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Measurement of proximal tibial morphology in northeast Chinese population based on three-dimensional reconstruction computer tomography

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Abstract

Tibial component of total knee arthroplasty (TKA) is designed according to morphology of proximal tibia to a large extent. Owing to racial difference, current design of tibial component based on Caucasian may not be suitable for Chinese patients. Meanwhile, data of proximal tibial morphology in Chinese population is lacking. The objective of this research was to investigate proximal tibial morphology of northeast Chinese population.

Computer tomography (CT) image of 164 northeast Chinese participants was collected. After three-dimensional (3D) reconstruction, size of tibia plateau and TKA resected surface were gauged to guide the design of TKA tibia prothesis in northeast Chinese population. Measurement of tibial size mainly includes tibial mediolateral length (tML), tibial medial/lateral anteroposterior length (tMAP and tLAP). Afterwards, tML/tAP ratio of tibia plateau and TKA resected surface were calculated as feature point of tibia prothesis. tMAP/tLAP ratio of TKA resected surface was calculated to represent tibial asymmetry degree. Medial and lateral posterior tibial slope (MPTS and LPTS) were also measured to give reference to posterior angle of tibia prothesis and angle of tibia osteotomy in TKA. Independent sample *t* test was performed to conduct statistical analysis, $P < .05$ was regarded as statistically significance.

Northeast Chinese male has larger knee size than female. Significant difference of tML/tAP ratio was also observed between male and female on tibia plateau (1.71 ± 0.07 vs 1.77 ± 0.09) but not on TKA resected surface (1.60 ± 0.05 versus 1.61 ± 0.06). Significant difference of tMAP/tLAP ratio between male and female was also found and they were 1.31 ± 1.03 and 1.11 ± 0.05 respectively. Northeast Chinese female has higher PTS than male (MPTS: $9.56 \pm 2.96°$ vs $8.81 \pm 2.87°$ and LPTS: $8.57 \pm 3.19°$ vs $8.44 \pm 2.76°$).

Significant gender-difference of tibial size and asymmetry degree of tibial resected surface were found between northeast Chinese male and female. Meanwhile, northeast Chinese population has smaller knee size, larger PTS and tML/tAP ratio than that of Caucasian population. Therefore, Chinese-specific and gender-specific tibial prostheses were strongly recommended to be designed.

Abbreviations: 3D = three-dimensional, CT = computer tomography, DICOM = digital imaging and communications in medicine, kVp = kilovolt peak, LPTS = lateral posterior tibial slope, mA = milliampere, MPTS = medial posterior tibial slope, MRI = magnetic resonance imaging, ROM = range of motion, tAP = average tibial anteroposterior length, TKA = total knee arthroplasty, tLAP = tibial lateral anteroposterior length, tMAP = tibial medial anteroposterior length, tML = tibial mediolateral length.

Keywords: Chinese population, computer tomography, tibial morphology, total knee arthroplasty

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KZ and QH contributed equally to this article.

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1. Introduction

Total knee arthroplasty was standard surgery for end-stage degenerative and rheumatoid knee disease. With high incidence of osteoarthritis in China, the amount of TKA has been rapidly increasing over the past decade.[1–4] However, it was found that 4.1% Asian patients required revision surgery after primary TKA, meanwhile only 2.6% patients in United States required revision surgery, more unsatisfied postoperative result and higher revision rate happened in Asian population according to Yue et al's study.[1] Although many factors such as different medical condition and follow-up rate may influence the incidence of revision surgery, racial difference between Asian and Caucasian might also play a role in different outcomes.[2,3] Whereas most tibial prostheses used now were designed according to the anthropometric database of Caucasian.[1,2,5–7]

Tibial morphology has significant impact on biomechanical stability and motion function of knee joint in patients who underwent TKA. Postoperative complications of TKA such as prosthetic loosening and subsidence mainly occurred in tibial side.[2,6,7] Therefore, systemic measurement of proximal tibia was essential in design of tibial component.

Measurement of TKA resected surface was of great importance in the design of platform shape. In order to achieve accurate coverage, it is necessary to keep tML/tAP ratio identical between tibial resected surface and prostheses.[1–3,5,6] Inconsistent ratio would either lead to poor coverage or prosthetic overhang.[8,9] Posterior tibial slope (PTS) also has great influence on postoperative stability and range of motion (ROM) of knee joint.[10–19] It was generally reported that Asia population has higher PTS than that of Caucasian.[1,3] Mean PTS of Asian people was 11° in Ho et al's study, which was far from that of 2.8° to 7.0° in Caucasian population.[4,13,14] Although difference of tibial morphology between Asian and Caucasian population was already confirmed by previous studies, few individual tibial components were particularly designed to satisfy the demand of Chinese population. Besides, there were even few studies about measurement of proximal tibial morphology of Northeast Chinese population.

The objective of this study was to measure size of tibia plateau and TKA resected surface, medial PTS (MPTS) as well as lateral PTS (LPTS) of 164 northeast Chinese participants to provide reference for platform design of tibial prosthesis in TKA. Gender difference of tibial morphology within northeast Chinese population was also evaluated in this study. Comparison with that of Caucasian will also be discussed in this study.

