STUDY OF ANTHROPOMETRIC MEASUREMENT OF DISTAL FEMUR AMONG MALAY, CHINESE AND INDIAN

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STUDY OF ANTHROPOMETRIC MEASUREMENT OF DISTAL FEMUR AMONG MALAY, CHINESE AND INDIAN

FROM THE YEAR 2017 TO 2020

STUDY VENUE:

HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM), KUBANG KERIAN, KOTA BHARU, KELANTAN

HOSPITAL SULTAN ABDUL HALIM (HSAH), SUNGAI PETANI, KEDAH

HOSPITAL PULAU PINANG (HPP), GEORGETOWN, PULAU PINANG

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ABSTRAK

Pengenalan

Pembedahan penggantian sendi lutut memerlukan bentuk yang baik antara implan dan permukaan lutut yang dilindungi untuk memastikan hasil yang baik. Telah diketahui bahawa lutut Asia lebih kecil jika dibandingkan dengan rakan Barat mereka. Walau bagaimanapun, terdapat kekurangan data mengenai pengukuran antropometri femur distal dalam populasi Asia. Oleh itu, objektif utama kami adalah untuk mengkaji perbezaan antara pengukuran antropometri femur distal dalam populasi Asia terutamanya Melayu, Cina dan India.

Kaedah Kajian

Sebanyak 90 gambar lutut CT subjek Melayu, Cina dan India yang dilakukan diukur dengan menggunakan potongan paksi yang berserenjang dengan paksi panjang femur. Parameter yang diukur adalah pengukuran anteroposterior lateral (APL) dan medial (APM) kondoral femoral dan mediolateral (ML) pengukuran condil femur distal. Nisbah aspek dikira menggunakan formula (ML / AP). Semua parameter diukur hingga 0.1mm dan analisis statistik dilakukan dengan menggunakan IBM SPSS Statistics Version 24. Analisis Varians Dua Hala (ANOVA) dilakukan untuk menganalisis pengaruh dua pemboleh ubah bebas (jantina dan bangsa) terhadap pengukuran antropometri femur distal. Sebarang perbezaan ukuran antropometri femur distal antara kaum dipastikan menggunakan Analisis Covariance sehala (ANCOVA) setelah mengawal usia. Ujian korelasi Pearson digunakan untuk mengukur korelasi antara morfologi femur distal dan usia.

Keputusan

Terdapat perbezaan yang signifikan pengukuran AP Medial pada femur distal antara tiga perlumbaan ($F(2,89): 6,88$, $p = 0,002$). Perbezaan jantina juga menunjukkan kesan yang signifikan pada medial AP ($F(1,86): 33,36$, $p < 0,001$) dan AP lateral ($F(1,86): 26,79$, $p < 0,001$)

pengukuran femur distal. Kajian kami menunjukkan korelasi yang kuat antara pengukuran AP dan ML yang menunjukkan bahawa dengan bertambahnya panjang AP, lebar ML meningkat. Populasi India mencatat ketidaksesuaian implan lutut yang paling ketara dalam kajian kami.

Kesimpulan

Kami membuat kesimpulan bahawa tidak semua lutut Asia sama dan dengan itu reka bentuk implan serupa tidak dapat diterapkan secara universal di seluruh populasi Asia.

Kata Kunci:
Pengukuran lutut antropometrik, Pembedahan sendi lutut, Perbezaan kaum, Pengukuran CT, Lutut asia

ABSTRACT

Introduction:

Knee joint replacement surgery requires a good shape match between the implants and the resected knee surface to ensure good outcome. It is well known that Asian knees are smaller compared to their Western counterparts. However, there is paucity of data regarding the anthropometric measurement of distal femur within the Asian population. Hence, our main objective is to study the difference between the anthropometric measurement of distal femur within the Asian population particularly the Malay, Chinese and Indian.

