The Coronal Alignment of Tibial Prosthesis in Total Knee Replacement with Lateralization of Tibial Plateau Reference Point

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Abstract

Background: In Asian populations, proximal tibial vara is mostly present. The tibial cut referenced from the center of the intercondylar eminence to the center of the ankle often leads to varus malalignment.

Objective: To evaluate the effect of lateralizing the tibial reference point on the coronal plane alignment in postoperative radiographic evaluation.

Materials and Methods: In this retrospective study, radiographs of 41 patients (79 knees) with primary osteoarthritis with proximal tibial vara underwent primary total knee arthroplasty (TKA) between May 2017 and April 2024. The tibial alignment of 40 knees used a conventional landmark with a proximal tibial reference point at the center of the intercondylar eminence, and 39 knees used a lateralized proximal tibial reference point from the individual pre-operative radiographs. The postoperative medial proximal tibial angle (MPTA) of both groups were compared with the chi-square and Odds ratio. The lateralized distance between the tibial reference point and the center of the intercondylar eminence was measured in the lateralized tibial alignment group. The degree of correlation between the magnitude of tibia vara and the lateralized distance of the proximal tibial reference point was analyzed using linear regression analysis.

Results: The MPTA outlier over 3 degrees found 9 knees in the conventional tibial alignment method and 2 knees in the lateralized tibial alignment method of TKA. A significant interaction was found (chi-square 4.972, p=0.026, odds ratio 5.371). The mean lateralized distance of the proximal tibial reference point was 6.17 mm (SD 1.58). There was a strong correlation between the magnitude of the tibial vara and the lateralized distance of the proximal tibial reference point (R^2=0.751, p<0.001).

Conclusion: TKA in patients with osteoarthritis of the knee with proximal tibia vara can use the lateralized proximal tibial reference point for tibial alignment to increase the acceptable coronal alignment of the tibial prosthesis. The proximal tibial vara angle had a high degree of positive correlation with the lateralized distance of the proximal tibial reference point.

Keywords: Total knee arthroplasty; Proximal tibial vara; Medial proximal tibial angle

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Survivorship of total knee arthroplasty (TKA) depends on the accurate restoration of the coronal alignment of the weight-bearing axis of the lower limb and the ideal placement of the femoral and tibial components perpendicular to their respective mechanical axis[1]. When neutral mechanical alignment is restored, the leg's mechanical axis passes through the center of the knee, leading to an even mediolateral load distribution and a minimized risk for implant wear and component loosening[2-4]. Increased incidence of aseptic loosening has been reported in patients with persistent abnormalities in the mechanical axis following TKA[4,5]. The initial varus position of

What is already known about this topic?

Previous studies in India recommend that the accuracy in tibial component alignment in total knee replacement with proximal tibial varus can be improved by laterally shifting the proximal tibial reference point. The study had a descriptive design, which reported the mean and SD of the degree of coronal plane alignment of the tibial prosthesis; there was no data on the statistical comparison between the tibial alignment of this technique and the conventional technique.

What does this study add?

This retrospective study on radiographic evaluation of the coronal plane profile of the lower limbs in patients with proximal tibia vara who underwent total knee replacement between conventional and lateralized tibial alignment. The findings support that the lateralized tibial alignment statistically significantly improved the acceptable coronal alignment of the tibial prosthesis.

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the TKA implant is expected to worsen with time, probably due to abnormal polyethylene wear in the medial compartment[6]. Several studies showed a significant portion of knee varus, especially in the Asian population[7-9]. Proximal tibia vara contributes to the knee varus, tilting the tibia condyle and shifting the tibial articular surface medially. It affects MPTA measurement and tibia implant placement during surgery[10-12]. The extramedullary tibial guides are preferred by most surgeons for alignment of the tibial component in TKA. When using an extramedullary guide, the center of the intercondylar eminence has been the standard proximal reference point for the tibial plateau. However, it has been observed that the tibial cut referenced to the center of the intercondylar eminence leads to a varus malalignment in the presence of preexisting proximal tibia vara[13,14]. Whereas, there is no data on statistical comparison between the tibial cut referenced to the center of the intercondylar eminence and the lateralized tibial reference point. This study aims to assess the coronal alignment of tibia prosthesis in post-operative radiographic evaluation between both groups. And assess the correlation between proximal tibia vara with the lateralized tibial reference point distance.

