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Predicting patient reported outcome in total knee arthroplasty using body mass index and limb measurements☆,☆☆

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ABSTRACT

Background: Body mass index (BMI) has not been shown to correlate with Patient Reported Outcome Measures (PROMs) following total knee arthroplasty (TKA). We investigated the relationship between weight, BMI, limb morphology, and Oxford Knee Score (OKS). Furthermore, the utility of a novel radiological measurement, the Knee Mass Index (KMI), was investigated.

Methods: Data including weight, BMI, gender, preoperative and 12 month OKS were collected from an arthroplasty database that contained 268 patients who underwent TKA. Measurements of soft tissue and bone width were made from the preoperative radiograph and 'KMI' was calculated. Pearson correlation and multivariate regression analyses were used to assess the relationship between OKS and the above variables.

Results: The novel measurement, KMI, was not a predictor of the OKS. The BMI was predictive of initial OKS (Odds Ratio (OR) −0.26 $p < 0.001$), 12 month OKS (OR −0.39 $p < 0.001$) and change in OKS (OR −0.39 $p < 0.001$). The initial OKS was predictive of 12 month OKS (OR 0.32 $p < 0.001$) and change in OKS (OR −0.68 $p < 0.001$).

Conclusions: The novel KMI metric was not useful in predicting function. Both the post-operative OKS and change in OKS are predicted by BMI and pre-operative OKS. This is one of the first studies to show a relationship between BMI and OKS.

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1. Introduction

Body mass index (BMI) is sometimes used to determine eligibility for total knee arthroplasty (TKA). Some organisations within the National Health Service (NHS) in the United Kingdom have introduced policies that prevent patients being referred for consideration of TKA on the basis of BMI [1].

Conflicting evidence exists regarding the effect of BMI on functional outcome. One author has shown lower absolute postoperative satisfaction scores in obese patients (BMI > 30 kg/m^2) [2]. It has been reported that whilst postoperative Patient Reported Outcome Measures (PROMs) are poorer in obese patients, the preoperative PROMs are also poorer and therefore obese patients may achieve comparable relative improvements [3,4]. The effect of obesity on revision rates is unclear. Some authors have

☆ This paper relates to patient reported outcome following total knee arthroplasty.
☆☆ More specifically we assess the relationship between weight, soft tissue diameter, bone morphology and patient reported outcome.

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found no increase in revision rates with BMI > 30 kg/m^2 [4]. However other authors have reported increased rates of osteolysis on the post-operative radiographs of obese patients when compared to "normal" controls [2]. There is further evidence that reports a higher risk of postoperative wound leakage and infection in obese patients [5,6]. A study of morbidly obese patients (BMI > 40 kg/m^2) though was able to demonstrate that they have lower patient reported outcome scores, higher revision rates and higher rates of peri-operative complications [7].

Using body mass index to identify patients at risk of complications and poor outcomes may have some limitations. The accuracy of BMI in the diagnosis of obesity is limited [8]. Patient height can have an adverse effect on BMI as BMI is known to artificially increase in tall individuals [9]. BMI also does not account for body composition (i.e. body fat percentage). The sole use of a BMI criterion in the TKA setting therefore may exclude taller patients with an inaccurately high BMI, whilst height itself is very unlikely to have an effect on outcome following TKA. In addition, patients with central obesity and thin limbs may not pose any technical difficulties during surgery and wound healing would be less likely to be impaired.

Where BMI relates total body weight to height, we aimed to relate overall weight to the bony and soft tissue morphology of the knee by creating a "Knee Mass Index" (KMI).

The aim of this study was to investigate the relationship between body weight, BMI, soft tissue diameter, bone morphology and patient reported outcome. We hypothesised that increasing patient weight and soft tissue diameter would have a negative impact on outcome scores whilst increased bone diameter may reduce pressure through the weight bearing surface and would be associated with higher outcome scores.

2. Patients and methods

The study was performed in a university teaching hospital serving a metropolitan area of approximately 350,000 patients. Research Ethics Committee approval was obtained (REC-15/SC/0177). The study was a retrospective arthroplasty database analysis from a database including in excess of 5000 patients. Patients who underwent primary TKA using the NexGen Posterior Stabilised LPS-Flex fixed bearing knee (Zimmer Biomet, Warsaw, Indiana, USA) between 2012 and 2015 were included. Patients from prior to 2012 were excluded from analysis due to a lack of necessary information in the database. Patient reported outcomes were assessed using the Oxford Knee Score (OKS), a reliable, valid and responsive outcome measure, recommended for the assessment of large knee arthroplasty databases in a cross-sectional population [10]. All patients included had a preoperative OKS and an OKS at one year postoperative follow-up. The OKS is a 12-item questionnaire, which generates a score between 0 and 48 with a higher score indicating better function and satisfaction. Follow-up had been undertaken by arthroplasty nurse practitioners who were not directly involved in the study. No bilateral TKAs were included. Patients could not be included if the soft tissue shadow on their radiographs did not fit on the screen. We also had to exclude patients who underwent reoperation within the first postoperative year to ensure that they did not report artificially low 12 month results.

The total number of patients analysed was 268. This was a consecutive series taken from 2012 onwards. There were 101 male patients and 167 female patients. The age range was 27–86 (mean 68.4). The range of BMI was 18.8–49 kg/m^2 (mean 32) and the weight range was 48–150 kg (mean 84.7). A more complete summary of the baseline demographics is presented in table form (Table 1).

2.1. Measurements

For all patients BMI, weight in kilograms, preoperative OKS and postoperative OKS at one year follow-up was recorded. From the preoperative X-ray, measurements were taken of soft tissue diameter and bone diameter using the following method. The soft tissues were measured at the joint line on the Anteroposterior (AP) view. This measurement was added to the soft tissue diameter on the lateral view measured at the joint line along the line of the tibial plateau (Figure 1). The diameter of the tibial plateau on the AP view at the joint line was added to the diameter of the tibial plateau on the lateral view at the joint line to give the overall bone diameter (Figure 2). For each patient the "Knee Mass Index" (KMI) was calculated as follows:

$$\text{Knee Mass Index} = \frac{\text{Weight} \times \text{Soft tissue diameter}}{\text{Bone diameter}}$$

Table 1
Baseline demographics for all patients (n = 268).

	Minimum	Maximum	Mean	Standard deviation
Weight (kg)	48	150	84.7	17.4
BMI (kg/m^2)	18.8	49	32	5.9
KMI	26.8	454.6	156.1	47.9
Age	27	86	68.4	9.5
OKS (pre-operative)	3	35	16	6.7
OKS (12 months)	3	48	34.3	9.6
OKS (change)	−15	40	18.3	10

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