Methodology:

A total of 90 CT knee images of Malay, Chinese and Indian subjects performed were measured using axial slice perpendicular to the long axis of femur. Parameters measured are anteroposterior measurement of lateral (APL) and medial (APM) femoral condyle and mediolateral (ML) measurement of distal femur condyle. Aspect ratio were calculated using the formula (ML/AP). All parameters were measured up to 0.1mm and statistical analysis was performed using IBM SPSS Statistics Version 24. Two-way Analysis of Variance (ANOVA) was conducted to analyze the influence of two independent variables (gender and race) on anthropometric measurement of distal femur. Any differences in anthropometric measure of distal femur between races were ascertained using one-way Analysis of Covariance (ANCOVA) after controlling the age. Pearson correlation test was used to measure correlation between distal femur morphology and age.

Results:

There was a significant difference of AP Medial measurement of distal femur between three races ($F(2,89): 6.88$, $p = 0.002$). Difference in gender also showed a significant effect on the AP medial ($F(1,86): 33.36$, $p < 0.001$) and AP lateral ($F(1,86): 26.79$, $p < 0.001$) measurement of distal femur. Our study showed strong correlation between AP and ML measurement

indicating that with increasing AP length, the ML width increases. Indian population noted to have the most pronounced knee-implant mismatch in our study.

Conclusion:

We concluded that not all Asian knees are the same and thus similar implant designs cannot be universally applied throughout all Asian population.

Key Words:

Anthropometric knee measurement, Total knee arthroplasty, Racial difference, CT measurement, Asian knee

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Knee joint replacement surgery requires a good shape match between the implants and the resected knee surface to ensure good outcome. [1] This highly complex surgical techniques require accurate placement of well fitted implants to reduce the complications and to improve the implant survival rate. [2] The anteroposterior diameter of the femoral component is vital in maintaining flexion-extension spacing and optimal tension in quadriceps mechanism. [3] Mediolateral diameter ensures adequate coverage of resected bone surface, allowing even stress distribution and smooth tracking of the patellar component in trochlear groove during flexion. [4]

Most of the commercially available total knee arthroplasty (TKA) implants are designed based on the anthropometric data of White knees. This could be the cause of component mismatch in Asian people. [5] Majority studies were done comparing Asian knees to White knees. B. Yue et al [6] reported that the Asian population has smaller distal femoral and proximal tibia size than that of its Western counterpart. Siow et al [7] reported that there is significant difference in terms of clinical outcome post TKA among Chinese, Malay and Indian. This could be attributed to the probable mismatch of distal femur morphology among different ethnic groups. Mahfouz et al evaluated 1000 knees of Asians, Caucasians and African Americans showed significant differences in the size of distal femur between different gender as well as different races. [8] However, there is remarkable paucity of information pertaining to the differences in morphology of distal femur among different races in Asian population.

In a multiracial country like Malaysia and Singapore, it becomes essential to understand the differences between knee morphology of different races particularly Malay, Chinese and Indian. There was a study conducted in 2013 in Malaysia compared anthropometric measurement of distal femur of Malay adult population against Chinese and Indian data from China and India showed significant difference result. However, to the best of our knowledge, up to date no

studies were done comparing the differences obtained from local distal femur data of local Malaysian Malay, Chinese and Indian population. [9] As metric and morphological techniques are often used by forensic anthropologist to determine the race, [10] we hypothesize that there is a distinct difference in size between local Malay, Chinese and Indian distal femur morphology in Malaysia.

