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# Knee Anthropometry Using Magnetic Resonance Imaging and Its Suitability with Three Implant Brands in Semen Padang Hospital Indonesia

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## Abstract

Knee implant is used in grade IV osteoarthritis for replacing the function of damaged joint. The precise measurement is highly needed. The smaller built and stature of the Indonesian population gives rise to geometric mismatch. It may need special size of implants. This research is a descriptive study of patients who underwent MRI examination without fractures, tumours or infections at distal femur and proximal tibia. The femoral and tibial components are measured. We compare it with three implant brands; Johnson&Johnson®, Smith&Nephew® and Gemini SL LINK®. From the study, we get the results that the femoral components of three implants are suitable for being used, yet tibial components are not. Thus, it leads to overhang or underhang for Indonesia population which can cause impingement.

**Keywords:** knee, anthropometry, implant, TKR

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## 1. Introduction

Osteoarthritis (OA) is a chronic non-inflammatory disorder of synovial joints in which there is progressive softening and disintegration of articular cartilage accompanied by new growth of cartilage and bone at the joint margins (osteophytes), cyst formation and sclerosis in the subchondral bone, mild synovitis and capsular fibrosis.<sup>1</sup> People with OA in Indonesia by 2009 was increasing to 5% at age below 40 years old, 30% at age 40-60 years old and 65% at age above 60 years old. By gender, the prevalence of osteoarthritis in Indonesia is also increasing in which 15.5% for men and 12.7% for women. World Health Organization (WHO) also predicts that by 2025 the prevalence of OA in Indonesia will increase to 414% compared to year 1990.<sup>2</sup>

One last management of patients with OA is total knee replacement (TKR). It is indicated for grade IV osteoarthritis patients who experienced severe pain and limited daily activities that has no response to medications or intraarticular injection. By doing the TKR procedure, it could help in relieving the pain, restoring the function of the knee and daily activities.<sup>3</sup>

TKR is a high precise procedure where it uses implants for distal femur and proximal tibia to replace the function of damaged joint. The precise measurement of distal femur and proximal tibia is highly needed to obtain an ideal and promising result.<sup>4</sup> Otherwise, if there are any differences between resected bones and implant size, it could increase the complexity of the procedure. There are many brands of knee implant. In this study, we will discuss about three commonly used implant brands in Indonesia, consist of Johnson&Johnson®, Smith&Nephew® and

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Gemini SL LINK®. There are only few studies discussed about the anthropometry of the knee correlating to size of implants in Indonesia. Thus, we did the study to collect data of West Sumatera, Indonesia –in this case, Padang-population in order to define the suitability of the commonly used implants with the knee of people with indication of TKR procedure.

## 2. Method

The method of this study is a descriptive research. It was conducted in Padang from January to March 2018. The samples were gotten from Outpatient Clinic of Orthopaedics and Traumatology in Semen Padang Hospital, Indonesia. The inclusive criterias of this study are patients age 20-60 years old who underwent MRI examination without fractures, tumours or infections at distal femur and proximal tibia.

By using Sample Size WHO application, the size of sample is 46 samples. Anthropometric measurements of the knee were done using MRI and components that measured consist of femoral components (Femoral Mediolateral=fML, Femoral Medial Anteroposterior=fMAP, Femoral Lateral Anteroposterior=fLAP, Femoral Medial Condyle=fMC, Femoral Lateral Condyle=fLC, Intercondylar Fossa=ICF, Total Femur=TF) and tibial components (Tibial Mediolateral=tML, Tibial Anteroposterior=tAP, Tibial Lateral Anteroposterior=tLAP, Tibial Medial Anteroposterior=tMAP). The data was collected and processed to find out the mean and standard deviation of the anthropometry. Then we also find the suitability of the data with the size of three commonly-used implants.

### 2.1. How to measure the knee anthropometry using MRI

The measurement of femoral and tibial components must be defined in standard analysis in appropriate plane of MRI plane. For femoral components, fML is measured at the level of the surgical intercondylar axis, fAP is measured by taking line of the greatest distance between the posterior and anterior parts of the condyles, fMC is measured at 10 mm from the posterior articular surface simulating the external rotation of the femur, fLC is measured at 8 mm from the posterior articular surface, simulating the external rotation of the femur. For tibial components, tAP is measured from the center of the insertion of the posterior cruciate ligament to the medial end of the patellar tendon and tML is measured by the greatest distance perpendicular to the anteroposterior width.

