Incidence of component size asymmetry in bilateral total knee arthroplasty patients in National Orthopaedic Hospital, Igbobi, Lagos, Nigeria, West Africa

Adejare Adedire[a], Wakeel Olaide Lawal[b], Aofolajuwonlo Taiwo[b], Kehinde Adesola Alatishe[b], Michael Ebiyon Ugbeye[b], Akinwale John Faniyi[c]

[a]Department of Surgery, Osun State University, Osogbo, Nigeria, [b]National Orthopaedic Hospital, Igbobi, Lagos, Nigeria, [c]International Foundation Against Infectious Disease, Nigeria

Correspondence to Akinwale John Faniyi, BMLS, International Foundation Against Infectious Disease, Nigeria
Tel: +2348065552310;
E-mail: faniyiakinwale2014@gmail.com

Received: 03-Jul-2024
Revised: 12-Aug-2024
Accepted: 13-Aug-2024
Published: 08-Mar-2025

The Egyptian Orthopaedic Journal 2024, 59:579–584

Background
Total knee arthroplasty (TKA) is a common surgical intervention for managing advanced knee osteoarthritis. The symmetry of components in bilateral TKA has been a subject of interest due to its potential impact on clinical outcomes. This study investigates the incidence of component size asymmetry in bilateral TKA patients at the National Orthopaedic Hospital, Igbobi (NOHI), Lagos, Nigeria, West Africa.

Objective
The study seeks to investigate the prevalence of component size asymmetry in patients undergoing bilateral TKA, emphasizing the importance of awareness regarding this frequent occurrence. This awareness is critical to mitigate the risk of inadvertent selection of incorrect component sizes during time-pressured surgical scenarios.

Method
The study included 66 eligible patients who underwent bilateral simple primary TKA at NOHI between 2018 and 2022. Data, including age, sex, BMI, component size, operation interval, and preoperative and postoperative knee scores, were retrospectively collected from their operative and postoperative records. Statistical analysis was conducted using SPSS Version 22, and results were presented using relevant tables and charts. A significance level of *P* less than 0.05 was used for analysis.

Result
The mean age of patients was 65.4 years (range 51–78 years), with a female-to-male ratio of 4: 1. Obesity was prevalent in 72.7% of patients, while 25.8% were overweight and 1.5% were of normal weight. Component size asymmetry was observed in 45.5% of cases, with 55.5% having symmetrical components. There was a significant improvement in both preoperative and postoperative knee scores across all groups ($P<0.001$). No significant difference was found in the distribution of larger size components between the left (19.7%) and right (25.8%) knees.

Conclusion
Proper sizing of components is paramount for achieving successful outcomes in bilateral TKA. The incidence of component size asymmetry observed underscores the necessity for meticulous preoperative planning and intraoperative decision-making. Surgeons must adhere to accurate sizing protocols, independently measure each knee particularly in time-pressured surgical scenarios, and avoid solely relying on previously operated contralateral knee.

Keywords:
arthroplasty, bilateral, component, size, total

Egypt Orthop J 2024, 59:579–584

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Introductions

Total knee arthroplasty (TKA) is a surgical procedure where the femur and tibia's joint surfaces are replaced, with the option of including the patella's surface. If the patella's surface is not replaced, it is denervated to prevent anterior knee pain. When this procedure is done in both knee joints of an individual, it is called bilateral TKA. The TKA is the goal standard surgical procedure indicated in the treatment of arthritic knee joints. Pain associated with end-stage primary or secondary osteoarthritis which is refractory to nonoperative measure [1,2]. Studies show that TKA is a cost-effective procedure that not only relieves pain

but also improves the quality of life [3–5]. The primary goal of TKA is to relieve pain and restore knee joint movement [6].