Materials and Methods

This retrospective study involved pre and postoperative radiographic evaluation of the coronal plane profile of the lower limbs in patients with proximal tibia vara who underwent TKA. The study was approved by the Ethics Committee (EC08/2568). Patients undergoing primary TKA for osteoarthritis of the knee with coronal plane tibia vara were included in the study. The defined proximal tibia vara is a minimum of 5° of coronal plane angulation[13]. Patients with posttraumatic knee arthritis, deformities of the femur and tibia due to old fractures, and patients undergoing revision knee arthroplasties were excluded from the study.

The formula for calculating sample size for a study comparing two proportions or means for non-inferiority or superiority is

$$n_2 = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2 \sigma^2(1 + 1/k)}{(\epsilon-\delta)^2}$$

$$\epsilon = \mu_2 - \mu_1$$

$$k = \frac{n_1}{n_2}$$

μ_1=7.0 (mean distance of lateral shift of the proximal tibial reference point from the center of intercondylar eminence by 7 millimeters)[13]

μ_2=12.0 (maximal distance of lateral shift of the proximal tibial reference point from the center of intercondylar eminence by 12 millimeters)[13]

σ=2.2 (standard deviation [SD] of lateral shift of the proximal tibial reference point from the center of intercondylar eminence by 2.2 millimeters)[13]

δ=3.0 (outlier angle is classified as MPTA deviation of more than 3°, either in varus or valgus direction of the tibial component)[15,16]

Mean in group 1 (μ_1)=7.0, mean in group 2 (μ_2)=12.0, SD (σ)=2.2, margin (δ)=3.0, ratio (k)=1.0, Z(0.95)=1.64, Z(0.8)=0.84, α=0.05, β=0.2, n_2 was calculated as 14.88. Therefore, each sample group consisted of at least 15 knees, totaling at least 30 knees in all sample groups. When the number of sample groups was increased by 20%, the total sample comprised at least 36 knees.

A total of 83 TKA procedures were performed on 41 patients by a single surgeon between May 2017 and April 2024. Three limbs were excluded from deformities of the femur and tibia due to old fractures. Seventy-nine knees from 39 patients were assessed in this study. The 40 TKA procedures were performed in the conventional tibial alignment group with tibial cut referenced from the center of the intercondylar eminence (center point between medial and lateral tibial spine) to the center of the ankle (center point of ankle clamp of extramedullary tibial resection guide), and 39 TKA procedures were performed in the lateralized tibial alignment group with tibial cut referenced from lateralized proximal tibial reference point from the individual pre-operative radiographs. The position of patients for pre and post operative scanogram radiograph was controlled by the radiological technician; the knee rotation was controlled by adjusting the patient's patella directly forward, centered between the femoral condyles. The measurements were performed using the picture archiving and communications system (SYNAPSE PACS version 5.7 Fujifilm). The three orthopedic surgeons performed the postoperative MTPA measurements independently, and the average of the three measurements was obtained. The proximal tibial vara angle was defined as angle α. The lateralized distance was defined as the distance between the center of the intercondylar eminence and the lateral condyle reference point (Figure 1). The same reference point was replicated intraoperatively.

During the operation, the knee joint was exposed through the medial parapatellar approach, and the patella was everted, and the osteophyte was cleared. The distal femoral resection was done with an intramedullary technique. The tibial cut referenced

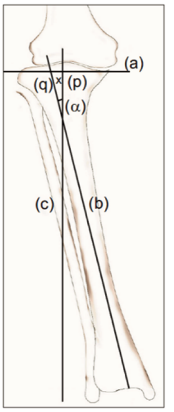


Figure 1. Diagrammatic representation of the method of determining the lateralized tibial reference point. (a) Line drawn along the tibial articular surface, (b) Line drawn along the anatomical axis of the tibia, (c) Line drawn perpendicular to line (a) at the center of the tibial intercondylar eminence, (p) Center of the intercondylar eminence, (q) Point of intersection of lines (a) and (b), (α) Angle between lines (b) and (c), (x) Distance of the reference point from (p).