2. Methods

This study was performed on 164 tibias from 86 male and 78 female participants. All participants were recruited from northeast China, aged from 21 to 27 (Average 24.2 ± 2.0 years old). Complete lower limbs CT-scan (Scope from superior margin of acetabulum to inferior margin of ankle joint) was conducted for each volunteer. Average height of male and female participants was 171.8 ± 8.4 cm and 163.8 ± 3.7 cm respectively. Ethic approval was obtained from Medical Research Ethics Committee of our hospital before execution. Inform consent was obtained from each participant who had been recruited. It was promised that all information of participants would be kept secret. One knee of each participant was chosen for measurement by random (either left or right). The inclusion criteria were healthy knee without symptoms of knee joint pain, joint stiffness and limited range of motion. The exclusion criteria were morbid knee with radiology evidence of osteoarthritis, rheumatoid arthritis, fracture, and bone tumor of knee joint.

2.1. CT acquisition and data management

CT image was obtained with 256-rows CT scanner (Philips Healthcare. Japan). The parameter of CT scan was drawn lessons from relative study[20] and as following: Tube voltage: 120 kilovolt peak (kVp), Tube current: 232 milliampere (mA), Rotation time: 0.75 seconds, Layer thickness: 0.9 mm, $CTDI_{vol}$: 20.8 mGy, DLP: 705.3 mGy*cm, Collimation: 64×0.625, Pitch: 0.579, Matrix: 512×512. After image acquisition, CT image was preserved as DICOM (Digital imaging and communications in medicine) format which was exported into Mimics Software (Materilase Corporation. Belgium). Afterward, 3D-reconstruction of CT image was performed with Mimics Software. Meanwhile, tibia was separated from acquired 3D-model.

2.2. Measurement methods

2.2.1. Measurement method of tibia plateau. Draw on the experience of previous studies, medial and lateral tibia plateau were measured by creating best-fitted ellipses which matched precisely with the boundary of tibia plateau.[1,20,21] Centers of ellipses drawn on the medial and lateral plateau were defined as center points of medial and lateral tibia plateau. The connecting line between center points was mediolateral line (tML) of tibia plateau. The major axis of ellipses were defined as medial and lateral anteroposterior lines (tMAP and tLAP) of tibia plateau (Fig. 1). Average value of tMAP and tLAP was defined as tAP length. tML/tAP ratio of tibia plateau was calculated and compared between Northeast Chinese male and female.

2.2.2. Measurement method of posterior tibial slope. Posterior tibial slope (PTS) was gauged in Magics Software (Materialise Corporation. Belgium). Three-dimensional reference was automatically established in this Software. In order to guarantee measurement accuracy, orientation of tibial mechanical shaft should be posed cautiously. Draw on the experience of Ho et al's study, tibial mechanical shaft was defined as the line which passed through center points of tibia plateau and distal tibia.[17] Center point of distal tibia was located by creating a sphere which had best-fitted diameter to match the distal joint surface of tibia and fibulae (Fig. 2C, D). Center of sphere was considered as center point of distal tibia (Fig. 2B). Subsequently, boundaries of medial and lateral tibia plateau were drawn respectively in Mimics software (Materialize Corporation. Belgium). Afterwards, geometrical centers of these two regions were generated automatically. Mid-point of geometrical centers of medial and lateral tibial plateau was defined as center of tibia plateau (Fig. 2A). For convenience and accuracy of measurement, tibial mechanical shaft was kept vertical with horizontal plane and paralleled with z axis in 3D reference. Then planes which fitted precisely with the boundary of tibia plateau were generated to measure medial and lateral PTS respectively (Fig. 2C, D). The intersectional angle between tibial mechanical shaft and the plane of medial and lateral tibia plateau and were defined as MPTS and LPTS.

