

Original Article

The difference of posterior slope angle between intra-operation and post-operation in total knee arthroplasty

Xiaolei Song¹, Jiangtao Dong², Juan Wang², Xiaozuo Zheng², Yisheng Wang¹

¹Department of Orthopaedic Surgery, The First Affiliated Hospital of Zhengzhou University, Zhengzhou 450000, China; ²Department of Joint, The Third Hospital of Hebei Medical University, Ziqiang Road, Shijiazhuang, Hebei, China

Received December 11, 2015; Accepted April 9, 2016; Epub February 15, 2017; Published February 28, 2017

Abstract: This study aimed to analyze the difference of posterior slope angle between intra-operation and post-operation during total knee arthroplasty (TKA) to provide a theoretical basis for adjusting the posterior slope angle. Clinical patients (44 cases) with TKA admitted to the Hospital from June 1 to September 2 in 2013 were involved in this study. According to the difference of the prosthesis, patients were divided into two groups: cruciate-retaining group (n=22, 33 knees) and posterior-stabilized group (n=22, 31 knees). Then the difference between posterior slope angle of intra-operation and post-operation were analyzed. In the cruciate-retaining group, the posterior slope angle of post-operation was $5.73^{\circ} \pm 2.81^{\circ}$ greater than that of intra-operation ($P=0.00$); While in the posterior-stabilized group, the posterior slope angle of post-operation was $1.66^{\circ} \pm 1.43^{\circ}$ greater than that of intra-operation ($P=0.00$). In the cruciate-retaining group, the posterior slope angle of post-operation is much smaller than the intra operation which indicating that there is no need to adjust the posterior slope angle when it is too small during intra-operation. As for the posterior-stabilized group, there was no statistical difference of posterior slope angle between post-operation and intra-operation, so we could predict the posterior slope angle of post-operation according to that of intra-operation.

Keywords: Arthroplasty, replacement, knee, tibia plateau, posterior slope angl

Introduction

Total knee arthroplasty (total knee arthroplasty, TKA) was designed to remove the joint surface which had been damaged and could not be repaired to restore knee joint function by replacing the damaged joints with artificial joint components [1]. It could correct the deformity effectively, ease pain, enhance the function of the affected limb and maintain the stability of the joint [2]. In total knee arthroplasty, the choice of slope angle posterior (PSA), TKA (PSA) would affect the flexion and extension of knee-joint function, joint stability and the life of the prosthesis after post-operation [3]. Therefore, the influence of PSA on TKA was gradually more and more important. In current study, the accurately select of the inclined angle was a major problem facing the surgeon in operation. In this study, we analyzed the difference on posterior slope angle between intra-operation and post-operation of total knee arthroplasty which

aimed to provide a guide for the doctors for the selecting of posterior slope angle between intra-operation and post-operation.

Materials and methods

Materials

All the clinical patients (44 cases) with TKA were admitted to the Hospital from June 1 to September 2 in 2013. Inclusion criteria: (1) All the operation were performed by the same surgeon (2) All the patients suffered from total knee arthroplasty for the first time (3) The patient was diagnosed with knee osteoarthritis. Exclusion criteria: (1) the patients who suffered from revision of knee joint (2) The patient was diagnosed with rheumatoid arthritis and other types of arthritis. About 44 cases (64 knees) were involved in this study. Among this, in the cruciate group, there were prosthetic knee replacement (22 cases), total joint replacement

The different between the surgeries

Table 1. Comparison of preoperative basic data between two TKA groups (n, %)

	CR group (n=33)	PS group (n=31)	P
Gender			
Male	2 (0.6)	5 (16.1)	0.84
Female	31 (99.4)	26 (83.9)	
Age	63.95±6.61	65.52±7.51	0.46
KSS Score			
60-69	11 (33.3)	12 (38.7)	
30-59	17 (51.5)	16 (51.6)	0.43
< 30	5 (15.2)	3 (9.7)	

CR: cruciate-retaining; PS: posterior-stabilized.

(33 knees), male (2 knees), female (31 knees), average age (63.95); In the posterior-stabilized group, there were prosthetic knee replacement (22 cases), total joint replacement (31 knees), male (5 knees), female (26 knees), average age (65.52). The basic data of the CR group and the PS group were compared, including gender, age and preoperative KSS score. The results showed there were no significant differences between the two groups. The data were shown in **Table 1**.