Numerous factors influence the outcome of TKA, among which proper sizing of the components is crucial [1]. Ensuring correct sizing of both femoral and tibial components in each knee is essential for optimizing results and minimizing potential complications [7]. Unbalanced soft tissues resulting from improper placement of the component due to improper sizing erroneously may cause a higher strain in the surrounding tissues and consequently produce pain [8]. Improper femoral and tibia component sizing may, apart from the pain, cause a periprosthetic fracture, affecting the range of motion and stability and increasing spacer wear and tear [8]. Notching of the anterior femoral cortex reduces the axial and rotational strength, increasing the risk of periprosthetic femoral fractures when the component is undersized [1]. Surgeons may compensate by overstuffing the patellofemoral joint through oversizing, potentially leading to tightness in the extensor mechanism and reduced knee flexion post-surgery, negatively affecting range of motion and stability [1]. Oversizing tibial components can create excessive lateral pressure, causing impingement on the popliteal tendon and iliotibial band, while undersized components can accelerate wear and cause implant sinking in osteoporotic patients [9]. Understanding component size asymmetry is crucial for achieving favorable outcomes in bilateral TKA procedures. Significant bony anatomical differences between the right and left knees have been observed when performing bilateral TKA in a single session by different surgeons [1]. The optimal range of motion in both knees underscores the importance of accurate component selection, whether symmetrical or asymmetrical, for successful bilateral TKA [1]. Therefore, arthroplasty surgeons should carefully consider these differences and measure component sizes separately for each knee, rather than rushing to use measurements from one knee for the other [8]. This awareness has the potential to enhance functional outcomes for patients undergoing bilateral TKA [8]. Many studies have documented racial anatomical differences in the knee joint [10–15], which are more pronounced in females [11,15]. However, limited research has focused on asymmetry in component sizes among patients undergoing bilateral TKA. Relying on the sizes of the opposite knee can lead to incorrect component selection during bilateral TKA [8,16]. The focus of this study is to analyse the incidence of component size asymmetry in bilateral TKA.

Methodology

A retrospective study of operative and outpatient note was performed on all patients that had bilateral TKA done with the same manufacturer's prostheses over 5 years between January 2018 and December 2022 in NOHI, Lagos. The study was approved by the Research and Ethical review board of NOHI. The Inclusion criteria were patients who had primary bilateral TKA with both knees operated at two separate occasions, patients who had the same manufacturer prosthesis implanted bilaterally and had all data regarding the implant details available. Bilateral TKA patients whose data were incomplete, revision TKA patients or complex primary TKA with large bone loss, and patients with prostheses of different manufacturers for the bilateral TKA were excluded from the study. Out of several manufacturers that partner with NOHI, Lagos, the INDUS Knee (BioRad Medisys Pvt. Ltd. Pune, India.) TKA patients were selected due to the larger number of patients that INDUS Implants were used on. The INDUS knee is a high flex, posterior-stabilized design with a monoblock metal-backed tibial tray. It has five different sizes:- Small, Medium category (Medium and Medium-Plus) and Large Category (Large and Large-Plus) with a femoral/tibial component matching process of size for size (Table 1a and b). The insert sizes are 10, 12.5, 15, and 19 mm. The preoperative planning included a True size standing plain radiograph of the knees - Anteroposterior and lateral views, Complete blood count, erythrocyte sedimentation rate, C-reactive protein, Serum Electrolyte, Urea and Creatinine, Chest radiography, electrocardiogram, echocardiogram,

Table 1a Dimensions of the femoral condyle in indus knee prosthesis as depicted by the company and size correlation (in indian population)

Femoral Component		
Size	M/L(mm)	A/P(mm)
SMALL	59	50
MEDIUM	61	53
MEDIUM PLUS	64	57
LARGE	68	62
LARGE PLUS	72	67

Table 1b Dimensions of the tibial surface in indus knee prosthesis as depicted by the company and size correlation (in indian population)

Tibial component		
Size	M/L(mm)	A/P (mm)
SMALL	60	41.5
MEDIUM	63	43.5
MEDIUM PLUS	67	45
LARGE	71	47
LARGE PLUS	75	49

Fasting blood sugar, glycosylated hemoglobin (HbA1c), Clotting profile, Urinalysis and microscopy culture and sensitivity.

The bilateral TKA were done at separate occasions with similar surgical techniques under regional Anaesthesia and pneumatic tourniquet. Standard Medial parapatellar approach was used in all cases. The osteophytes, hypertrophied synovium and degenerated menisci were excised. Coronal alignment was restored with intramedullary jig for distal femur cut and extramedullar jig system for proximal tibial cut. Thickness of the cuts was 9 mm as determined by the cutting guide and Soft tissue releases were done to ensure a rectangular extension gap before component sizing was entertained.

INDUS Knee is a Posterior referencing system. This technique was used in all patients for femoral component sizing and rotation in order to match the femur geometry and ensure balanced flexion and extension gaps. When a femur is noted to be between sizes, the practice is to size the femoral component to the larger size in order to avoid notching. The appropriate cutting block was used to make other femur cuts such that it conformed with the implant geometry.

The tibial sizing was done using a tibial tray that maximally covered the tibial surface without an overhang on either or both sides of the plateau. The matching of both femoral and tibial component sizes was confirmed and proper tibial component rotation was ensured before tibial preparation was done with the appropriate tray. Patents who had downsizing of the tibial component by reduction osteotomy of the tibia plateau to balance the soft tissue were excluded from this study.