2.2.3. Measurement method of tibial resected surface. Typical TKA resection was performed for each tibia with

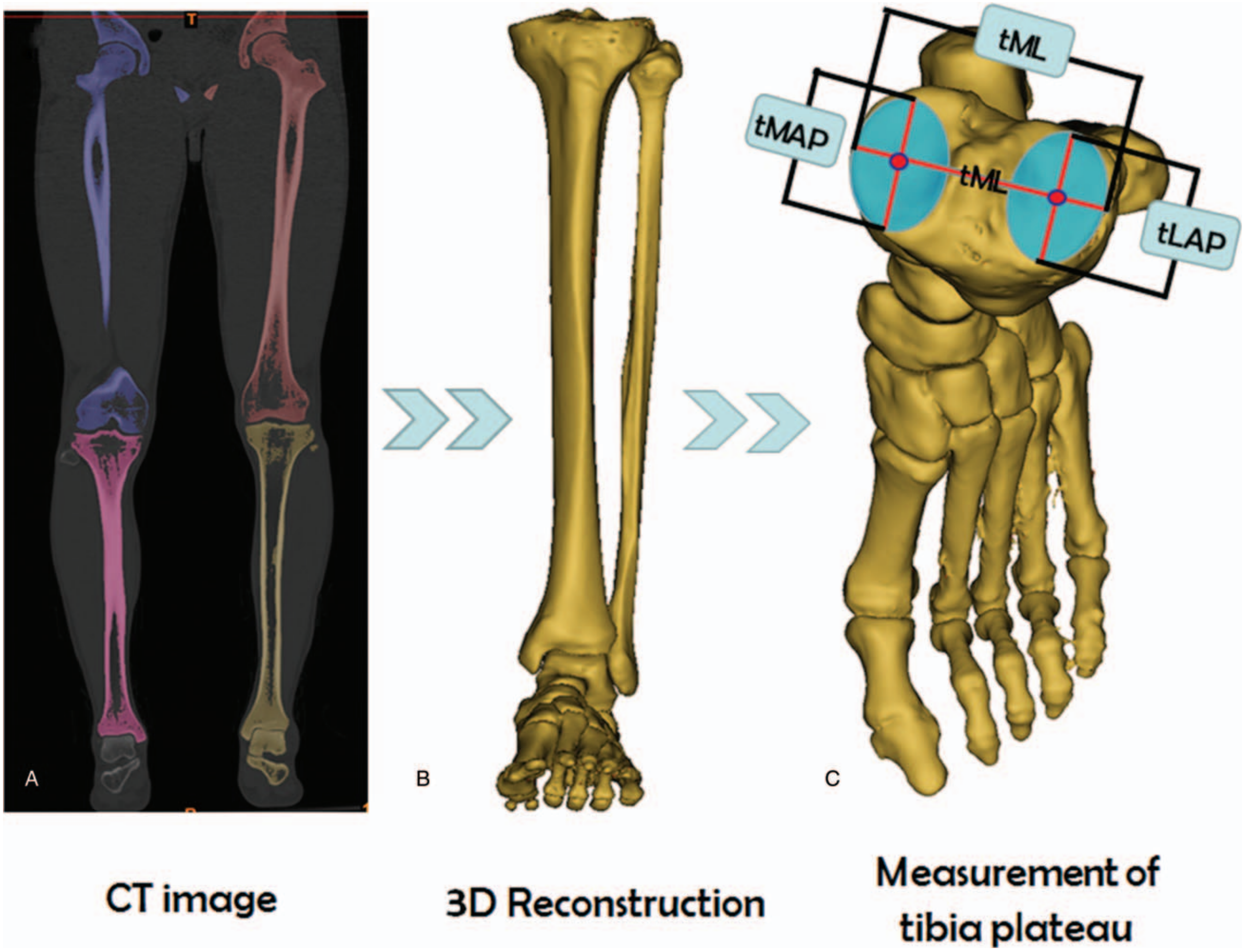

Figure 1. Brief procedure of measurement method of tibia plateau. (A): Origin CT image (B): Operation of 3D reconstruction (C) Measurement method of tibia plateau.

3° posterior tilt and 0° varus/valgus rotation. Following Clary et al's recommendation, cartilage on tibia plateau with thickness of one millimeter should be take into consideration. Seeing that, cartilage on tibia plateau could not be reconstructed in 3D model, tibial resected surface was located at 8 mm below joint surface of lateral tibia plateau (Fig. 3 A, B).[6] In order to avoid the interference of tibia rotation, orientation of tibial osteotomy was kept parallel with surgical trans*epicondylar* axis of femur in coronal view.[2] After acquisition of TKA resected surface, mediolateral length (tML), medial and lateral anteroposterior length (tMAP and tLAP) of resected surface were measured. Mediolateral line of resected surface was paralleled with surgical trans*epicondylar* axis of femur. According to Cheng *et al*'s suggestion, surgical trans*epicondylar* axis of femur was drawn as the connecting line which passed through the lateral epicondylar prominence and medial sulcus of the medial epicondyle[3] (Fig. 3C). tMAP and tLAP of tibial resected surface were defined as lines which passed through the posterior-most points of tibial condyles and perpendicular with tML line. Similar as the measurement method of tibia plateau, average value of tMAP and tLAP was defined as tAP length. tML/tAP ratio was calculated to represent morphology character of tibial resected surface. tMAP/tLAP ratio of tibial resected surface was calculated to represent degree of asymmetry.

2.3. Statistical analysis

All parameters were expressed as mean ± SD. SPSS Statistics for Windows version 21.0 (Released 2012, IBM Corp, Armonk, NY) was applied to carry out statistical analysis. First, Kolmogorov–Smirnov test was used to test normality. Subsequently independent sample t test was used to test statistical significance (with a level of significance $\alpha = .05$).

3. Result

After measurement of 164 cases of 3D tibial models, it was realized that northeast Chinese male has generally larger size tibia plateau than female. Both tML, tMAP and tLAP length of tibia plateau have statistical significance between male and female ($P < .001$) (Fig. 4 A, B). Nevertheless, female has larger tML/tAP ratio of tibia plateau than male. The ratio of female was 1.77 ± 0.09 (Range: 1.52~1.98) and male 1.71 ± 0.07 (Range: 1.52~1.87) ($P < .001$) (Table 1).