### 2.2. Size of Three Commonly-Used Implant Brands

We also collect the information of implant size of Johnson&Johnson®, Smith&Nephew® and Gemini SL LINK®. The implants have their own sizing system which makes them different (Table 1).

Table 1. Size of knee implant of Johnson & Johnson® and Gemini SL LINK®

Implant Brand	Implant Size	FML	FAP	TML	TAP
Johnson & Johnson®	1.5	57	53	61	41
	2	60	56	64	43
	2.5	63	59	67	45
	3	66	61	71	47
	4	71	65	76	51
	5	73	69	83	55
LINK®	6	78	74	89	59
	XS	55	52	62	43
	S	62	59	69	46
	M	69	65	74	47
	L	72	67	78	53
	XL	76	72	85	56

For Smith&Nephew® knee implant, they have a unique sizing system (Table 2).

Table 2. Size of knee implant of Smith & Nephew®

Implant brand	Implant size	FML	FAP	TML	TAP
Smith & Nephew®	1			60	42
	2	58	50	64	45
	3N	58	54		
	3	62	55	68	48
	4N	62	58		
	4	66	59	71	50
	5N	66	61		
	5	70	62	74	52
6N	70	65			
6	73	66	77	54	
7	77	70	81	56	
8	80	75	85	59	

## 3. Results and Discussion

The measurement of knee anthropometry is described in Table 3. From 46 samples, we found that the anthropometry of Padang population is smaller than Western population. By gender, men have larger knee anthropometry than women. It is supported by another

studies done by Yue Bing, et al in 2011 also showed significant relationship where women have narrower femoral bicondylar than men ( $p > 0.000$ ).<sup>5</sup> The research also showed the fML width is  $71.9 \pm 6.4$  mm. It is smaller than the study done by Lim et al in 2013, where the width is  $78.6 \pm 5.1$  mm.<sup>6</sup> The width of tML is also smaller than the study done by Loures et al in 2017, where  $tML = 70.9 \pm 5.9$  mm.<sup>7</sup> Otherwise, compared to the measurement done by Miyatake et al in 2016, mean width of tLAP and tMAP in our study is larger, where our study shows tLAP size is  $45.4 \pm 4.5$  mm and tMAP is  $48.9 \pm 5.1$  mm.<sup>8</sup>

For Johnson&Johnson® the size that suits to Semen Padang Hospital's patients is size 4 for femoral component, size 3 for tML and size 1.5 for tAP. For Smith&Nephew® the size that suits is size 6N for femoral component, size 4 for tML and size 1 for tAP. For Gemini SL LINK® the size that suits is size L for femoral component, size S for tML and size XS for tAP.

Table 3. Knee Anthropometry of Semen Padang Hospital patients

Components		Measurement (mm)
Femoral component	fML	$71.9 \pm 6.4$
	fLAP	$64.2 \pm 5.3$
	FMAP	$64.2 \pm 5.1$
	FMC	$26.6 \pm 3.4$
	FLC	$25.6 \pm 3.8$
	ICF	$19.7 \pm 1.9$
	TF	$75.3 \pm 6.3$
Tibial component	TML	$70.9 \pm 5.9$
	TAP	$41.2 \pm 4.3$
	TMAP	$48.9 \pm 5.1$
	TLAP	$45.4 \pm 4.5$

There is a significant founding from the study. We found that the femoral component is suitable for being used in our sample, yet the tibial component seems to be not. The mismatch of tibial component is essential because slight oversizing of a tibial component may increase the overall contact surface area between the implant and tibial plateau.<sup>9</sup> Overhang could lead to pain from irritation of soft tissues to damage of MCL, while underhang could lead to subsidence and failure.<sup>10</sup>

#### 4. Conclusion

In conclusion, the anthropometry of knee in Semen Padang Hospital's patient is smaller than previous studies. The femoral components of three-commonly used implants are suitable for being used, yet tibial components are not. Thus, we need to consider to design implant that is more suitable to be used in West Sumatera population.

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