Implantation of the definitive femoral and tibial components was done with cement impregnation on the undersurfaces. Patella was not resurfaced in all the patients.

Irrigation of the knee joint was done with normal saline and the wound was closed in layers over active drain. Tourniquet pressure was either deflated before or after wound closure, depending on the surgeon's preference. Postoperative rehabilitation was similar in all TKA patients

The data extracted from the medical records for analysis were age, sex, BMI, Diagnosis, preoperative and postoperative knee scores at 1 year, Operation interval, left and right Femur Component sizes and left and right tibia component sizes.

Table 2 Case Characteristics

Variable	Frequency	Percentage
Age group		
48–60 years	16	24.2
61–70 years	40	60.6
>70 years	10	15.2
Sex		
Male	13	19.7
Female	53	80.3
BMI		
Normal weight	1	1.5
Overweight	17	25.8
Obese	48	72.7

Statistical analysis was done with Microsoft Excel and IBM- SPSS version 22.0 (IBM Corp; Armonk, NY, USA). Descriptive analysis and correlation coefficients were employed to examine the occurrence and magnitude of factors, as well as their statistical associations respectively. Analysis of mean Knee scores within groups comparing preoperative and postoperative values was done with paired *T*-test. A significance level of *P* less than 0.05 was used to determine statistical significance in all analyses.

Results

Case characteristics

This study had 66 bilateral TKA patients in total. The mean age of patients was 65.4 years (range 51–78 years), with a female-to-male ratio of 4: 1. Obesity was prevalent in 72.7% of patients, while 25.8% were overweight and 1.5% were of normal BMI. (Table 2). All patients were diagnosed of severe bilateral knee osteoarthritis and the ranges of components used were Medium (M), Medium plus (M+), Large (L), Large plus (L+). The majority of patients had M+ femoral and tibial components implanted while none of the patients used the small implant category (Table 3a). The mean operation interval between the right and left knees was 2.2 ± 0.8 weeks.

Component asymmetry

The overall component asymmetry in the 66 bilateral TKAs was 30 (45.5%) patients; the right and left implants differed by 1 size in all instances with the majority within M and M+. There was no difference in the distribution of the larger sizes irrespective of the side. (Table 3b). Of these, isolated femoral component asymmetry was observed in three (4.5%) patients, femoral and tibia component asymmetry was found in 27 (40.9%) patientsbut there was no isolated tibia component asymmetry.

Clinical outcome

Generally, the mean functional knee society score (KSS) improved from 41.76 ± 8.75 preoperatively to

Table 3a Distribution of bilateral total knee arthroplasty (TKA) Components Size

Variable	M *n* (%)	M+ *n* (%)	L *n* (%)	L+ *n* (%)
Right Femur	15 (22.7)	38 (57.6)	11 (16.7)	2 (3.0)
Left Femur	23 (34.8)	36 (54.5)	6 (9.1)	1 (1.5)
Right Tibia	19 (28.8)	34 (51.5)	11 (16.7)	2 (3)
Left Tibia	28 (42.4)	31 (47.0)	6 (9.1)	1 (1.5)

Table 3b Differences between knee joints component between the left and right

Variable	Frequency	Percentage
Differences between knee joints components between the left and right		
Asymmetry	30	45.5
Symmetry	36	54.5
Tibia asymmetry only	None	
Femur asymmetry only		
Yes	3	4.6
No	27	40.9
Both femur and tibia asymmetry		
Yes	27	40.9
No	3	4.6
Total asymmetry in femur components	30	45.5
Total asymmetry in tibial components	27	40.9
Distribution of larger asymmetry components		
Right knee	17	25.8
Left knee	13	19.7

M-Mediun, M+ means Medium plus, L-Large size and L+ - Large Plus size.

Table 4 Comparison of pre-operative and post-operative knee scores

Time	Mean	SD	T	df	*P*
Preoperation knee score	41.76	8.75	–37.919	65	<0.001
Postoperation knee score	85.61	4.95			

85.61 ± 4.95 postoperatively. The was no significant difference between preoperative and postoperative knee scores (T=–37.919, *P*<0.001) (Table 4).

Discussion

Many studies had described the normal variation in the anatomy of the knee joint [10–14,16] however, few studies have described the incidence of components size asymmetry in patients undergoing bilateral TKA [1,8,17–19].