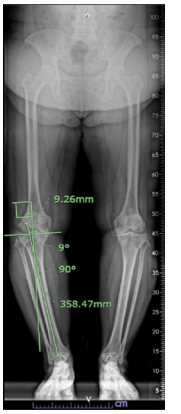


Figure 2. Preoperative lower limb scanogram radiograph shows proximal tibial vara angle of 9 degrees and lateralized distance of proximal tibial reference point of 9.26 mm.

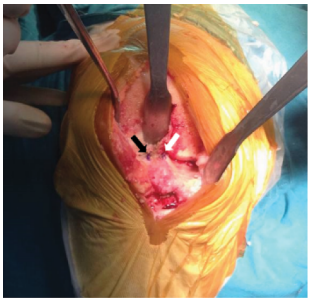


Figure 3. Intraoperative photograph of the right knee showed the lateral tibial spine (black arrow) and the medial tibial spine (white arrow). The center of the intercondylar eminence is the center point between both arrows.

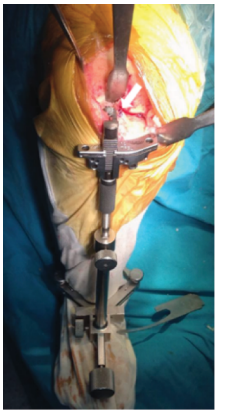


Figure 4. The extramedullary jig was placed on the reference point marked on the lateral tibial plateau. The lower end of the jig was placed at the center of the ankle.

from the center of the intercondylar eminence to the center of the ankle was performed in the conventional tibial alignment group. In the lateralized tibial alignment group, the proximal tibial vara angle and lateralized distance of the tibial reference point were determined from the preoperative scanogram radiograph (Figure 2). The tibial reference point was measured from the center of the intercondylar eminence with lateralized distance by ruler and marked (Figure 3). The extramedullary jig was placed with the reference point marked on the lateral tibial plateau. The lower end of the jig was placed at the center of the ankle (Figure 4). The coronal alignment was checked using the alignment rod. The proximal tibial resection was done. The Advance® medial-pivot knee system (Microport Orthopedics Inc., Arlington, TN, USA) was used in all the patients.

The coronal alignment of the tibial prosthesis was determined with MPTA. The MPTA was defined as the angle between the mechanical axis of the tibia and the line to the base plate of the tibial component, more than 3° varus or valgus of tibial component angle was defined as an outlier[15,16]. The MPTA was measured from postoperative lower limb scanogram radiographs in conventional and lateralized tibial alignment groups (Figure 5). The intra and interobserver reproducibility of MPTA measurement was assessed and expressed as the intraclass correlation coefficients (ICCs), which varied from zero (no agreement at all) to one (total agreement).

The MPTA was the primary variable. The acceptable and outlier MPTA of conventional and lateralized tibial alignment groups were measured and compared with the chi-square and odds ratio. In

Table 1. Demographic data of both groups

Characteristics	Conventional alignment (n=40)	Lateralized alignment (n=39)	p-value
Age (years); mean±SD	69.02±4.01	70.36±4.63	0.087
Sex (female:male)	17:3	17:2	0.245
Body weight (kg); mean±SD	63.43±8.27	62.49±8.31	0.309
Height (m); mean±SD	1.55±0.06	1.54±0.04	0.203
Body mass index (kg/m^2); mean±SD	26.46±2.21	26.33±3.56	0.424
Type of operation (unilateral:bilateral)	2:38	1:38	0.313

