Original Article

Can Shoe Size Correctly Predict The Size Of Components Of Total Knee Replacement Pre-Operatively

Ahmed Furqan[1], Sohail Hafeez[2], Faheem Khan[3], Ali Asghar[4], Mahim Manzoor[5], Talha Kareem[6]

[1] Resident Surgery, Shifa International Hospital, Islamabad.
[2] Professor, Shifa International Hospital, Islamabad.
[3] Consultant, Shifa International Hospital, Islamabad.
[4,5,6] Medical Officer, Shifa International Hospital, Islamabad.

Author's Contribution
[1] Conception of study
[1,6] Experimentation/Study Conduction
[4,6] Analysis/Interpretation/Discussion
[1] Manuscript Writing
[2,3] Critical Review
[5] Facilitation and Material analysis

Corresponding Author
Dr. Ahmed Furqan
Resident Surgery
Shifa International Hospital
Islamabad
Email: ahmadfurqanmani@gmail.com

Article Processing
Received: 01/07/2022
Accepted: 24/11/2022

Cite this Article: *Furqan, A., Hafeez, S., Khan, F., Asghar, A. ., Manzoor, M., & Kareem, T. (2023). Can Shoe Size Correctly Predict The Size Of Components Of Total Knee Replacement Pre-Operatively. Journal of Rawalpindi Medical College, 27(1).*
DOI: https://doi.org/10.37939/jrmc.v27i1.1972

Conflict of Interest: *Nil*
Funding Source: *Nil*

Abstract

Objective: To ascertain the correlation between shoe size and sizes of femoral and tibial components of total knee replacement preoperatively in patients undergoing total knee arthroplasty.

Study design: Prospective cohort study

Study settings and duration: This study was conducted at the Department of orthopedic surgery, Shifa International Hospital, Islamabad from July 2020 – December 2020.

Material and methods: The sample size was calculated using the WHO calculator and it was 43 patients in total. Patients were approached through non-probability consecutive sampling. The shoe size of patients was measured using a Brannock device. During surgery, the Implant model and sizes of the femoral and tibial components implanted during knee replacement were noted. Data were analyzed with the help of SPSS version 24. We applied Pearson's correlation coefficient. P value ≤ 0.05 was considered significant.

Results: Out of 43, there were 9(20.9%) male and female 34(79.1%). The mean age of patients was 51.7±6.8 (SD). We found a good positive correlation between shoe size and tibial component (p=<0.001). A positive correlation was found between the femoral component and shoe size (p=0.001). Shoe size predicts 72% of the Tibial component and 65% femoral component.

Conclusion: Shoe size is an effective and safe predictor of total knee replacement components pre-operatively. This procedure is more accurate and less labor-intensive. Accurate templating results in less surgical duration and provides several benefits to patients and health care providers.

Keywords: Femoral Component, Shoe Size, Tibial Component, Total Knee Replacement

Introduction

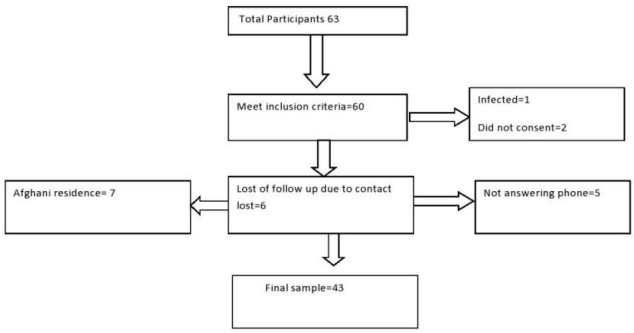
Total knee replacement (TKR) is a modern surgical procedure during which replacement of damaged knee joints with articular surfaces[1]. An estimated 1 million or more total knee and hip replacement procedures are performed each year in the United States. The prevalence of TKR is more in women as compared to men[2]. Moreover, the frequency of total knee replacement prevalence increases with age (10.38% at 80 years)[3]. The primary common indication of TKR is pain and functional disability. There are three main types of knee replacement prostheses; i) Non constrained prostheses (In which stability for prosthesis is provided by the patient's muscles and ligaments), ii) Semi constrained prostheses **(**a certain degree of stability of prosthesis is provided by the patient's muscles and ligaments but the reliance is not absolute), iii) constrained prostheses (these prosthesis is used for patients whom muscles and ligaments are unable to afford any stability for knee prostheses[4]. Complications of TKR include infection, loosening, deep venous thrombosis, stiffness, and osteolysis. Patients are provided with antibiotics for 24 hours following surgery for risk reduction of infection; however, stiffness could be avoided by encouraging early knee motion in days and weeks after surgery[5].

Total knee replacement effectiveness is dependent upon the surgeon's planning prior to predicting component size. Proper knee kinematics are promoted by the correct component size that reduces pain intensity and needs revision. Too large components lead to reduced motion, overhang, and irritation surrounding soft tissue. Too small a component leads to spongy bone exposure, bleeding risk, and bone loss eventually[6]. Accurate pre-operative prediction of component size reduces operative time and improves the efficacy of the procedure. There are several methods for predicting TKA component size including traditional methods and digital methods of templating. These methods significantly predict tibial and femoral component size (50-60% of the time)[7]. Trainor et al. reported that shoe size is a superior covariate for sizes of components in total knee replacements[8]. So, the rationale of our study was to find an easier, user-friendly, safe, and cost-effective method for preoperative templating of total knee replacement. We also wanted to contribute and enhance the literature available in this regard. So, our study was planned to determine the correlation between shoe size and the size of femoral and tibial components of total knee replacement preoperatively in patients undergoing total knee replacement in our population.