1.2 OBJECTIVE

Main objective:

To determine whether there is any difference in anthropometric measurements (APL/APM/ML) of distal femur among different races in Malaysia

Secondary objective

1. To determine the association between gender of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur
2. To determine the association between age of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur

CHAPTER 2: STUDY PROTOCOL

2.1 DISSERTATION PROTOCOL

DISSERTATION PROPOSAL

TITLE:

STUDY OF ANTHROPOMETRIC MEASUREMENT OF DISTAL FEMUR AMONG MALAY, CHINESE AND INDIAN

NAME: DR CHEW YU WEI

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SUPERVISOR:

DR MOHAMMAD BIN PAIMAN

CO-SUPERVISOR:

DR SL VIJAYAKUMAR

Introduction

Knee joint replacement surgery requires a good shape match between the implants and the resected knee surface to ensure good outcome. [1] This highly complex surgical techniques require accurate placement of well fitted implants to reduce the complications and to improve the implant survival rate. [2] The anteroposterior diameter of the femoral component is vital in maintaining flexion-extension spacing and optimal tension in quadriceps mechanism. [3] Mediolateral diameter ensures adequate coverage of resected bone surface, allowing even stress distribution and smooth tracking of the patellar component in trochlear groove during flexion. [4]

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showed significant difference result. However, to the best of our knowledge, up to date no studies were done comparing the differences obtained from local distal femur data of local Malaysian Malay, Chinese and Indian population. [9] As metric and morphological techniques are often used by forensic anthropologist to determine the race, [10] we hypothesize that there is a distinct difference in size between local Malay, Chinese and Indian distal femur morphology in Malaysia.

Problem statement & Study rationale

As shown in previous paper, different ethnic groups may have different distal femur anthropometric measurement. It is well known that the Asian population has a smaller distal femoral and proximal tibia size than that of its Western counterpart [6-8]. Due to the comparatively smaller built and stature of the Asian population, many surgeons believe that imported implants, which are mainly designed from the morphometrics gained from the Western population, may not be suitable for patients located in Asian countries [8]. It is therefore of paramount importance that an appropriate femoral size for the different demographical and ethnic populations be used for the appropriate individuals. This would ensure that the implants use would provide an optimal performance during its lifetime.

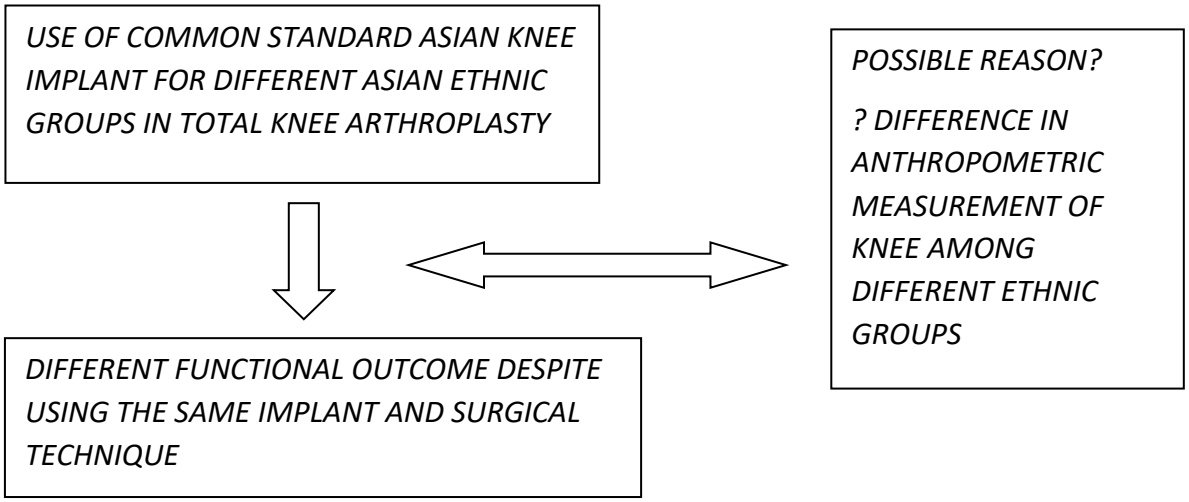
The aim of the current study is therefore to determine the anthropometric measures of the distal femur amongst the young adult Malay, Chinese and Indian population in Malaysia, measured from the axial cut of largest diameter (APL/APM/ML) of distal femur from computer tomographic(CT) knee images datasets.