SD=standard deviation

Table 2. Radiographic parameters in this study

Parameter	Conventional alignment (n=40)	Lateralized alignment (n=39)	p-value
Kellgren-Lawrence grade of osteoarthritis; n (%)			
Grade 4	37 (46.84)	37 (46.84)	0.330
Grade 3	3 (3.80)	2 (2.53)	0.411
Preoperative tibia vara (°); mean±SD	7.35±2.01	7.64±1.75	0.246
Severity of preoperative tibial vara; n (%)			
5° to 8°	29 (36.71)	29 (36.71)	0.50
9° to 12°	10 (12.66)	9 (11.40)	0.444
>12°	1 (1.27)	1 (1.27)	0.50
Lateralized distance of the tibial reference point; mean±SD	NA	6.17±1.58	
Range of lateralized distance; n (%)			
<8 mm lateral	NA	34 (87.18)	
8 to 12 mm lateral	NA	5 (12.82)	
Postoperative MPTA (°); mean±SD	89.85±2.73	90.46±1.71	0.117
Postoperative MPTA outlier >3°; n (%)	9 (11.40)	2 (2.53)	0.026

SD=standard deviation; MPTA=medial proximal tibial angle; NA=not applicable

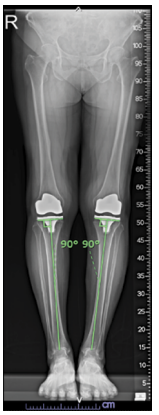


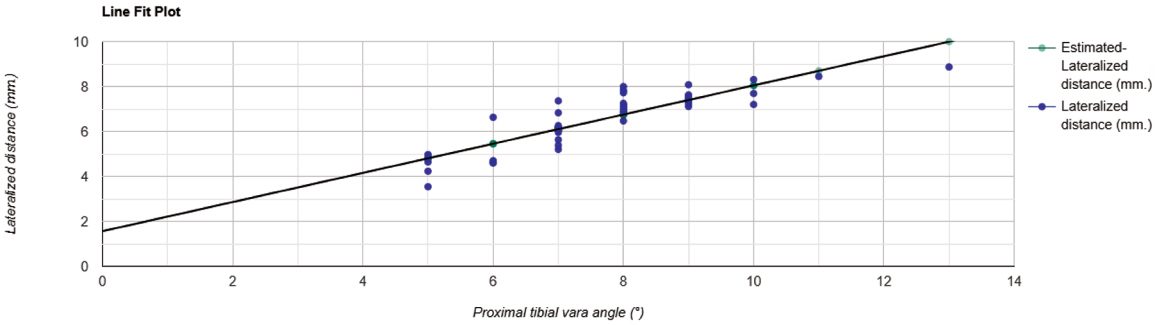
Figure 5. MPTA tibial angle was measured from post operative lower limb scanogram radiograph.

lateralized tibial alignment groups, linear regression analysis was used to assess the relationship between proximal tibia vara angle and lateralized distance of tibial reference point from the center of intercondylar eminence, which were secondary variables. The R^2 value and p-value were calculated. The p-values less than 0.05 were regarded as statistically significant. Statistical analysis was carried out with the aid of the IBM SPSS Statistics, version 29.0 (IBM Corp., Armonk, NY, USA).

Results

A total of 83 knees with proximal tibia vara were assessed in this study. Three limbs were excluded from deformities of the femur and tibia due to old fractures. 79 knees from 39 patients were assessed in this study. The descriptive statistics of the patient involved in the study are shown in Table 1, and the radiographic measurements are summarized in Table 2. The ICCs in the postoperative measurement of MPTA were 0.854 (95% CI 0.7801 to 0.943, p<0.001). The comparison results of MPTA are shown in Table 3.

Lateralized distance of tibial reference point from the center of intercondylar eminence by a mean of 6.17 mm (SD 1.58). The linear regression analysis showed a very high degree of positive correlation between the magnitude of tibia vara and the amount of



R^2=0.751, R=0.867, p<0.001, b_1=0.649

Figure 6. Relationship between proximal tibia vara angle and the lateralized distance of the tibial reference point.

