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Hip Knee J. Vol. 4, No. 2, 2023, pp.72-78
p-ISSN: 2723-7818
e-ISSN: 2723-7826
http://dx.doi.org/10.46355/hipknee.v4i2.153

DISTAL FEMUR MORPHOLOGICAL DISCREPANCY COMPARED WITH TOTAL KNEE ARTHROPLASTY IMPLANTS IN INDONESIA

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ABSTRACT

The prosthesis of knee joint in total knee arthroplasty (TKA) can give better fixation and stabilization if it's chosen properly. Most of prosthesis have been designed to be compatible with western population, not for Asian population. Whether the implant size need to be adjusted with ethnics and gender still being a controversy. Aim to define whether the morphology of Distal Femur, among men and women in Indonesia have discrepancy and to assess compatibility of the prosthesis size in Indonesia. The Methods this study was a descriptive cross-sectional study that conducted at Prof. Dr. R Soeharso's Orthopaedic Hospital – Surakarta, Indonesia, using purposive quota sampling methods. The inclusion criteria MRI knee joint of men and women (age ≥ 18 years old) which have soft tissue injury of knee joint. The morphological measurement of Distal Femur with the use of certain Software. Then, the data were analyzed with SPSS ver.17 using independent T-Test. The results is Among 130 patients, we found that Women's fML were narrower than men. While the ratio aspect of femur implants compared to gender, showed that it was not compatible for men, but more compatible for women. There is discrepancy of morphological size of Distal Femur among men and women in Indonesia. It causes incompatibility of using TKA implant in men patients in Indonesia, which more suitable for women size.

Keywords: Total Knee Arthroplasty, Implants, Femur, Prosthesis, Discrepancy

Article History:
Submission : July 21th, 2023
Revision : July 21th, 2023
Accepted : August 27th, 2023

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INTRODUCTION

Total Knee Arthroplasty (TKA) is a surgical procedure which has aim to eliminate pain sensation, improve and maintain knee joint function. So it is important to choose compatible prosthesis for Distal Femur and Proksimal Tibia size (1). The prosthesis which compatible with patient's morphology can give better fixation and stabilization (2,3). It becomes controversy, is there any discrepancy among men and women's knee joint, and whether it is necessary to adjust the specific prosthesis based on ethnics and gender (4-6). The latest studies have showed that there was discrepancy of knee joint morphology based on gender and ethnics. (6-10) So many scientists suggest to adjust the implant size with gender size. But in the other hand, some studies say that the gender's differences were not significant. (11-13).

Most of prosthesis have been designed to be compatible with western population, and for Asian population sometimes have to use bigger implant than patient's needs. (14-19). So we conducted this study to define whether the morphology of Distal Femur, Proximal Tibia, and Patella among men and women in Indonesia have discrepancy and to assess compatibility of the prosthesis size in Indonesia.

MATERIAL AND METHODS

This study was a descriptive cross-sectional study that conducted in Soeharso's Orthopaedic Hospital – Surakarta, Indonesia using purposive quota sampling methods. The inclusion criteria were MRI knee joint of men and women (age ≥ 18 years old) which have soft tissue injury of knee joint. Those who did not fulfill the inclusion criteria, had been excluded. This research was approved by our institutional ethical review board.

The MRI data were taken from Radiology Department database of hospitals in Surakarta which have MRI facility. While the patient's data were taken from medical records and selected using inclusion and exclusion criteria. The morphological measurement of Distal Femur with the Use of certain Software. Then, the data were analyzed with SPSS ver (17). using independent T-Test.

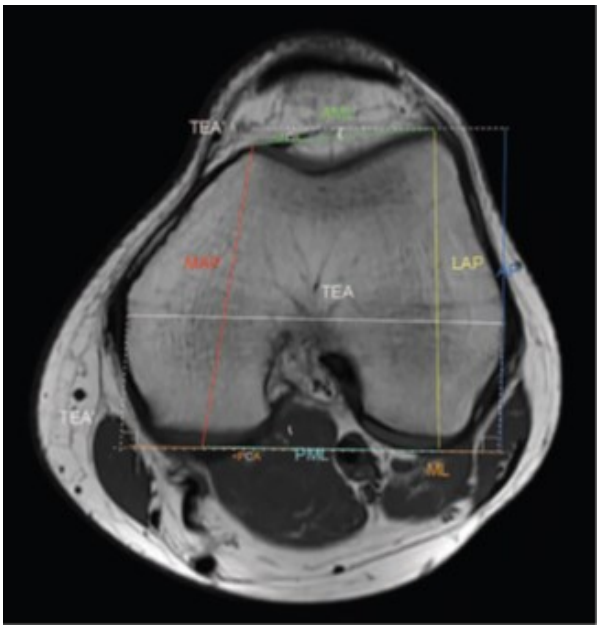

Figure.1 Morphological measurement of Distal Femur on MRI.