Literature review

Siow et al in 2013 did a study comparing the functional outcome after TKA among Chinese, Malay and Indian population in Singapore noted that Indian patients have significantly poorer outcome as compared to Chinese and Malay patients.

Another study done by Fitdriyah Hussain et al in 2013 showed significant difference between anthropometric measurements of local Malay population in comparison with previously published data of Chinese and Indian population from China and India. This could be one of the cause of the difference in functional outcome as noted by Siow et al. However, the accuracy of the study may be limited by the fact that the comparison was done with young local Malay data against older Chinese and Indian patients of different origins. Most study only measured the anteroposterior diameter of lateral femoral condyle. Our study will include both APL and APM in view of the medial femoral condyle is the main weight bearing area as opposed to previous study which only measured and compared APL.

Conceptual framework



Research Question(s)

Is there any difference in anthropometric measurements (APL/APM/ML) of distal femur among different races in Malaysia?

Is there any association between gender of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur?

Is there any association between age of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur?

Objective

Main objective:

To determine whether there is any difference in anthropometric measurements (APL/APM/ML) of distal femur among different races in Malaysia

Secondary objective

1. To determine the association between gender of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur
2. To determine the association between age of different ethnic groups and anthropometric measurements (APL/APM/ML) of distal femur

Research design

This is a cross-sectional study based on Picture Archiving and Communications System (PACS) database from Hospital Universiti Sains Malaysia (HUSM).

Study area

1. Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan

    - 760-bed tertiary referral centre

2. Hospital Sultan Abdul Halim (HSAH), Sungai Petani, Kedah

    - 498-bed hospital which provides secondary and tertiary specialist services.

3. Hospital Pulau Pinang, Georgetown, Pulau Pinang

    - Main northern tertiary referral centre

Study population

My reference population will be individuals of Malay, Chinese and Indian ethnicity in Malaysia whereas my source population are individuals that presented to HUSM, HSAH and HPP. My target population are Malay, Chinese and Indian ethnicity patient that underwent CT knee in HUSM, HSAH and HPP. My sampling frame will be patient CT knee database in PACS.

Subject criteria

INCLUSION CRITERIA:

- All CT knees with normal distal femur morphology (including male and female, left and right)

EXCLUSION CRITERIA

- Age < 18, > 60 years old
- Abnormal distal femur configuration
- previous fracture e.g. united fracture, malunion, non-union
- bony or ligamentous injury over knee
- congenital deformity
- active or previous history of infection
- benign or malignant tumour
- CT knee images with artefacts

Sample size estimation

Sample size estimation was calculated using two population means formulae. Prior data indicate that the mean ML of the malay group was 64.5 (standard deviation = 3.12) and the mean of chinese group was 66.8 (standard deviation = 3.10). Thus, a minimum sample size of 30 samples per group to be able to reject the null hypothesis with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. We do not anticipate any dropout as this is retrospective study. The independent t-test statistic will be used to evaluate this null hypothesis.

Summary of sample size calculation for main and secondary objectives as below:

APL	Ethnic	Mean	SD	Sample Size
Male	Malay vs Chinese	63.93	3.36	19
		66.6	2.4	
	Malay vs Indian	63.93	3.36	25
		61.09	3.74	
	Chinese vs Indian	66.6	2.4	5
		61.09	3.74	
Female	Malay vs Chinese	57.39	3.29	11
		61.0	2.7	
	Malay vs Indian	57.39	3.29	14
		54.47	1.91	
	Chinese vs Indian	61.0	2.7	3
		54.47	1.91	

ML	Ethnic	Mean	SD	Sample Size
Male	Malay vs Chinese	74.88	3.55	724**
		74.4	2.9	
	Malay vs Indian	74.88	3.55	7
		69.64	3.11	
	Chinese vs Indian	74.4	2.9	7
		69.64	3.11	
Female	Malay vs Chinese	63.53	3.12	**30**
		66.8	3.1	
	Malay vs Indian	64.53	3.12	13
		61.06	3.11	
	Chinese vs	66.8	3.1	5

	Indian	61.06	3.11	

** The largest sample size per group calculated is 724. However, in view of limitation of study subject, study area and time constraint, we have decided to take the second highest sample size which is 30 per group.