Table 3. Comparison results of MPTA

Position of the proximal tibial reference point	MPTA; n (%)		
	Accepted	Outlier	Total
Lateralized tibial alignment	37 (46.84)	2 (2.53)	39 (49.37)
Conventional tibial alignment	31 (39.24)	9 (11.40)	40 (50.63)
Total	68 (86.08)	11 (13.93)	79 (100)

MPTA=medial proximal tibial angle
Chi-square=4.972, p=0.026, odds ratio=5.371

lateralization of the tibial reference point (R^2=0.751, p<0.001) (Figure 6).

Discussion

The incidence of constitutional varus is higher among the Asian population than the Caucasian counterparts[17-19]. Higher degrees of tibial angle deviation were also found in the Asian population than the commonly reported 3°[17,19]. Nagamine et al. compared the mean tibial angle in the Japanese patient with data for people in the United States and France; data showed that the mean tibial angle is larger than 4°[10]. The pre-existing proximal tibia vara affects preoperative measurements; surgeons must consider the presence of proximal tibia vara to plan TKA[20].

In Asian patients with varus osteoarthritis, the center of the tibial plateau is often medial to the anatomic axis. Thus, it is not an ideal reference point for the placement of the tibial component[10]. Earlier studies have recommended the use of the lateral edge of the intercondylar eminence instead of the center of the intercondylar eminence as the reference point[13,16,21]. Because of the pre-existing proximal tibia vara affecting preoperative measurements, a long-standing lower extremity X-ray should be obtained as part of knee replacement preparation for locating the preoperative tibial alignment and proximal tibial reference point. The author has a potential change in surgical technique from conventional tibial alignment to lateralized tibial alignment due to the study of Butarbutar et al[20].

Thippana & Kumar recommended that, in TKA patients with proximal tibia vara, reasonable accuracy can be achieved with the use of the extramedullary jig for tibial component alignment by lateralizing the proximal tibial reference point; the degree of lateralization should be individualized based on the deformity on preoperative full-length radiographs. Mean of medial coronal angle of tibial implant was 90.3±1.3 degrees[13], but no data on statistical comparison between tibial cut referenced to the center of the intercondylar eminence and lateralized tibial reference point.

Burghardt et al. showed standing long-leg radiograph provided a similar outcome to computed tomography (CT) scan in terms of the alignment measurement. Thus, the standing long-leg view radiograph remains the gold standard for alignment measuring. Furthermore, standing or weight-bearing long-leg radiographs provide cartilage characteristics that the non-weight-bearing CT scan or magnetic resonance imaging (MRI) do not provide[22].

Seventy-nine knees with proximal tibia vara were assessed in this study. The tibial cut referenced from the center of the intercondylar eminence to the center of the ankle was performed in the conventional tibial alignment group. In the lateralized tibial alignment group, the surgeon has not used the intercondylar eminence as a fixed proximal tibial reference point. The reference point was individualized based on the degree of metaphyseal tibial deformity, and it can extend even further laterally to the lateral intercondylar eminence. The outlier MPTA in post operative radiographic evaluation over 3° found 9 knees from 40 knees in the conventional tibial alignment group, and 2 knees from 39 knees in the lateralized tibial alignment group.

The chi-square statistic is 4.972. The p-value is 0.026. Significant at p-value less than 0.05. The odds ratio of 5.371 means that acceptable alignment of tibial prosthesis by using lateralized tibial alignment is just 5.371 times the odds of acceptable alignment of tibial prosthesis by conventional tibial alignment. The odds that an acceptable alignment of the tibial prosthesis is increased by using the lateralized tibial alignment.

Furthermore, Butarbutar et al. showed the mean distance of the proximal tibial reference point in proximal tibia vara patients was 4.99±4.08 mm lateral to the tibia eminence center[22]. Similarly, Thippana & Kumar showed that the proximal tibial reference point as determined from the preoperative scanograms was lateral to the center of the intercondylar eminence by a mean of 7 mm (SD 2.2). Linear regression analysis showed a very high degree of positive correlation between the magnitude of tibia vara and the amount of lateralization of the tibial reference point (R^2=0.79, p<0.001)[13].