RESULTS

Distal femur the variable TEA in male patients was 81.05 + 3.83 while female patients are 67.65 + 1.55. The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the results of the

TEA examination between male and female patients. ML variable in male patients with an average of 81.07 +4.44 while female patients with an average of 68.11 +1.72. The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the results of the ML examination between male and female patients. MAP variable in male patients with an average of 65.75 +3.21 while female patients with an average of 59.81 +2.36.

The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the results of the MAP examination between male and female patients. LAP variable in male patients with an average of 67.23 +3.10 while female patients with an average of 61.01 +2.01. The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the results of the LAP examination between male and female patients. AP variable in male patients with an average of 69.27 +3.58 while female patients with an average of 63.95 +2.56. The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the AP examination results between male and female patients. PML variable in male patients with an average of 51.96 +2.58 while female patients with an average of 41.93 +1.41 (Table 1.).

Table 1. Comparison between male and female patients of distal femur morphology

Distal Femur	Total (n=130)	Male (n= 80)	Female (n=50)	p-value
TEA[a] (mm)	75,90 ±7,26	81,05 ±3,83	67,65 ±1,55	<0,00 1*
ML[b](mm)	76,08 ±7,30	81,07 ±4,44	68,11 ±1,72	<0,00 1*
MAP[b](mm)	63,47 ±4,10	65,75 ±3,21	59,81 ±2,36	<0,00 1*
LAP[b](mm)	64,84 ±4,08	67,23 ±3,10	61,01 ±2,01	<0,00 1*
AP[b](mm)	67,22 ±4,14	69,27 ±3,58	63,95 ±2,56	<0,00 1*
PML[b](mm)	80,69 ±5,37	51,96 ±2,58	41,93 ±1,41	<0,00 1*
AML[b](mm)	31,50 ±3,16	32,49 ±3,55	29,91 ±1,33	<0,00 1*
< ACA[b](0)	9,10 ±0,88	9,04 ±0,85	9,20 ±0,93	0,268
< PCA[b](0)	2,48 ±0,86	2,38 ±0,79	2,64 ±0,94	0,086
ML/AP[b](mm)	1,13 ±0,06	1,17 ±0,03	1,07 ±0,02	<0,00 1*

The statistical test results obtained a value of p = <0.001 (p <0.05) which means that there was a significant difference in the results of the PML examination between male and female patients (Figure 2.). AML variable in male patients with an average of 32.49 +3.55 while female patients with an average of 29.91 +1.33. The statistical test results obtained a p value = <0.001 (p <0.05) which means that there was a significant difference in the AML examination results between male and female patients (Figure 3.). It was found that fMAP and fLAP show differences between men and women, where fMAP and fLAP in women tend to have narrower fML than men. In a comparison of the aspect ratio measurements of TKR implants with gender, it shows that the aspect ratio of implants does not match the male gender but matches the female gender more (Figure 4.).

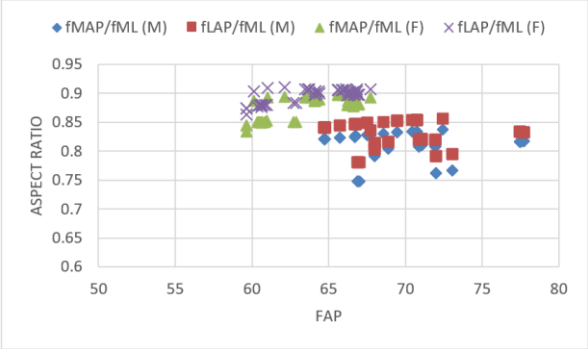

Figure 2. Femoral Surface Ratio (fML/fAP %) Comparing fMAP/fML ratio and fLAP/fML ratio based on fAP Between Male and Female (fMAP; femoral medial condyle anteroposterior dimension, fLAP; femoral lateral condyle anteroposterior dimension, M; male, F; female).