Medial and lateral posterior tibial slope of northeast Chinese male were 8.81 ± 2.87° and 8.44 ± 2.76°. MPTS and LPTS of northeast Chinese female were 9.56 ± 2.96° and 8.57 ± 3.19° (Fig. 5 and Table 2). Though female has larger PTS than male, no significant gender difference between male and female was found both in MPTS ($P = .10$) and LPTS ($P = .54$) (Table 3). Meanwhile,

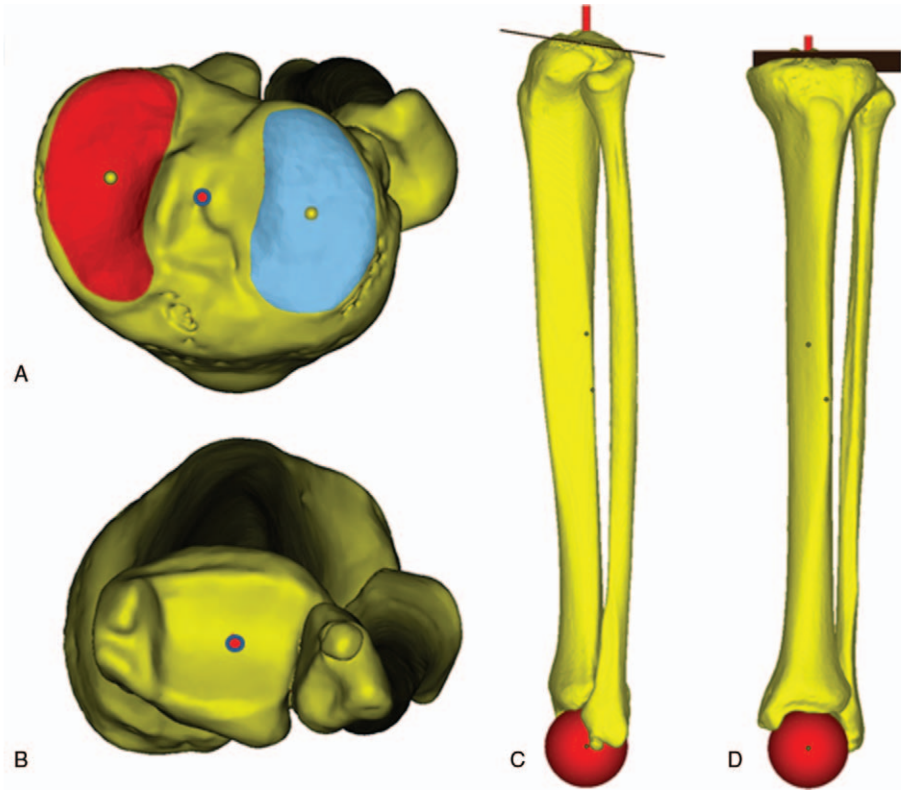

Figure 2. Flow chart of measurement of posterior tibia slope. Boundary of medial and lateral tibia plateau were drawn, while geometric center (yellow points) were automatically generated. Red circle represented the center of tibia plateau (A) and distal tibia (B). Lateral (C) and anteroposterior (D) view of measurement procedure of PTS. A best-fitted sphere was created to match distal tibia. Column which passed through center of tibia plateau and distal tibia was tibial mechanical shaft (C and D).