From the lateral tibial alignment group in this study, the lateralized distance of the tibial reference point from the center of the intercondylar eminence was a mean of 6.17 mm (SD 1.58). Linear regression analysis showed a very strong direct relationship between proximal tibial vara angle and lateralized distance of tibial reference point (R=0.867). If we increase the proximal tibial vara angle by 1°, the value of the lateralized distance of the proximal tibial reference point increases by 0.649 mm (b_1=0.649). The proximal tibial vara angle explains 75.1% of the variability of the lateralized distance of the tibial reference point (R^2=0.751, p<0.001). The authors found a very high degree of positive correlation between the magnitude of tibia vara and the amount of lateralized distance of the tibial reference point.

The 2 knees in the lateralized group still had outlier alignments; both knees had a valgus tibial component malalignment due to the lateralized proximal tibial reference point. The lateralized proximal tibial reference point technique would not completely solve the tibial component malalignment problem in an osteoarthritis knee patient with proximal tibial vara.

There are limitations to this study. The retrospective nature of the study limits control over data quality and introduces potential selection and information bias. The relatively small sample size may reduce statistical power and limit the detection of subtle differences between alignment groups. All procedures were performed by a single surgeon, which may limit the generalizability of the findings to other surgeons or surgical techniques. The non-randomized allocation to conventional and lateralized tibial alignment groups increases the risk of selection bias. Radiographic measurements may be affected by patient positioning and rotational errors despite attempts to standardize scanogram acquisition. The study focused primarily on radiographic alignment outcomes without correlating them with clinical or functional patient-reported outcomes. Exclusion of complex cases, such as posttraumatic deformities and revision surgeries, limits applicability to more heterogeneous TKA populations. Potential confounding factors such as soft-tissue balance, implant positioning variability, and postoperative rehabilitation protocols were not analyzed.

Conclusion

The lateralized proximal tibial reference point for tibial alignment in TKA on osteoarthritis knee patients with proximal tibial vara has essentially increased the acceptable coronal alignment of tibial prosthesis. Linear regression analysis showed a high degree of positive correlation between the magnitude of tibia vara and the amount of lateralized distance of the proximal tibial reference point.

Author Contributions

NR: Conception and design of the study, acquisition of data, data and statistical analysis, data interpretation, drafting of the manuscript, critical revision of the manuscript, and final approval of the version to be published. AP: Acquisition of data. MW: Acquisition of data.

Clinical Trial Registration

This study is not a clinical trial; it does not require a registration number for a clinical trial.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Data Availability Statement

The datasets generated and/or analyzed during this study are not publicly available due to patient confidentiality and institutional regulations, but are available from the corresponding author on reasonable request and with permission from the Institutional Review Board of Pranangklao Hospital.

Ethics Approval and Consent to Participate

This study was reviewed and approved by the Ethics Committee of Prananklao Hospital, with

the approval number EC08/2568. Agreements for academic use of radiographic data were obtained from the patients by the hospital at the time of their hospitalization, and no identifiable information of participants is included in the manuscript.

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Use of Artificial Intelligence

The study was conducted without artificial intelligence.

