of primary knee arthroplasty patients from our institution, particularly assessing the fat distribution about the knee. We introduce a novel radiographic prepatellar fat thickness ratio (PFTR), comparing the thickness of the soft tissue shadow anterior to the patella with the radiographic thickness of the patella. It has previously been shown that increased soft tissue envelope about the knee increases the risk of reoperation for infection or wound complication in morbidly obese patients [8]. Also, it has been shown that for patients with a BMI of 45 kg/m^2 or greater, there is a dramatically increased risk of complications after TKA [9]. The goals of the present study are to (1) introduce to the literature a novel radiographic technique for measuring the soft tissue envelope about the knee and (2)

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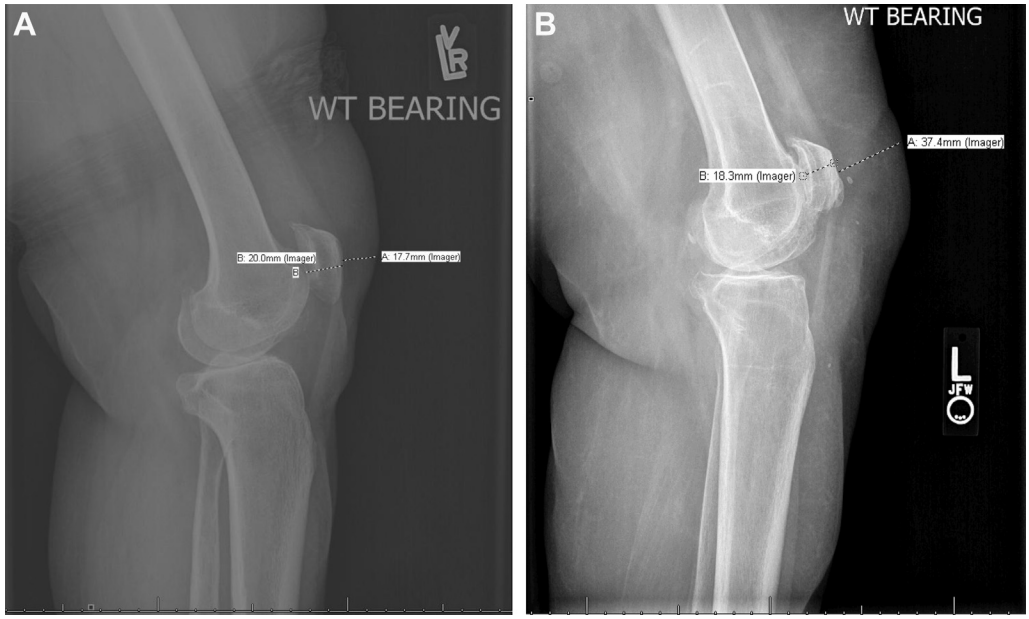

Fig. 1. The figure shows the method used to obtain the prepatellar fat thickness ratio (PFTR). (A) This patient had a PFTR of 0.86. (B) This patient had a PFTR of 2.04. PFTR, prepatellar fat thickness ratio; WT, weight.

introduce the utility of the PFTR vs commonly accepted BMI cutoffs when deciding whether to perform TKA in an obese patient population.

Materials and Methods

We identified 572 patients who underwent primary TKA during the period of January 2006 to December 2010. Charts with incomplete medical records or lack of adequate preoperative lateral knee plain film (n = 44) were excluded. No patient had previous internal fixation for a fracture around the knee joint. Patients received perioperative antibiotics, generally cefazolin, or vancomycin in penicillin allergic patients. Knees were bandaged with standard gauze dressings, drains were not used, continuous passive motion was placed in the recovery room and continued for 3 weeks, and chemical anticoagulation and pneumatic pumps were used for deep venous thrombosis prophylaxis.

Lateral radiographs were taken with the patient supine, with the knee bent between 10° and 30°. The posterior femoral condylar overlap was evaluated, and no radiograph was judged to be too malrotated. Phillips iSite PACS system was used to view and measure preoperative lateral view knee radiographs. We measured the thickness of the center of the patella and thickness of the soft tissue directly anterior to the center of the patella on lateral knee radiographs (Fig. 1). The center of the patella was determined by measuring from the most proximal aspect of the patella to the most distal aspect of the bone, excluding obvious osteophytes, and dividing that in two. The thickness of the patella and the thickness of the fat were measured at a right angle from the anterior cortex of the patella, measured at the midpoint of the patella. Soft tissue thickness was then divided by the thickness of the patella to yield the PFTR. The soft tissue shadow was measured directly anterior to the center of the patella regardless of the amount of "dimpling." Image contrast was adjusted so as to visualize the junction between anterior knee skin and air. No adjustment was made for magnification. Two researchers measured all radiographs separately and interobserver reliability was calculated. An average of these 2 PFTR values was used in the analysis. To validate the measurements taken radiographically, magnetic resonance imaging (MRI) was available for 125 patients in the series. T2 weighted midsagittal MRI cut containing the thickest view of the patella was similarly used to calculate the PFTR as outlined previously for plain lateral knee films.

Retrospective chart review gathered patient characteristics: age, sex, BMI, smoking history, diabetes status, and preoperative radiographs of the knee. BMI is classified as per previously described World Health Organization guidelines. BMI <18.5 kg/m^2 is underweight, 18.5-24.9 kg/m^2 is normal weight, 25-29.9 kg/m^2 is overweight, 30-34.9 kg/m^2 is obese class I, 35-39.9 kg/m^2 is obese class II, and >40 kg/m^2 is obese class III [10]. Infection status was determined by reviewing patient charts and infection control notes. The criteria used to make a diagnosis of periprosthetic joint infection was the presence of a draining sinus tract or 2 positive cultures. In addition, the presence of any 3 of the following minor criteria: elevated ESR and CRP, elevated synovial white blood cell count or positive leukocyte esterase, elevated synovial fluid polymorphonuclear neutrophil percentage, positive histological diagnosis, and a single positive culture. These criteria are consistent with the gold standards for diagnosis of periprosthetic joint infection recently published by the musculoskeletal infection society [11,12].

Statistical Methods

An alpha level of 0.05 was used to determine statistical significance. Descriptive statistics including means, standard deviations, and frequencies were computed. Univariate analysis was performed using simple logistic regression, chi-square, or Fisher exact tests to identify associations between an SSI post-TKA and various risk factors. To compare the predictability of the PFTR and BMI, separate multivariate logistic regression models were used to examine the adjusted association with an SSI. Patient variables (gender, age at procedure, smoking, and diabetes status) were adjusted in the models. Using a chi-squared test, a subset analysis of 271 patients from the study who had a BMI ≥30 kg/m^2 and a PFTR <1 was performed to assess infection risk between obesity