Materials and Methods

A prospective cohort study was conducted at the Department of orthopedic surgery, Shifa International Hospital, Islamabad. The study duration was 6 months (July 2020-Decemeber 2020). A sample size of 43 cases in each group was calculated with 5% type I error, and 10% type II error, and taking the magnitude of correlation i.e., r=0.589 between shoe size and size of knee components. Patients were selected through non-probability consecutive sampling. The internal review board permitted us to conduct the study at the hospital (IRB ref # 174-994-2020). Consent forms were taken from all participants of the study. Inclusion criteria were based on patients of age 40-70 years of either gender, undergoing primary total knee replacement (a surgical procedure to replace the weight-bearing surfaces of the knee joint to relieve pain and disability due to bone degeneration of the knee joint). Exclusion criteria were based on patients with osteomalacia, bone malignancy, patients with skeletal deformity, and those who had undergone complex TKR. A demographic profile (name, age, gender, lateral side) was obtained. Shoe size was measured before surgery, using a Brannock device. Then patients undergo surgery under general anesthesia by a surgical team with the assistance of a researcher.

Figure 1: Flow chart of participant's selection



During surgery, the Implant model and sizes of the femoral and tibial components implanted during knee replacement were noted. All surgeries were done via the midline medial para-patellar approach. All patients received standard care according to the total knee replacement protocol. During surgery implant sizing was done by standard anteroposterior sizing jigs. Post-op rehabilitation and follow-up were also according to set guidelines. Data were analyzed with the help of SPSS version 24. Mean and Standard deviation were measured for numerical value. Moreover, frequency and percentages were measured for categorical data. We applied Pearson's correlation coefficient. P value ≤ 0.05 was considered significant. A regression equation was used in the analysis of data. Effect modifiers were controlled through stratification of age and gender. Biasing was minimized.

Results

Total of 43 patients were included in study. There were 9(20.9%) male and female 34(79.1%). Affected knee was left in 23(53.5%) patients and right in 20(46.5%) patients. Mean age of patients was 51.7±6.8SD. There were 25(58.1%) patients in age group 40-55 years and 18(41.9%) were in age group 56-70 years age group. Mean shoe size was 24.7 cm ±1.1 while mean tibial component was 2.9±0.7SD (p=0.000). We found good positive correlation between shoe size and tibial component (p=0.000) as shown in table 1. Mean shoe size was 24.7 cm ±1.1SD while mean femoral component was 2.72±0.58SD (p=0.001). We found a moderate positive correlation between femoral component and shoe size (p=0.001) as shown in table 2. Shoe size predict 72% of Tibial component and 65% femoral component as shown in table 3.

Table-1 Correlation between tibial component and shoe size

Outcomes	*Mean±SD*	*R^2*	*P value*
Shoe size	24.7±1.1SD	0.72	0.001
Tibial component	2.9±0.7SD		

Table-2 Correlation between the femoral component and shoe size

Outcomes	*Mean±SD*	*R^2*	*P value*
Shoe size	24.7±1.1	0.650	0.001
Femoral component	2.72±0.58		

Table-3 Percentage of shoe size prediction

Shoe size	*Tibial component*	*Femoral component*
Predicted	72%	65%
Regression equation	Y=0.72292+0.6252	y=0.6501+2.5165

Discussion

Pre-operative orthopedic surgery planning is an important factor better surgical efficacy and improved patients care[9]. Total knee replacements planning include correct femoral and tibial component prediction[10]. Proper knee biomechanics are established with measurement of accurate component size that ensure better post-operative functionality and reduces revision surgery rate[11]. Accurate component size leads to appropriate management of theatre stock, operating time, reducing intra operative size trials and associated complications. Accurate component size prediction results in less surgical trays being opened and sterilization costs[12].

Our study found a significant correlation between shoe size and femoral or tibial component ($p<0.05$). A similar study reported positive strong correlation between shoe size and tibial components ($r=0.75$)[13]. Hernandez-vaquero et al. reported that shoe size predict correct templating of femoral and tibial components 50% and 55% respectively[14]. Stoker et al. reported that body height is more accurate predictor of femoral and tibial components as compared to shoe size[15]. Shershon et al. reported that templating alongside demographic data allowed prediction within one size for femoral and tibial components 90-99% as compared to shoe[16].

In our study, shoe size predicts 72% tibial component and 65% femoral component. Evidence reported that 59% tibial components is predicted by shoe size while 49% femoral component is predicted by shoe size[17]. Another similar study reported that shoe size is 50% more likely to predict tibial and femoral components in total knee replacement therapy as compared to height and demographic data[18]. Rehman et al reported that pre-operative prediction of components is an important factor for better surgical outcomes[19]. Shoe size could predict 62% of tibial components and relatively low femoral components 43% (p=0.05)[20].

Our small sample size and conduction of study at single center limits generalizability of study. A larger randomized trial is required for better understanding of shoe size prediction regarding components in TKA. Another limitation of our study is that we did not verify the findings with X-rays and CT-scan imaging. We consider that regular X-rays have a variable amount of magnification resulting in not actual intra operative sizing. So, use of actual implants is better variables for TKA surgery. Moreover, our study did not report any type of complications associated with shoe size.

Conclusion

Shoe size is an effective and safe predictor of total knee replacement components implemented preoperatively. This procedure is more accurate and less labor intensive than other procedures like height. Accurate templating results in less surgical duration and provides several benefits to patients and providers.

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