Surgical methods

All cases were completed by the same surgeon. After the preoperative preparation, 15 cm length of incision was performed in the middle of anterior knee. After the opening of skin and subcutaneous tissue, then the synovium and the lower part of the patellar fat pad were cut off. The periosteum was cut at 1 cm of the medial tibia, and the medial articular capsule was initially loosened by the dissection along the periosteum. The eversion of the patella, knee joint, resection of the femoral tibial osteophytes, hyperplastic synovial membrane, meniscus and anterior anterior ligament were performed. The tibial plateau was pried out by plate hook, the positioner was setup in the neck bone and the proximal tibial osteotomy device was installed at roximal tibia. The position was fixed by vertical angel of tibial glucosamine line and along the outside. To restore the patient's own back backward, the cut of posterior articular cartilage of the tibial plateau was as a reference and the post dip angle was recorded. The femur was positioned and washed with hydrogen peroxide solution and 0.9% sodium chloride injection before installation of prosthesis. The wound was stitched up

at the neutral position of the knee joint. The posterior slope angle was measured at the posterior lateral position by x line. Gemini prosthesis and rp-f prosthesis were respectively used for CR and PS groups.

The measurement of posterior slope angle

The posterior tilt angle was measured by the matching of the tibial bone marrow locator. The cut of posterior articular cartilage of the tibial plateau was as a reference and the post dip angle was recorded. The posterior slope angle between intra-operation and post-operation was measured at the X line of knee joint. Having no obvious tibial rotation and a clear outline of the tibial plateau prevail were as standards for the selection of X-ray. The posterior angle of the tibia was measured with the axis of the middle and upper end of the tibia. Reference curve was perpendicular to the axis, the angel between the connection line for the posterior horn of the anterior tibial platform and reference curve was recorded as the posterior angle of the tibia (4-8) (**Figure 1**).

Groups

Based on the type of prosthesis used, the prosthesis was divided into CR and PS group and the PSA of tibial plateau was recorded before surgery, intraoperative and postoperative. The difference of PSA during intra-operation and post-operation between the groups was compared to confirm whether the PSA was reduced to the preoperative anatomical PSA. The difference on posterior slope angle between intra-operation and post-operation was analyzed to explore the relationship of PSA between intra-operation and post-operation.

Functional outcome and safety concern between two methods

The curative effects of TKA closely correlate to the intra-operative osteotomy and the debonding of surrounding soft tissues. One of the key points of success is to recover the balance of soft tissues around the knee-joint. Except for the operative techniques of physicians, the prostheses were pretty important in the operations of TKA. The prostheses with minor size may furthest recover the functions of knee-joint. The main basis in choosing thighbone prostheses is keeping the knee-joint stable

The different between the surgeries

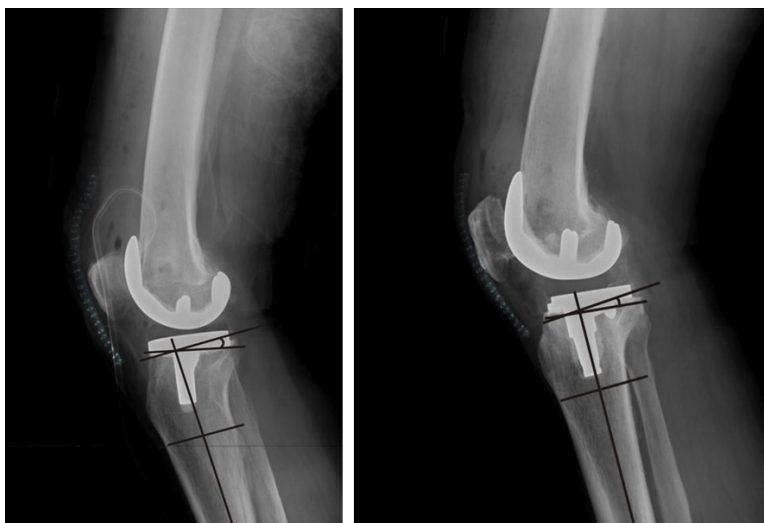


Figure 1. Posterior slop angle of post-operation in PS group (left); Posterior slop angle of post-operation in CR group (right).