References

1. Insall JN, Binazzi R, Soudry M, Mestriner LA. Total knee arthroplasty. Clin Orthop Relat Res 1985;(192):13-22.
2. Aglietti P, Buzzi R. Posteriorly stabilised total-condylar knee replacement. Three to eight years' follow-up of 85 knees. J Bone Joint Surg Br 1988;70:211-6.
3. Berend ME, Ritter MA, Meding JB, Faris PM, Keating EM, Redelman R, et al. Tibial component failure mechanisms in total knee arthroplasty. Clin Orthop Relat Res 2004;(428):26-34.
4. Fang DM, Ritter MA, Davis KE. Coronal alignment in total knee arthroplasty: Just how important is it? J Arthroplasty 2009;24(6 Suppl):39-43.
5. Jeffery RS, Morris RW, Denham RA. Coronal alignment after total knee replacement. J Bone Joint Surg Br 1991;73:709-14.
6. Matsuda S, Miura H, Nagamine R, Urabe K, Harimaya K, Matsunobu T, et al. Changes in knee alignment after total knee arthroplasty. J Arthroplasty 1999;14:566-70.
7. Harvey WF, Niu J, Zhang Y, McCree PI, Felson DT, Nevitt M, et al. Knee alignment differences between Chinese and Caucasian subjects without osteoarthritis. Ann Rheum Dis 2008;67:1524-8.
8. Hovinga KR, Lerner AL. Anatomic variations between Japanese and Caucasian populations in the healthy young adult knee joint. J Orthop Res 2009;27:1191-6.
9. Ho JPY, Merican AM, Ayob KA, Sulaiman SH, Hashim MS. Tibia vara in Asians: Myth or fact? Verification with three-dimensional computed tomography. J Orthop Surg (Hong Kong) 2021;29:2309499021992618. doi: 10.1177/2309499021992618.
10. Nagamine R, Miura H, Bravo CV, Urabe K, Matsuda S, Miyanishi K, et al. Anatomic variations should be considered in total knee arthroplasty. J Orthop Sci 2000;5:232-7.
11. Matsuda S, Mizu-uchi H, Miura H, Nagamine R, Urabe K, Iwamoto Y. Tibial shaft axis does not always serve as a correct coronal landmark in total knee arthroplasty for varus knees. J Arthroplasty 2003;18:56-62.
12. Kawasaki M, Nagamine R, Chen W, Ma Y, Sakai A, Suguro T. Proximal tibia vara involves the medial shift of the tibial articular surface. J Orthop Surg (Hong Kong) 2020;28:2309499020902592. doi: 10.1177/2309499020902592.
13. Thippana RK, Kumar MN. Lateralization of tibial plateau reference point improves accuracy of tibial resection in total knee arthroplasty in patients with proximal tibia vara. Clin Orthop Surg 2017;9:458-64.
14. Vanlommel L, Vanlommel J, Claes S, Bellemans J. Slight undercorrection following total knee arthroplasty results in superior clinical outcomes in varus knees. Knee Surg Sports Traumatol Arthrosc 2013;21:2325-30.
15. Kim YH, Matsuda S, Kim TK. Clinical faceoff: Do we need special strategies for Asian patients with TKA? Clin Orthop Relat Res 2016;474:1102-7.
16. Kim SM, Kim KW, Cha SM, Han KY. Proximal tibial resection in varus-deformed tibiae during total knee arthroplasty: An in vitro study using sawbone model. Int Orthop 2015;39:429-34.
17. Bellemans J, Colyn W, Vandenneucker H, Victor J. The Chitranjan Ranawat award: Is neutral mechanical alignment normal for all patients? The concept of constitutional varus. Clin Orthop Relat Res 2012;470:45-53.
18. Shetty GM, Mullaji A, Bhayde S, Nha KW, Oh HK. Factors contributing to inherent varus alignment of lower limb in normal Asian adults: Role of tibial plateau inclination. Knee 2014;21:544-8.
19. Tang WM, Zhu YH, Chiu KY. Axial alignment of the lower extremity in Chinese adults. J Bone Joint Surg Am 2000;82:1603-8.
20. Butarbutar JCP, Mandagi T, Siahaan LD, Suginawan ET, Elson, Irvan. Prevalence of proximal tibia vara in Indonesian population with knee osteoarthritis. J Clin Orthop Trauma 2022;29:101871. doi: 10.1016/j.jcot.2022.101871.
21. Han KY, Chae WY. The position of proximal reference point of tibia plateau for correct tibial osteotomy in total knee replacement: Prospective randomized and 6 years follow-up study. Knee Surg Relat Res 2011;23:197-202.
22. Burghardt RD, Hinterwimmer S, Bürklein D, Baumgart R. Lower limb alignment in the frontal plane: Analysis from long standing radiographs and computer tomography scout views: An experimental study. Arch Orthop Trauma Surg 2013;133:29-36.