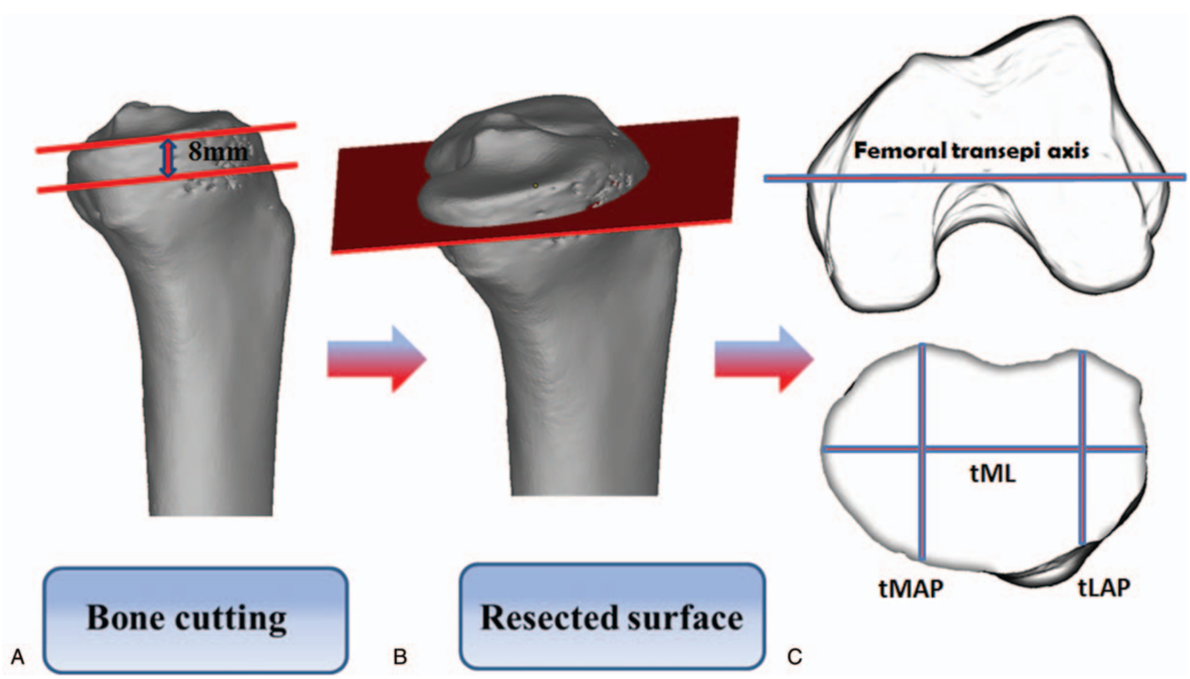

Figure 3. Schematic representation of measurement methods of tibial resected surface. and (B): Bone cutting of proximal tibia was conducted 8 mm below lateral tibia plateau with 3° posterior tilt. (C): tML line of tibial resected surface was paralleled with transepicondylar axis of femur. tMAP and tLAP lines passed through most posterior point of medial and lateral tibial condyles and perpendicular with tML line.

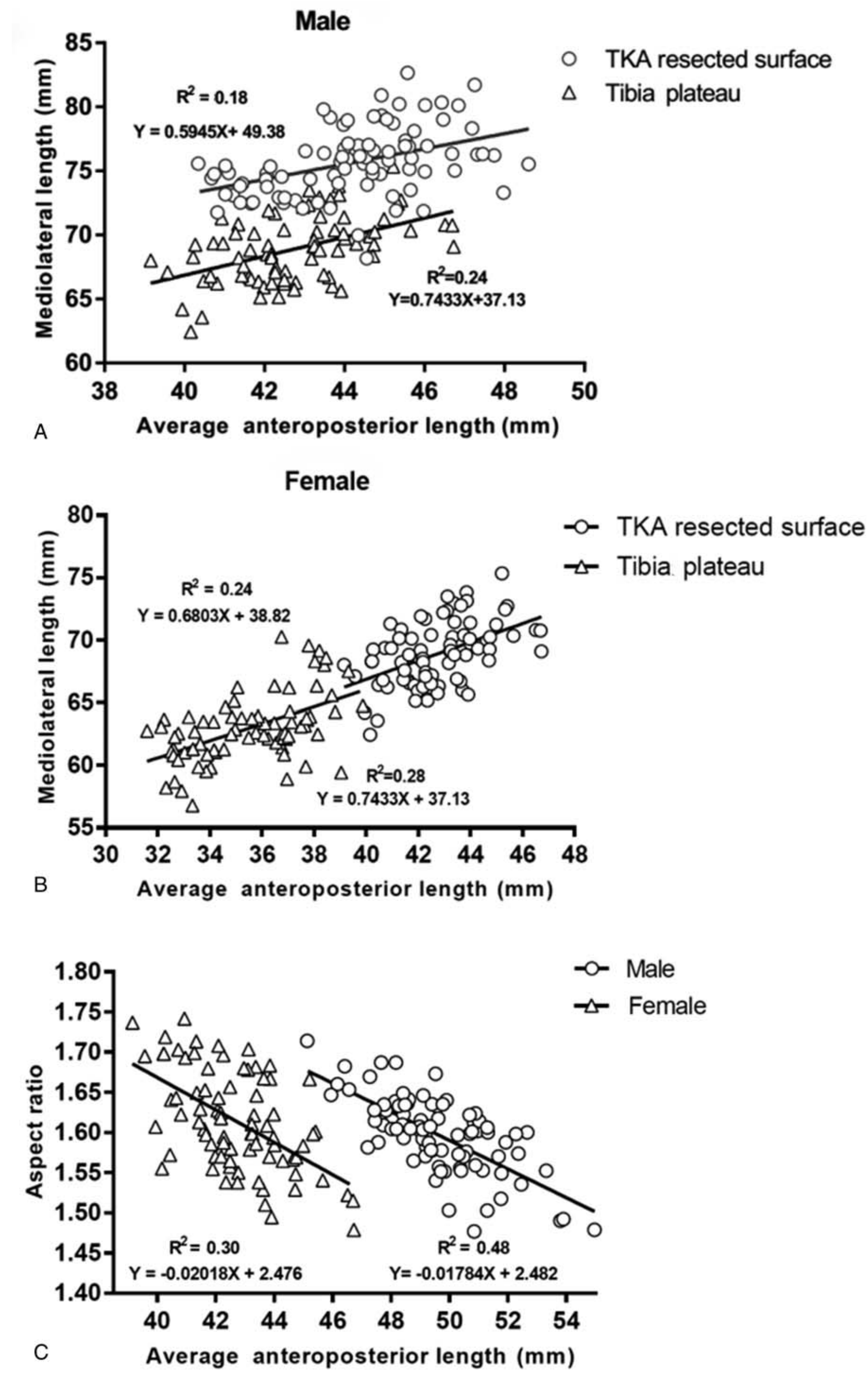

Figure 4. Relation between tML and tAP length. Relation between tML and tAP length of tibia plateau and TKA resected surface of male (A) and female (B). (C): Relation between tML/tAP ratio of TKA resected surface and tAP length.

no statistical difference between MPTS and LPTS was found in male ($P=.13$). But MPTS of northeast Chinese female was significantly higher than their LPTS ($P=.01$).