Thus, total sample size required for this study is 90 (30 x 3 ethnic groups).

To the best of our knowledge there is no previous published paper comparing the age and APM of different ethnic groups with the anthropometric measurement of distal femur. Thus, a pilot study of 30 per group will be used as sample size.

Sampling method and subject recruitment

Non-probability sampling is used to select patients from the PACS database, who is Malay, Chinese and Indian ethnicity that done CT knee and falls into the inclusion and exclusion criteria. Subject recruitment is not required as data is obtained from the system.

Research tool

CT images are measured using the measurement tool of the workstation Centricity™ Universal Viewer Web Client Version 6.0 by GE Healthcare by three persons (Chew Yu Wei/ Wong Bor Chern, Chew Yu Wei/ Tan Shun Herng) for all the parameters and documented in millimetre (mm) rounded up to two decimal point.

Data collection method

Measurement will be recorded in the data collection sheet (Study Proforma).

Data collection obtained will be analysed and compared among the different ethnic groups eg. Malay, Chinese and Indian

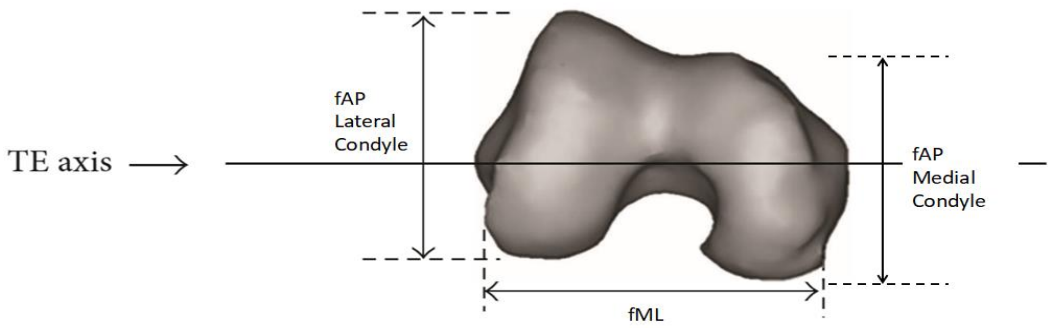
Two separate independent investigators will be tasked to measure the APM/ APL/ ML length of distal femur and the mean of two measurements will be taken to increase the inter-observer reliability

Subject's names will be kept on a password-protected database and will be linked only with a study identification number for this research. The identification number instead of patient identifiers will be used on subject data sheets. All data will be entered into a computer that is password protected. On completion of study, data in the computer will be copied to CDs and the data in the computer erased. CDs and any hardcopy data will be stored in a locked office of the investigators and maintained for a minimum of three years after the completion of the study. No personal information will be disclosed and subjects will not be identified when the findings of the survey are published.

Data will be collected by measuring CT knee images from the PACS database. Patient's participation is not required and data will be collected with strict confidentiality. CT knee images will be reconstructed to obtain axial view perpendicular to the long axis of femur and measured according to the method shown below:

To simulate the distal femoral bone cut in TKA, a line perpendicular to the mechanical axis of the femur is drawn 9 mm from the joint surface from the coronal plane. In the axial plane, the rotation will be simulated according to the transepicondylar axis and the AP and ML dimensions will be measured at this level. The femoral mediolateral (ML) dimensions was

measured on this cut surface at the measured point 10mm on the medial condyle and 8 mm on lateral condyle from the lowest point on medial and lateral condyle which parallel to the femoral transepicondylar axis (TEA). The femoral anteroposterior (APL) dimension was measured as anterior–posterior length of the lateral condyle perpendicular to the TEA. The femoral anteroposterior (APM) dimension was measured as anterior–posterior length of the medial condyle perpendicular to the TEA. Subsequently, the femoral aspect ratio (AR = ML/mean AP) was calculated d by dividing ML by mean AP [(APM+APL)/2].