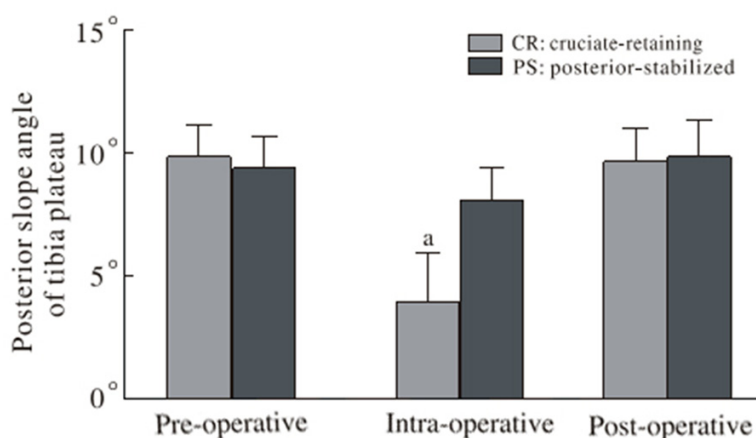


Figure 2. Comparison of posterior slope angle of pre- and postoperative between two groups (* $P < 0.05$, vs. post-operative).

when bend the knees. Only depending on the residuary natural bones of patients is impracticable, or it will make flexion gaps of knee-joint greater than the Swollen knee clearance thus cause the dislocation of knee-joint. If the patella should be replaced is mainly on the basis of the lesion of patelia or the state of patients' knee-joint. Patients with serve regression and partial dislocation or subluxation in patellofemoral joint are in need of replacing the patella; Patients (especially the elderly people) with thinner patella or slight regression in cartilage are not in need of replacing the patella, on the contrary, the replacement for those patients may cause the lability of the functions of joints

and poor post-operative effect. The main operating points for replacing the patella are that the thickness of the patella should be greater than 12 Rim after being excised, the thickness of patella replaced by prosthesis should be the same with the pre-operative thickness of patella, the excision line should be parallel with the surface of patella, and the patella should be placed in the inner side as far as possible.

The main complications after the operations of TKA are the infection and the deep vein thrombosis (DVT) in the lower limbs. For the sake of preventing the post-operative infection, prompt, standard and enough usage of antibiotic should be arranged, and the post-operative changes around the knee-joint and the vital signs of patients should be closely observed during the perioperative period. DVT is the result of multiple comprehensive factors, and the risk factors of the occurrence of DVT include that the application of tourniquet is long, the site of implementing the operation is in the site of bending the knee, partial tissues occur tumidness and

oppress the blood vessels, less limbs' activities cause the hypercoagulable state, the intracorporal blood vessels are damaged and the blood flow rate decends, the coagulation is activated, the functions of antithrombase recedes and the endogenous fibrinolysis system is restrained. Hense, patients with the above-mentioned risk factors should be promptly applied the anti-freezing drugs and antiplatelet drugs after the operations.

Statistical analysis

All experiments were independently performed in triplicate. Statistical analyses using analysis

The different between the surgeries

of variance (ANOVA) and Duncan's multiple range test for differences among different groups were performed with SPSS software version 20 (Chicago, IL, USA). Comparisons that yielded $P < 0.05$ were considered significant.

Results

In the CR group, the PSA was $9.66^{\circ} \pm 1.32^{\circ}$ and $3.94^{\circ} \pm 2.24^{\circ}$ for post-operation and intra-operation. The PSA was $5.73^{\circ} \pm 2.81^{\circ}$ higher in the post-operation than that in intra-operation; In the PS group, the PSA was $9.81^{\circ} \pm 1.54^{\circ}$ and $8.10^{\circ} \pm 1.27^{\circ}$ for post-operation and intra-operation. The PSA was $1.66^{\circ} \pm 1.43^{\circ}$ higher in the post-operation than that in intra-operation. The data showed there was significant difference for the PSA between the post-operation than that in intra-operation in the two groups (CR group: $P=0.00$; PS group: $P=0.00$). However, there was no significant difference between the posterior tilt angle in post-operation and tibial plateau angle intra-operation (CR group: $P=0.57$; PS group: $P=0.29$) which indicated postoperative tibial slope angle was substantially reduced to the preoperative anatomic tilting angle. The data was shown in **Figure 2**.