As for measurement result of TKA resected surface, northeast Chinese male had larger tML, tMAP and tLAP length than female ($P<.001$). No significant difference of tML/tAP ratio of TKA resected surface was investigated between male (1.60 ± 0.05) and female (1.61 ± 0.06) ($P=.10$) (Table 1). tMAP/tLAP ratio of TKA resected surface represented degree of asymmetry, and this ratio of male and female were 1.31 ± 1.03 and 1.11 ± 0.05 respectively. Asymmetry degree of tibial resected surface of male was statistically larger than female ($P<.001$).

4. Discussion

In total knee arthroplasty, accurate coverage of tibial resected surface and appropriate posterior angle of tibial osteotomy was of great importance to good clinical outcomes.[2–6,16,18]

Table 1

Measurement result of tibia plateau and TKA resected surface.

Surface	Tibia plateau				TKA resected surface			
	tML*	tMAP†	tLAP‡	tAR§	tML[1]	tMAP[2]	tLAP[3]	tAR[4]
Male = 86	75.67 ± 2.71	46.50 ± 1.99	41.95 ± 2.47	1.71 ± 0.07	79.16 ± 2.14	52.62 ± 2.05	46.59 ± 2.26	1.60 ± 0.05
Range	(68.18~82.66)	(39.47~50.37)	(35.88~ 48.26)	(1.52~1.87)	(74.64~84.25)	(48.37~57.27)	(41.77 ~52.65)	(1.48~1.71)
Female = 78	63.07 ± 2.71	38.77 ± 2.18	32.51 ± 2.44	1.77 ± 0.09	68.88 ± 2.56	44.92 ± 1.51	40.52 ± 2.25	1.61 ± 0.06
Range	(56.78~70.26)	(34.58~43.20)	(27.92~38.82)	(1.52~1.98)	(62.45~75.35)	(41.53~ 48.65)	(35.83 ~45.81)	(1.48~1.74)
P value	<.001‖	<.001‖	<.001‖	<.001‖	<.001 *	<.001 *	<.001 *	.10

All value was represented as mean ± SD and range.
* tML = tibial mediolateral length.
† tMAP = tibial medial anteroposterior length.
‡ tLAP = tibial lateral anteroposterior length.
§ tAR: tML/ tAP aspect ratio. ‖ $P < .05$ was considered significant difference.

Therefore, morphology of proximal tibia was particularly concerned by orthopedic surgeons. According to Motififard et al, 25% of revision TKA happened due to loosening or mismatching of tibial prostheses, which was higher than 19.4% of femoral side.[16] Previous studies have revealed that compared with Caucasian population, Chinese has generally smaller knee size, larger tML/tAP ratio and higher PTS.[1–4,14] Therefore, anthropometric data of proximal tibia was meaningful for design of tibia prostheses for Chinese population.

Previous studies mainly focused on tibial measurement through X-Ray, 2D, and 3D CT, MRI as well as cadaveric study.[1–12,16] The inclusion and exclusion criteria of these studies was similar with our study. Among these studies, measurement methods of 3D CT studies were closer to the method of our study. Size of TKA resected surface of tibia was fundamental in prostheses design. But measurement accuracy was susceptible during procedure of bone cutting. In comparison with tibial resected surface, size of tibia plateau was more reliable and could serve as correction of tibial resected surface.[1] In Yue et al's study, 76 cases normal Chinese knees were measured by 3D CT. Same parameter such as tML, tMAP, and tLAP of tibia plateau were measured in both Yue et al's and our study. But there was subtle difference about defination of center point of tibia plateau between Yue et al's and our study. Yue et al proposed that tML length of Chinese male and female was 75.2 ± 3.6 mm and 66.2 ± 2.1 mm, which were approximated to 75.59 ± 2.8 mm and 62.89 ± 2.77 mm in our study. Meanwhile significant difference of tibia plateau was investigated between Chinese and Caucasian. As for tML/tAP ratio, Yue et al reported that it ranged from 1.78 to 1.82 in Chinese population. The same index of Caucasian male and female were 1.75 and 1.76 which were smaller than their Chinese counterpart.[1] In our study, tML/tAP ratio of Northeast Chinese male and female were 1.71 and 1.77 respectively. It was concluded that smaller tML/tAP ratio existed in larger knee.[5] In consideration of larger knee size of Caucasian population, it might be one of the reasons why tML/tAP ratio of Caucasian was bigger than that of Chinese. Though tML/tAP ratio of tibia plateau might be insufficient to guide the design of tibial prostheses, it could serve as reference.[1–3,6,7]