Data collection sheet

Subject ID

Age

Sex: Male/ Female

Ethnicity

1. Malay ☐
2. Chinese ☐
3. Indian ☐

ML measurement: _____ mm

APL measurement: _____ mm

APM measurement: _____ mm

Data analysis

Normality test was conducted and showed that our data is normally distributed. We determined the differences in anthropometric measurement of distal femur between racial groups using one-way Analysis of Variance (ANOVA). When $p < 0.05$, we performed pairwise comparisons among racial groups using post hoc analysis with Bonferroni Holms correction. Two-way Analysis of Variance (ANOVA) was conducted to analyze the influence of two independent variables (gender and race) on anthropometric measurement of distal femur. Two-way analysis of variance was conducted to analyze the influence of two independent variables (gender and race) on Aspect Ratio measurement of distal femur. Any differences in anthropometric measure of distal femur between races were ascertained using one-way Analysis of Covariance (ANCOVA) after controlling the age. Pearson correlation test was used to measure correlation between distal femur morphology and age. All statistical analysis was analyzed using SPSS software version 24.

Dummy tables for data analysis

Table 1: Descriptive statistic (n=90)

Variable		N	(%)	Mean	(SD)
Gender	Female				
	Male				
Race	Malay				
	Chinese				
	Indian				
Age					
Anthropometric Measurements					
	AP Lateral				
	AP Medial				
	ML				
	Aspect ratio				

Table 2: Anthropometric Measurements among different races (n=90)

Anthropometric Measurement	Race	n	Mean	(SD)	F-statistics	(df)	p-value [a]
AP Lateral	Malay						
	Chinese						
	Indian						
AP Medial	Malay						
	Chinese						
	Indian						
ML	Malay						
	Chinese						
	Indian						
Aspect Ratio	Malay						
	Chinese						
	Indian						

Table 3: Anthropometric Measurements among different gender and races (n=90)

Measurement	Variable		n	Adj. Mean (95% CI) [a]	Adj. Mean Diff. (95%, CI) [b]	F-statistics	(df)	p-value [a]
AP Lateral	Gender	Female						
		Male						
	Race	Malay						
		Chinese						
		Indian						
AP Medial	Gender	Female						
		Male						
	Race	Malay						
		Chinese						
		Indian						
ML	Gender	Female						
		Male						
	Race	Malay						
		Chinese						
		Indian						
Aspect ratio	Gender	Female						
		Male						
	Race	Malay						
		Chinese						
		Indian						

Table 4: Anthropometric Measurements among different races after controlling the age (n=90)

Anthropometric Measurement	Race	n	Adj. Mean	(95% CI) [a]	F-statistics	(df)	p-value [a]
AP Lateral	Malay						
	Chinese						
	Indian						
AP Medial	Malay						
	Chinese						
	Indian						
ML	Malay						
	Chinese						
	Indian						
Aspect Ratio	Malay						
	Chinese						
	Indian						

Ethical consideration(s) [if applicable]:

Study will be conducted in compliance with ethical principles outlined in the Declaration of Helsinki and Malaysian Good Clinical Practice Guideline

Declaration of absence of conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Privacy and confidentiality

All forms are anonymous and will be entered into SPSS software. Only research team members can access the data. Data will be presented as grouped data and will not identify the responders individually.

Other ethical review board approval [if applicable]

i. National Medical Research Review [NMRR,MOH]