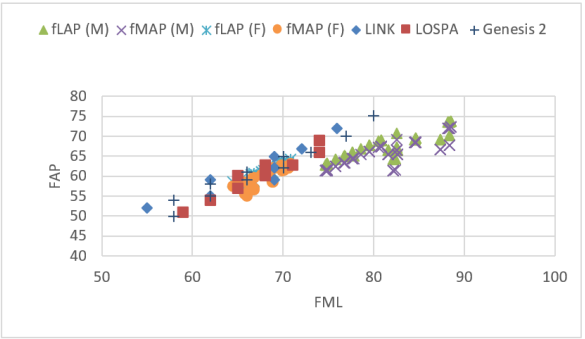

Figure 3. The femoral medialolateral (fML) and anteroposterior (fAP) dimensions were compared with the three femoral implants used in Indonesia. (fMAP; medial condyle anteroposterior dimension, fLAP; lateral condyle anteroposterior dimension, M; male, F; female).

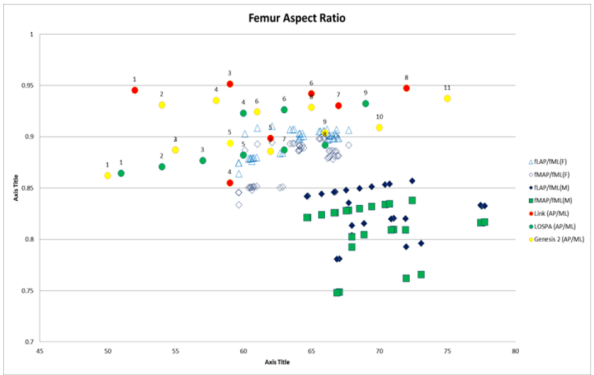

Figure 4. Aspect ratio dimension (fML/fAP %) and femoral anterior-posterior (fAP) compared with 3 femur implants in Indonesia (fMAP; medial condyle anteroposterior dimension, fLAP; lateral condyle anteroposterior dimension, M; male, F; female).

DISCUSSION

We analyzed 130 patient data and presented the results become some graphics. According to figure 1, there was discrepancy of fMAP and fLAP among male and female. Female's fML were narrower than male patients. While the ratio aspect of implant femur compared to gender, showed that it was not compatible for men, but more compatible for women. Besides, the measurement of implants aspect ratio was also not compatible for male, but more compatible for female. The study was to study by Budhiparama et al that found that the Dutch Caucasian patients had larger mediolateral (ML) and AP femoral dimensions than the Indonesian Asians. The aspect ratios of the distal femur were larger in Asians than in Caucasians. Both groups had larger ML distal femoral dimensions than the knee systems (20).

Hitt et al found that a wide variation in the aspect ratio for the femoral component was seen among the six different prosthetic systems was found. For women, there was a significant association between the component size and the amount of medial-lateral overhang, with larger sizes having more overhang ($p < 0.0001$). Although the femoral aspect ratio for the morphologic data showed higher ratios for smaller knees and proportionally lower ratios for larger

knees, the designs showed little change in the aspect ratio (21). Another study by Kim et al found that white patients had larger femoral AP measurements than East Asians (62 mm, (95% CI, 57-66 mm] vs 59 mm, [95% CI, 54-63 mm]; mean difference, 3 mm; $p < 0.001$), a smaller femoral aspect ratio than East Asians (1.20, [95% CI, 1.11-1.29] vs 1.25, [95% CI, 1.16-1.34]; mean difference, 0.05; $p = 0.001$), and a larger tibial aspect ratio than black patients (1.55, [95% CI, 1.40-1.71] vs 1.49, [95% CI, 1.33-1.64]; mean difference, 0.06; $p = 0.005$) (22). Therefore, the analysis showed uncovered differences of size (AP height and ML width of the femur and tibia) and shape (tibial and femoral aspect ratios) among knees from white, East Asian, and black populations (22).

There were some limitations to this study. We've only collected sample from one hospital, and it may be less representative to all Indonesian people. There was also limitation of MRI data sources, so we could not obtain other MRI data from other countries. And because 3D reconstruction MRI haven't done yet, we couldn't measure other indicators such as femoral curvature angle and tibia caster angle. So, we suggest that multicenter studies with bigger samples and complete MRI facility may be conducted.

CONCLUSIONS

In this study, we conclude that there is discrepancy of morphological size of Distal Femur male and female patients. It causes incompatibility of using TKA implant in male patients in Indonesia, which more suitable for female size. So, it is necessary to adjust the implant size for gaining better functional result.

