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The accuracy of two different extra-medullary tibial cutting guides for posterior tibial slope in total knee arthroplasty

Total diz artroplastisinde iki farklı ekstramedüller kesim kılavuzunun arka tibial eğimi sağlamadaki doğruluğu

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Objectives: This study aims to evaluate the effectiveness of two different external tibial cutting guides with and without a spike anchoring to the intercondylar eminentia to achieve a desired posterior tibial slope.

Patients and methods: Between January 2008 and December 2011, 120 posterior cruciate ligament protecting total knee arthroplasty (TKA) surgeries of 83 patients in which two different external tibial cutting guides used were included. Fifty-nine knees were included into the spiked and 61 knees were included into the spikeless cutting guide group. Posterior tibial slope angles were measured using the postoperative X-rays.

Results: There was no significant difference between two groups in terms of age, sex, and body mass indexes ($p<0.05$). While the mean postoperative slope angle was 2.66°±2.001°(range 0°-7°) in spiked group, it was 2.46°±2.277° (range 0°-7°) in spikeless group. Both systems had identical accuracy, indicating a low rate. The comparison of variances of two groups showed that both cutting guides had similar precision ($p=0.234$). There was no effect of body mass index on the results in both groups.

Conclusion: Although different extra-medullary tibial cutting guides with and without a spike can reproducibly impart a desired posterior tibial slope in TKA, we concluded that a spiked guide was considered user-friendly.

Key words: Cutting guide; external; posterior slope; tibial cut; total knee arthroplasty.

Amaç: Bu çalışmada interkondiler aralığa tespit edilebilen ve edilemeyen iki farklı eksternal tibial kesim kılavuzunun istenilen bir arka tibial eğim elde etmedeki etkinliği değerlendirildi.

Hastalar ve yöntemler: Ocak 2008 ile Aralık 2011 tarihleri arasında iki farklı tibial kesim kılavuzu kullanılarak, 120 dizine arka çapraz bağı koruyan diz protezi uygulanan 83 hasta çalışmaya dahil edildi. Elli dokuz diz tespit edilebilen, 61 diz ise tespit edilemeyen kesim kılavuzu grubuna alındı. Arka tibial eğim açıları ameliyat sonrası grafiler aracılığıyla ölçüldü.

Bulgular: Her iki grup arasında yaş, cinsiyet ve vücut kütle indeksleri açısından anlamlı farklılık yoktu ($p<0.05$). Ortalama ameliyat sonrası eğim açıları tespit edilebilen grupta 2.66°±2.001° (dağılım 0°-7°) iken, tespit edilemeyen grupta 2.46°±2.277° (dağılım 0°-7°) idi. Her iki sistem de birbirine benzer olarak düşük doğruluk oranına sahipti. Grupların varyans karşılaştırılmasında her iki kesim kılavuzu da benzer kesinliğe sahipti. Her iki grupta da vücut kütle indeksinin sonuçlar üzerine anlamlı bir etkisi bulunmadı.

Sonuç: Total diz artroplastisinde interkondiler aralığa tespit edilebilen ve edilemeyen ekstramedüller tibial kesim kılavuzları her ne kadar istenilen arka tibial eğimi benzer oranlarda sağlasa da, tespit edilebilen kesim kılavuzunun kullanıcı dostu olduğu kanısındayız.

Anahtar sözcükler: Kesim kılavuzu; eksternal; arka eğim; tibia kesimi; total diz artroplastisi.

Establishing the proper soft tissue balance, flexion-extension gap, alignment of the limb and the prostheses in both coronal and sagittal plane are the crucial factors for successful total knee arthroplasty (TKA) which is well-known to influence the joint kinematics and longevity of the implant.[1,2] Tibial cut which is well described is generally performed perpendicular to the mechanical axis in coronal plane.[1] Desired posterior inclination of proximal tibial cut is adjusted with using fixed angle cutting

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blocks that are available in a variety of angles by referencing anterior tibial cortex in the sagittal plane which is about 3 to 7 degrees in posterior cruciate retaining and 0 to 3 degrees in posterior-stabilized prosthesis.[1] However, the optimal operative technique for achieving desired postoperative alignment remains controversial.[3-5]

In the current study, we aimed to assess the accuracy and precision of two different extra-medullary tibial cutting guides with and without a spike anchoring to the intercondylar eminentia for achieving desired posterior tibial slope in total knee arthroplasty. We hypothesized that spiked extra-medullary tibial cutting guide had optimal accuracy and precision for achieving desired posterior tibial slope as it served ease of application by minimizing errors due to surgery.