This study demonstrated that majority of patient who underwent total knee replacement were within the age range of 61–70 years. This is similar to the findings in the study by Mohan BL in India in which the mean age was 64.7 years and also demonstrated female preponderance. These findings were similar to what this study revealed [1,8]. Analysis of the result showed that extreme of sizes are rarely used and as such, surgeon should have a sound knowledge of the implants as well as commonly used sizes. The surgeon should ensure that the commonly used sizes are present in his armamentarium before embarking on the surgery especially in this part of the world where desire to have full components of the implants is usually not met. This variation is a guide for arthroplasty surgeons that sizes M, M^{+} and L of INDUS knee arthroplasty must be readily available before embarking on TKA irrespective of the size of the opposite knee.

The main finding of this study was a 45.5% incidence of component asymmetry with the majority involving both femur and tibia together. Isolated femoral component asymmetry was seen in 4.6% cases and there was no incidence of isolated tibial component asymmetry. Similarly, the retrospective study done by Mohan BL reported a 4% incidence rate of isolated femoral component asymmetry but in contrast to our study, they reported 8% incidence of isolated tibial component in staged bilateral TKA cases [1]. These findings are at variance with a similar study by Bajwa *et al.* They demonstrated component asymmetry of 20%, isolated femoral asymmetry, and isolated tibial asymmetry of 12 and 2%, respectively, [8]. Their study was a prospective one which provided a greater level of evidence but the study population was quite low. In a review of 289 patients who underwent bilateral TKA, Reddy *et al.* reported the asymmetry rates of 9.2% and 8.7% for femoral and tibial components respectively [17]. Capeci *et al.*, and Pinsomak P also revealed the femoral component asymmetry of 8.7% and 9.9% [18,19].

Femoral component size selection may be affected not only by asymmetry caused by patient's anatomy, but surgical techniques such as distal femur valgus cutting angle, thickness of the distal femur cut, ligament balancing and referencing system for femur sizing [19]. The high incidence of component asymmetry in our study may be partly due to surgical technique concerning possible different anatomical landmarks on the anterior surface of distal femur selected by surgeons while sizing the femur with a posterior referencing system.

Intra-operative tibial component sizing may be influenced by magnitude of bone defect, thickness of the tibial cut, and reduction osteotomy of the medial tibial condyle done in varus knees to balance the soft tissue and gaps. Since the asymmetry between the sides differed just by a size, it could be that the surgeons deliberately up-sized or downsized to balance the flexion-extension gaps as demanded during the course of the surgery. An intraoperative mediolateral (M/L) and anteroposterior (A/P) measurements would have clarified the true incidence of asymmetry from anatomical differences

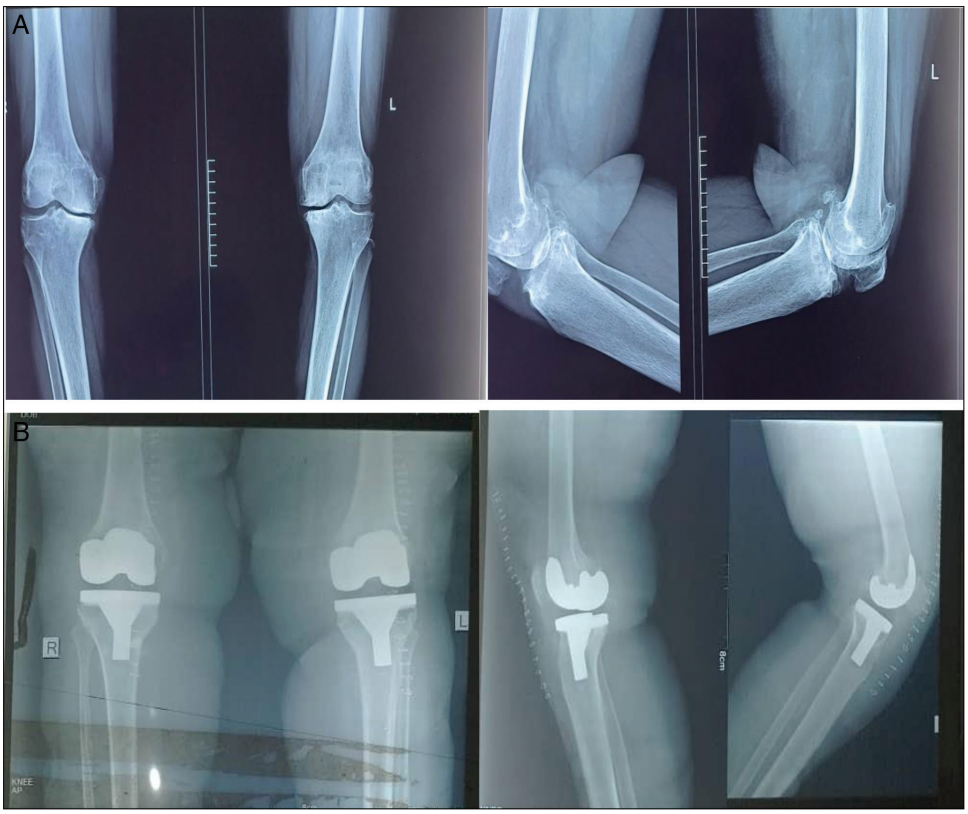
between the sides. Although, cadaveric arthropometric studies conducted in our country on nonarthritic knees revealed there was no significant anatomical differences between the right and left sides [20–22]. The mean M/L and A/P values of both distal femur and proximal tibia in these studies fell within the ranges for Large and Large plus components of INDUS knee. These sizes accounted for a smaller percentage of prosthesis implanted in our study population and this further buttresses the need to design TKA components based on racial anatomical dimensions.