Discussion

With the increase of China's aging and osteoarthritis, joint replacement surgery entered a period of rapid development [9, 10]. Currently, the correct of the power lines and soft tissue surgery balance in knee replacement surgery is still one of the difficulties [11]. Therefore, the posterior slope angle of the tibial plateau prosthesis is gradually being valued by clinicians. In the recent study, a number of domestic and foreign research reports indicate that there was inter-individual difference in PSA. In this study, the PSA measured was $9.85^{\circ} \pm 1.25^{\circ}$. Kunwano's study showed that the PSA was $8.1^{\circ} \pm 4.0^{\circ}$ measured by CT 3D reconstruction system [12]. Yoo measured the tibial lateral slice with 5 different reference standards and the average was $10.6^{\circ} \pm 3.5^{\circ}$ [5, 13]. In Khattak's report, the PSA was $10^{\circ} \pm 4^{\circ}$ [13]. The specimen of adult knee joint, dry tibial and MRI of adult knee joints were used to measure PSA by Huang Wenhua et al [10]. The average value of PSA in the lateral position of the knee was $11.3^{\circ} \pm 4.4^{\circ}$ studied by Wenyan DU [14]. The posterior tibial plateau angle was $15.02^{\circ} \pm 4.2^{\circ}$ in Shudong zhang's study [15]. In addition,

there was still no uniform standard on the tibial osteotomy in TKA operation [16]. Wang Yehua et al. considered that the difference of the angle between the posterior tibial plateau was larger, and it should be measured before and after the surgery to make the posterior tibial osteotomy individual. Kansara and Markel considered that osteotomy of 0° and 5° had no effect on the activity of the knee joint [2]. However, a small number of cases would appear front dip angle with the 0° osteotomy compared with 5° osteotomy, so 5° osteotomy was considered to be safer.

Another study confirmed that the knee joint flexion function was best when the PSA of tibial prosthesis was $7^{\circ} \sim 9^{\circ}$ after TKA [17]. But in our hospital, it would result in 0 degree posterior tilt and the tibial plateau cartilage could be complete amputated during the knee replacement. Moreover, postoperative X-ray measurement displayed PSA was still within the normal physiological range. In face of this embarrassing situation, the prosthesis of CR (Gemini) and Johnson's PS (RP-F) were incorporated in this study. It can be seen that both the PS and CR groups were significantly different on posterior slope angle between intra-operation and post-operation (CR group: $P=0.00$; PS group: $P=0.00$) which means that the PSA of intra-operation could not be represented by that of the post-operation.

For the prosthesis involved in this study, postoperative tibial slope angle was substantially reduced to the preoperative anatomic tilting angle (CR group: $P=0.57$; PS group: $P=0.29$). So, it can be concluded that the PSA is basically accurate. For the case of the small deviation of the measurement, the main reasons are as follows after the analysis of prosthesis and major surgical procedures: (1) The choice of rear angle is not intuitive because of the use of external fixation of the tibia in the surgical instruments which resulted the choice error for the PSA; (2) The completely capture of tibial cartilage was as the standard which made more subjective influence factors for the surgeon; (3) There were errors in the device, so the measurement of PSA was not actual. Since the minor application of other knee prosthesis, it was difficult to achieve larger sample size. In this study, the research had some limitations owing to the reason that only Gemini and RP-F prosthesis were used. However, it does not

The different between the surgeries

affect the purpose of the present study. At the same time, as a single center prospective study, it also has some limitations such as the deficiency of specimens. Therefore, it still need the large sample, multi center, multi prosthesis model for the study of knee replacement surgery to provide a strong theoretical support for the select of prosthesis in knee replacement surgery

Disclosure of conflict of interest

None.