PATIENTS AND METHODS

After obtaining permission from our institution's investigational review board, the postoperative lateral and anteroposterior radiographs of all primary cruciate retained TKAs by using two different tibial cutting system with and without a spike (Figure 1) done by the senior surgeon between January 2008 and December 2011 were enrolled to the study. Two types of prostheses were used in all patients. Spiked extra-medullary tibial guide had a cutting block of 7 degree posterior slope and these patients were designated as group 1 (n=59). Spikeless guide had a cutting block of 5 degree posterior slope and these knees were designated as group 2 (n=61).

Only primary knee arthroplasties were included. Patients were excluded if they had previous osteotomy or a requirement for a more constrained prosthetic design and augments. All radiographs were previewed with stringent criteria for adequacy. The radiographs were found to be suboptimal in 15 knees, mostly because of excessive rotation, imperfect centering at the knee joint, anterior bow of the tibia and insufficient images of the tibial shaft as considered by the bony landmarks in tibia. The radiographs in 120 knees of 83 patients were properly taken and considered to be suitable for measurements. There were 12 men and 71 women. The mean age in group 1 and 2 were 66.44±7.822 years (range 49-72) and 69.72±6.738 years (range 51-73) respectively. There were 66 right and 54 left knees. Diagnosis was osteoarthritis in 111 knees, rheumatoid arthritis in six knees, ankylosing spondylitis in three knees.

Two blinded reviewers had examined and measured the posterior tibial slope angles on all radiographs. The mean of two measurements was reported as posterior slope angle. The proximal anatomical axis of the tibia was drawn from the exact middle of the proximal tibia just distal to the tibial tubercle and the most distal points of the tibia where we can see on the lateral radiograph, which was previously described by Dejour and Bonnin.[6] A line drawn perpendicular to the anatomic axis of the tibia was defined as the reference line and represented 0 degree of slope. A line was then drawn parallel to the articular surface of the tibial component. The angle between the reference line and tibial component line was defined the tibial slope angle. If the slope proceeded from anterior-superior to posterior-inferior, it was defined as a posterior slope and was assigned a positive value. On the other hand, if the posterior tibia had higher elevation than the anterior tibia, then the slope was called an anterior slope and was given a negative value.

After then, the data were analyzed with the SPSS statistical software package version 15.0 for Windows (SPSS, Inc., Chicago, Illinois, USA). A power analysis