Some authors alluded to the fact that component asymmetry can arise from errors in preoperative templating, intra-operative measurements and anatomic variations of the knees [23]. Good function and maximal stability of knee joint depend on good and proper sizing of components [11]. Implanting an oversized femoral component can cause decreased flexion range of motion and increased anterior knee pain due to patella overstuffing while an undersized component can lead to flexion instability and increases the risk of aseptic loosening [7]. Similarly, oversized tibial component can lead to posterolateral corner impingement while undersized tibial component may be implicated in subsidence and premature aseptic loosening [9]. Hence, surgeons should pay more attention, not only to alignment restoration, but to component sizing during every TKA surgery.

Though in this study, the incidence of component asymmetry was higher than most of the results documented in several studies, notwithstanding; the significant difference between the preoperative and postoperative knee scores justifies the result that the components were correctly sized whether there was component size asymmetry or not in those studied patients.

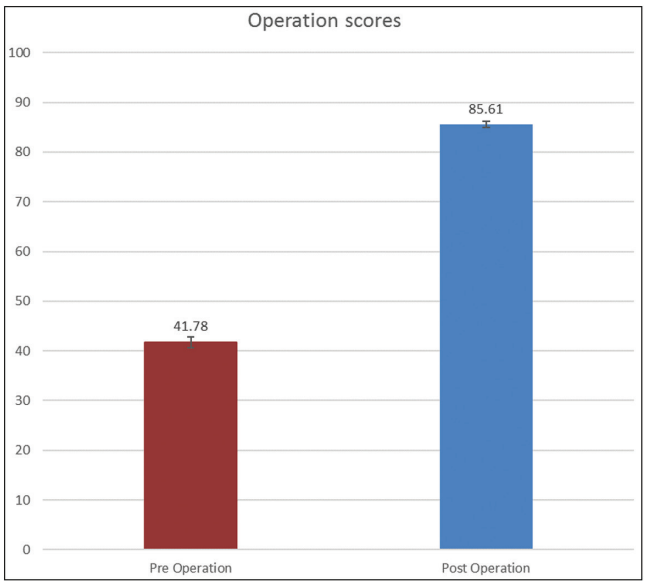
This study has some limitations; first, the small sample size which may affect overall generalisation from our study. Second, being a retrospective study the data from the patients' record were not tailored to the study. Some of the missing information included radiographic staging of the disease and arthropometric measurements of the knees on preoperative radiographs. Third, Intraoperative M/L and A/P measurements were not done in these patients. This would better reflect the actual anatomical size differences in the knees. Although, the authors believed that since the implants were not designed based on the study population's geometry, it may be difficult to correlate the measurements with the INDUS knee sizes. Forth,

Figure 1



(a): Preoperative anteroposterior and lateral radiographs of the knees. (b): Postoperative Anteroposterior and lateral radiographs of the knees with component asymmetry. The component on the right knee include -Medium femur on Medium/12.5 mm tibia while the left knee had Medium Plus femur on Medium/15 mm tibia implanted.

Figure 2



Shows the mean Knee score before and after operation.

the follow-up period was short and we found it difficult to correlate the component asymmetry with functional outcome beyond a year.

Conclusion

Proper sizing of components is paramount for achieving successful outcomes in bilateral TKA. The incidence of component size asymmetry observed underscores the necessity for meticulous preoperative planning and intraoperative decision-making. Surgeons must adhere to accurate sizing protocols, independently measure each knee particularly in time-pressured surgical scenarios and avoid solely relying on previously operated contralateral knee. Prospective studies with actual intraoperative anatomic measurements are recommended to validate our result, enhance surgical practices and improve patient outcomes in bilateral TKA Figs. 1 and 2.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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