Commercial available tibial prostheses have been reported relative poor coverage rate in Asian population.[1–5] A simulated matching study of TKA tibial prostheses from six manufacturer was conducted by Dai et al It was concluded that Chinese and Korean population had obviously poorer coverage rate than Caucasian.[18] Inconsistent tML/tAP ratio between tibial prostheses and TKA resected surface will lead to either poor coverage or prostheses overhang.[1–6,16,18] Prostheses overhang will cause irritation of soft tissue and imbalance of knee joint. It was proposed by Bonnin et al that prostheses overhang will also cause residual pain and poor flexion function of the knee.[8] Inadequate coverage rate would make tibial prostheses situated on weak cancellous bone, which lead to prostheses subsidence.[2,4,7,9] In our study, typical TKA resected surface was obtained from virtual osteotomy with 3° posterior tilt and 8 mm below lateral

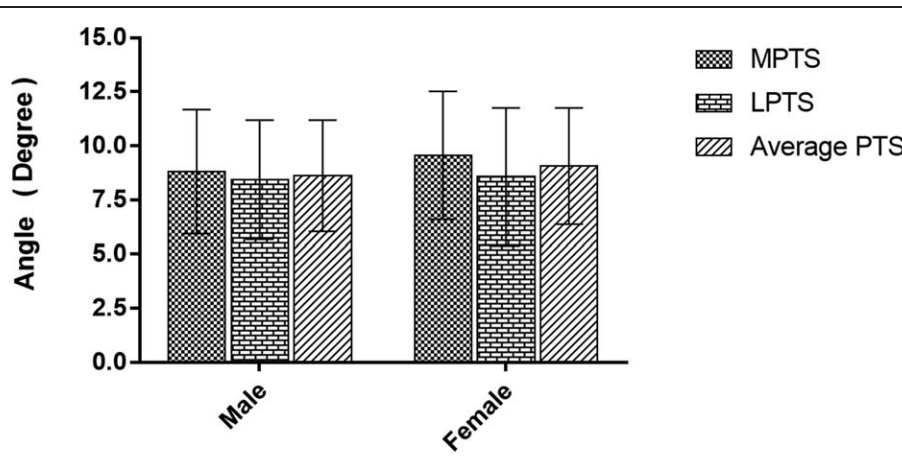

Figure 5. Statistical chart of MPTS, LPTS, and average PTS.

Table 2

Comparison of PTS between this study and previous published works.

Author (year)	This study (2018)	Ho (2016) [17]	Weinberg (2016)[27]	Yue (2017)[1]	Boer (2009) [26]	Bisicchia (2017) [10]
Population	Chinese	Asian	Caucasian and Black	Chinese	Caucasian and African	White and Black
Sample size	164	100	545	76	105	581
Imaging technique	3D CT	3D CT	Cadaver	3D CT	Cadaver	X-Ray
MPTS*	M‡:8.81 ± 2.87°	M:13.4° ± 3.3°	Mean: 6.9° ± 3.7°	M:6.0° ± 2.5°	M:7.9 ± 3.9° (PTS‖)	White (M):6.4 ± 1.1°
	F§: 9.56 ± 2.96°	F: 14.4° ± 4.1°		F: 5.4 ± 2.3°		Black (M):10.5 ± 3.1°
LPTS†	M:8.44 ± 2.76°	M: 9.8° ± 3.4°	Mean: 4.7° ± 3.6°	M:5.3° ± 3.6°	F:9.1 ± 3.2° (PTS)	White (F):7.6 ± 1.1°
	F: 8.57 ± 3.19°	F: 9.7° ± 3.8°		F: 4.8 ± 2.8°		Black (F):9.9 ± 3.0°

* MPTS = medial posterior tibial slope, †LPTS = lateral posterior tibial slope, ‡M: male, §F: female, ‖PTS: posterior tibial slope.

tibia plateau. It could be concluded that tML/tAP ratio of resected surface in Northeast Chinese population were 1.60 (male) and 1.61 (female), which were approximated to data of Korean population (1.52~1.58).[5] In Cheng et al's study, tML/tAP ratio of tibial resected surface range from 1.49 to 1.51 in Chinese population.[3] The result of tML/tAP ratio in Asian population was far from the Caucasian reported by previous studies.[1] This phenomenon might be interpreted as the influence of smaller knee size of Northeast Chinese population.

In addition, negative correlation existed between tML/tAP ratio (1.48~1.71) and tAP length (45.1~55.0 mm) in this study (Fig. 4C). Similar conclusion was also obtained in studies of Kwak et al and Cheng et al.[3,5] In order to achieve optimal coverage of TKA resected surface, tML/ tAP ratio of tibial protheses should be lower in tibia with larger tAP length. Inconsistent tML/ tAP ratio may lead to prostheses overhang in tAP dimension of patients who have large-size tibia. Furthermore, asymmetry degree of tibial resected surface was 1.31 ± 1.03 (Northeast Chinese male) and 1.11 ± 0.05 (Northeast Chinese female) in this study. Significant gender-difference of asymmetry was found ($P < .05$). Therefore gender-specific prostheses were recommended. This suggestion is similar with the opinion of Dai et al and Cheng et al's study.[1–3,7] As for interracial comparison, no statistical difference of asymmetry between Caucasian (1.12 ± 0.05) and Asian population (1.11 ± 0.04) was found in Dai et al's study.[7] Measurement data of Dai et al's study was consistent with the result of Northeast Chinese female (1.11 ± 0.05), but not consistent with Northeast Chinese male (1.31 ± 1.03) in our study. This phenomenon might be interpreted as anatomical difference within Asia scope and individual characteristics of participants.