Address correspondence to: Yisheng Wang, Department of Orthopaedic Surgery, The First Affiliated Hospital of Zhengzhou University, No.1 of Eastern Jianshe Road, Erqi District, Zhengzhou 450000, Henan Province, China. E-mail: shijungao2015@163.com

References

- [1] Marouane H, Shirazi-Adl A and Hashemi J. Quantification of the role of tibial posterior slope in knee joint mechanics and ACL force in simulated gait. *J Biomech* 2015; 48: 1899-1905.
- [2] Kansara D and Markel DC. The effect of posterior tibial slope on range of motion after total knee arthroplasty. *J Arthroplasty* 2006; 21: 809-813.
- [3] Kuriyama S, Ishikawa M, Nakamura S, Furu M, Ito H and Matsuda S. Posterior tibial slope and femoral sizing affect posterior cruciate ligament tension in posterior cruciate-retaining total knee arthroplasty. *Clin Biomech* 2015; 30: 676-681.
- [4] Chiu KY, Zhang SD and Zhang GH. Posterior slope of tibial plateau in Chinese. *J Arthroplasty* 2000; 15: 224-227.
- [5] Yoo JH, Chang CB, Shin KS, Seong SC and Kim TK. Anatomical references to assess the posterior tibial slope in total knee arthroplasty: a comparison of 5 anatomical axes. *J Arthroplasty* 2008; 23: 586-592.
- [6] Chambers AW, Wood AR, Kosmopoulos V, Sanchez HB and Wagner RA. Effect of posterior tibial slope on flexion and anterior-posterior tibial translation in posterior cruciate-retaining total knee arthroplasty. *J Arthroplasty* 2016; 31: 103-106.
- [7] Zhang Y, Wang J, Xiao J, Zhao L, Li ZH, Yan G and Shi ZJ. Measurement and comparison of tibial posterior slope angle in different methods based on three-dimensional reconstruction. *Knee* 2014; 21: 694-698.
- [8] Okazaki K, Tashiro Y, Mizu-uchi H, Hamai S, Doi T and Iwamoto Y. Influence of the posterior tibial slope on the flexion gap in total knee arthroplasty. *Knee* 2014; 21: 806-809.
- [9] Ishida H, Suehiro T, Kurozumi C, Ono K, Ando S and Watanabe S. Correlation between neck slope angle and deep cervical flexor muscle thickness in healthy participants. *J Bodywork Movement Ther* 2015; 19: 717-721.
- [10] Schlatterer B, Linares JM, Cazal J, Merloz P and Plaweski S. Computer Assisted Orthopedic Surgery-France (CAOS-France). Posterior tibial slope accuracy with patient-specific cutting guides during total knee arthroplasty: A preliminary study of 50 cases. *Orthopaed Traumatol Surg Res* 2015; 101 Suppl: S233-40.
- [11] Chimento A, Saturnino C, Iacopetta D, Mazzotta R, Caruso A, Plutino MR, Mariconda A, Ramunno A, Sinicropi MS, Pezzi V and Longo P. Inhibition of human topoisomerase I and II and anti-proliferative effects on MCF-7 cells by new titanocene complexes. *Bioorgan Med Chem* 2015; 23: 7302-7312.
- [12] Kuwano T, Urabe K, Miura H, Nagamine R, Matsuda S, Satomura M, Sasaki T, Sakai S, Honda H and Iwamoto Y. Importance of the lateral anatomic tibial slope as a guide to the tibial cut in total knee arthroplasty in Japanese patients. *J Orthopaed Sci* 2005; 10: 42-47.
- [13] Khattak MJ, Umer M, Davis ET, Habib M and Ahmed M. Lower-limb alignment and posterior tibial slope in Pakistanis: a radiographic study. *J Orthopaed Surg* 2010; 18: 22-25.
- [14] Darrach SD, Miller MA, Ren D, Hoh NZ, Scanlon JM, Conley YP and Wagner AK. Genetic variability in glutamic acid decarboxylase genes: associations with post-traumatic seizures after severe TBI. *Epilepsy Res* 2013; 103: 180-194.
- [15] Lin L and Sun J. Adaptive conditional feature screening. *Comput Statist Data Analys* 2016; 94: 287-301.
- [16] Goyal N and Stulberg SD. Evaluating the precision of preoperative planning in patient specific instrumentation: can a single MRI yield different preoperative plans? *J Arthroplasty* 2015; 30: 1250-3.
- [17] Meric G, Gracitelli GC, Aram L, Swank M and Bugbee WD. Tibial slope is highly variable in patients undergoing primary total knee arthroplasty: analysis of 13,546 computed tomography scans. *J Arthroplasty* 2015; 30: 1228-32.