REFERENCES

1. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res. 1989; 13–4.
2. Incavo SJ, Ronchetti PJ, Howe JG, Tranowski JP. Tibial plateau coverage in total knee arthroplasty. Clin Orthop Relat Res. 1994; 81–5.
3. Westrich GH, Haas SB, Insall JN, Frachie A. Resection specimen analysis of proximal tibial anatomy based on 100 total knee arthroplasty specimens. J Arthroplasty. 1995; 10: 47–51.
4. Greene KA. Gender-specific design in total knee arthroplasty. J Arthroplasty. 2007; 22: 27–31.
5. Barrett WP. The need for gender-specific prostheses in TKA: does size make a difference? Orthopedics. 2006; 29: S53–5.
6. Conley S, Rosenberg A, Crowninshield R. The female knee: anatomic variations. J Am Acad Orthop Surg .2007;15 (Suppl. 1): S31–6.
7. Merchant AC, Arendt EA, Dye SF, Fredericson M, Grelsamer RP, Leadbetter WB, et al. The female knee: anatomic variations and the female-specific total knee design. Clin Orthop Relat Res . 2008; 466: 3059–65.
8. Mahfouz MR, Merkl BC, Fatah EE, Booth Jr R, Argenson JN. Automatic methods for characterization of sexual dimorphism of adult femora: distal femur. Comput Methods

Biomech Biomed Engin. 2007; 10: 447–56.
9. Hitt K, Shurman II JR, Greene K, McCarthy J, Moskal J, Hoeman T, et al. Anthropometric measurements of the human knee: correlation to the sizing of current knee arthroplasty systems. J Bone Joint Surg Am. 2003;85-A(Suppl. 4): 115–22.
10. Chin KR, Dalury DF, Zurakowski D, Scott RD. Intraoperative measurements of male and female distal femurs during primary total knee arthroplasty. J Knee Surg 2002; 15: 213–7.
11. Lingard EA, Katz JN, Wright EA, Sledge CB. Predicting the outcome of total knee arthroplasty. J Bone Joint Surg Am 2004; 86-A: 2179–86.
12. MacDonald SJ, Charron KD, Bourne RB, Naudie DD, McCalden RW, Rorabeck CH. The John Insall Award: gender-specific total knee replacement: prospectively collected clinical outcomes. Clin Orthop Relat Res. 2008; 466: 2612–6.
13. Clarke HD, Hentz JG. Restoration of femoral anatomy in TKA with unisex and gender-specific components. Clin Orthop Relat Res 2008; 466:2711–6.
14. Cheng FB, Ji XF, Lai Y, Feng JC, Zheng WX, Sun YF, et al. Three-dimensional morphometry of the knee to design the total knee arthroplasty for Chinese population. Knee. 2009; 16: 341–7.
15. Ho WP, Cheng CK, Liau JJ. Morphometrical measurements of resected surface of femurs in Chinese knees: correlation to the sizing of current femoral implants. Knee. 2006; 13: 12–4.
16. Uehara K, Kadoya Y, Kobayashi A, Ohashi H, Yamano Y. Anthropometry of the proximal tibia to design a total knee prosthesis for the Japanese population. J Arthroplasty. 2002; 17: 1028–32.
17. MahfouzM, Abdel Fatah EE, Bowers LS, Scuderi G. Three-dimensional morphology of the knee reveals ethnic differences. Clin Orthop Relat Res. 2012; 470: 172–85.
18. Yue B, Varadarajan KM, Ai S, Tang T, Rubash HE, Li G. Differences of knee anthropometry between Chinese and white men and women. J Arthroplasty 2011;26: 124–30.
19. Vaidya SV, Ranawat CS, Aroojis A, Laud NS. Anthropometric measurements to design total knee prostheses for the Indian population. J Arthroplasty. 2000; 15: 79–85.
20. Budhiparama NC, Lumban-Gaol I, Ifran NN, de Groot PCJ, Utomo DN, Nelissen RGHH. Mismatched knee implants in Indonesian and Dutch patients: a need for increasing the size. Knee Surg Sports Traumatol Arthrosc. 2021 Feb;29(2):358-369. doi: 10.1007/s00167-020-05914-9. Epub 2020 Mar 11. PMID: 32162046.
21. Hitt K, Shurman JR 2nd, Greene K, McCarthy J, Moskal J, Hoeman T, Mont MA. Anthropometric measurements of the human knee: correlation to the sizing of current knee arthroplasty systems. J Bone Joint Surg Am. 2003;85-A Suppl 4:115-22. PMID: 14652402.

22. Kim TK, Phillips M, Bhandari M, Watson J, Malhotra R. What Differences in Morphologic Features of the Knee Exist Among Patients of Various Races? A Systematic Review. Clin Orthop Relat Res. 2017 Jan;475(1):170-182. doi: 10.1007/s11999-016-5097-4. Epub 2016 Oct 4. Erratum in: Clin Orthop Relat Res. 2017 May;475(5):1507. PMID: 27704318; PMCID: PMC5174057.