Posterior tibial slope (PTS) was another essential characteristic in prostheses design and posterior angle of tibial osteotomy in TKA.[15,21–27] Inadequate posterior angle of osteotomy would lead to narrow posterior gap and limited postoperative ROM. Although there was no widely accepted angle of tibial osteotomy, angle between 0° and 7° was generally recommended in worldwide.[2,3,14] In early study, PTS has ever been gauged by lateral X-Ray of the knee. Measurement of PTS in 2D level has the following limitations. First, rotation of tibia could damage the measurement accuracy and lead to overestimation.[10,15,17,23] Second, owing to overlap of medial and lateral tibia plateau, merely the PTS of proximal side could be assessed. In contrast, MPTS and LPTS could be measured respectively in 3D-level. In consideration of high space resolution of 3D CT image, PTS was strongly recommended to be measured in 3D-level. In our study, MPTS and LPTS were measured respectively and their difference was paid specific attention. It could be concluded that MPTS was larger than LPTS in both sex of Northeast Chinese population. The difference between MPTS and LPTS were 0.38° in Northeast Chinese male and 0.98° in Northeast Chinese female.

Table 3

Measurement result of PTS.

Gender	MPTS	LPTS	*P* value
Male = 86	8.81 ± 2.87°	8.44 ± 2.76°	.13
Female = 78	9.56 ± 2.96°	8.57 ± 3.19°	.01*
P value	.10	.54	—

MPTS = medial posterior tibial slope, LPTS = lateral posterior tibial slope.
* $P < .05$ was considered as significant difference.

It was widely accepted that Asian population has higher PTS than Caucasian. For instance, 100 normal Chinese knees were measured by Ho et al, in which MPTS and LPTS was 10.8 ° and 10.0°, respectively.[17] In Yue et al's study, Caucasian male has an average PTS of 5.3°.[1] Bisicchia et al measured PTS using lateral X-Ray and deemed that Asian population had PTS of 7.7°, which was larger than 6.4° of Caucasian population.[10] In our study, mean PTS of Northeast Chinese male was 8.64 ± 2.72° (Range: 4.41~14.15°) and 9.36 ± 2.75° (Range: 4.07~13.83°) of Northeast Chinese female. Given the different methods between above studies and our study, there was reference meaning of these studies. By comparison with the result of previous studies, both Northeast Chinese male and female have higher PTS than their Caucasian counterpart.

Currently most commercially available tibial prostheses designed for Caucasian population have PTS of 3° to 7°, which means some of them are not suitable for Chinese patients. Shen et al applied 3D finite element to analyze contact stresses between polyethylene and femoral prostheses.[14] It was found that tibial component with 7° to 10° posterior inclination was effective to reduce the incidence of polyethylene wear in Chinese population. Polyethylene wear was common complication after TKA, which resulted in ten percentage of revision TKA surgery.[9] In order to reduce incidence of polyethylene wear, tibial prostheses with appropriate PTS should be considered for Chinese population. Inadequate PTS of tibial prostheses might be one reason why Chinese patients have higher revision rate and narrower postoperative range of motion.[1,2] So racial differences of PTS should be taken into consideration in TKA prostheses design.

Several limitations still existed in this study. First, 3° to 7° posterior tilt of tibial osteotomy was recommended in TKA surgery. But only resected surface of 3° was assessed in this study. Various resected surface with different tilt would be measured in further studies. The ignorance of coronal tibial slope was another limitation. Coronal tibial slope was defined as intersection angle between tML line of tibia plateau and tibial mechanical shaft which might interfere measurement result of PTS.[10,17] Measurement of coronal tibial slope should be carried out to explain its correlation with sagittal PTS. The third limitation was lack of multi-ethnic CT data. In our study, morphology difference between Chinese and other ethnic groups could be merely illustrated by comparison with previous studies. There will be systematic error in this process. CT data from multi-ethnic population would be collected and measured to analyze ethnic difference of tibial morphology. Finally, though measurement result of proximal tibia was more precise in 3D CT than X-Ray. Owing to image deviation, space error was brought during the procedure of 3D reconstruction. Hence, cadaveric measurement was essential as an assistant method in future practice.

5. Conclusion

In conclusion, gender difference within northeast Chinese population was found in this study. Northeast Chinese male has larger knee size and smaller PTS than female. As for measurement of TKA resected surface, northeast Chinese male has higher degree of asymmetry than female. According to the measurement results of tibia plateau and TKA resected surface, it could be concluded that northeast Chinese knee was generally smaller than Caucasian knee. In contrast to Caucasian knee, higher PTS and larger tML/tAP ratio were found in northeast Chinese knee. In consideration of morphological difference of proximal tibia, Chinese-specific and gender-specific tibial protheses were strongly recommended to be designed. Further clinical study would be warranted to verify these conclusions.

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