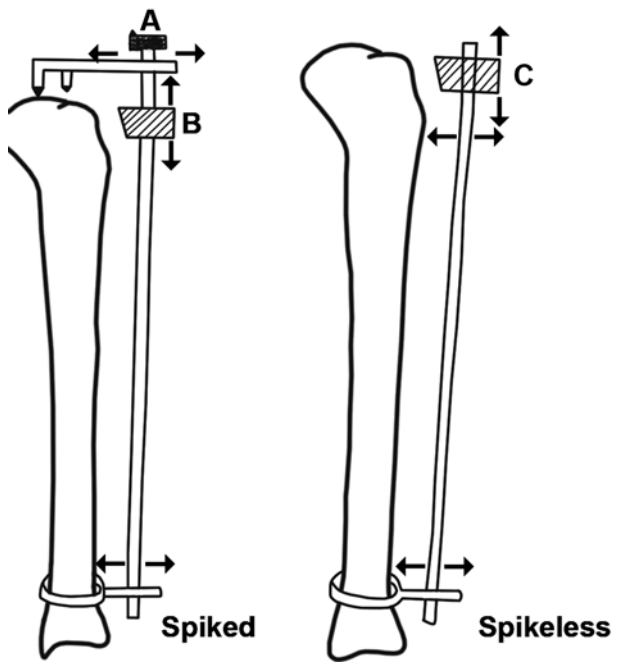

Figure 1. Schematic view of spiked and spikeless systems. In spiked external cutting guide, system additionally had been fixed proximally with a spike. Parallelism of the main rod is adjusted distally and proximally by moving it anterior and posterior. Finally it was fixed with bolds **(a)**. Deepening of the tibial cut was adjusted by using stylus and moving the cutting block **(b)** up and down. In spikeless system, while the distal rod fixation was performed as in spiked system, both parallelism of the rod and deepening of the tibial cut was performed by moving the cutting block **(c)** up-down, front and back with freehand technique. System stabilization and cutting block fixation were then completed with pins.

was performed to ensure that the study contained adequate number of patients. The groups were compared using Student t-test. Accuracy of the each extra-medullary cutting guide in terms of getting desired posterior tibial slope was evaluated with 1-tailed t test. A statistically significant difference between the mean postoperative tibial slope and the desired tibial slope showed that the method was not accurate. Precision and reliability of each extra-medullary cutting guide was evaluated by comparing the variances of postoperative slope angles of two groups with Levine test. Also slope angles within ±3 degrees of desired angles in each group was compared with Chi square test.

RESULTS

There was no statistically significant difference between two groups (p>0.05) in terms of age, body mass index and preoperative slope angles before surgery (Table 1). Use of 7 degree cutting block in group 1 resulted in a mean postoperative proximal tibial slope of 2.66°±2.001° (range 0-7 degrees), however; use of the 5 degree cutting block in group 2 resulted in a mean postoperative proximal tibial slope of 2.46°±2.277° (range 0-7 degrees). The comparison of each group in terms of accuracy for providing a desired postoperative slope with one-tailed t test revealed that spiked and spike-less systems had the identical accuracy, which was found to be low. The mean difference from the desired slope angle was -4.34 degrees for spiked extra-medullary cutting guide and -2.54 degrees for extra-medullary cutting guide without a spike. The differences were significantly different from the zero for both groups (p<0.05). With the use of Levine test, the comparison of variances of two groups showed that both cutting guides had similar precision. The difference between variances of two groups was not statistically significant (group 1: 4,004 vs. group 2: 5.184) (p=0.234) (Table 1). In group 1, 62% of patients were in ±3 degrees of desired slope and 71% of patients were in ±3 degrees of desired slope in group 2. There was no statistically significant difference between two groups (p=0.42). Moreover, high BMI values (>25 kg/m^2) did not have a statistically significant impact on the precision and accuracy of both systems (p>0.05). There was no difference between groups in terms of postoperative varus/valgus angles on the coronal plane.

DISCUSSION

The most important finding of our study is the equal accuracy and precision of both tibial cutting guides. In the literature, many studies have investigated the accuracy of bone cuts in TKA according to many conventional guide systems and navigation systems and comparison of them.[7-9] Each cuts in TKA has its own special science and each cut can affect the other cuts and potentially the outcome of the TKA.[10] While coronal alignment and clinical outcome has been extensively investigated, the ideal alignment in sagittal plane has been mostly overlooked.[11] The posterior slope of the tibial cut has several importance in a TKA procedure reported in the literature. It affects anteroposterior stability, range of motion and contact pressure within the tibio-femoral joint.[13-15]

Contrary to the prediction at the beginning of the study, both external tibial cutting guides with

TABLE I

Patient demographics and results

	Group 1 (Spiked)					Group 2 (Spikeless)					
	n	%	Mean±SD	Range	Degree	n	%	Mean±SD	Range	Degree	p
Patients/knees	40/59					43/61					
Age (years)		66.44		49-72			69.72		51-73		>0.05
Gender											
Female	36					35					>0.05
Male	4					8					
BMI (kg/m^2)	32.416					32.584					>0.05
Preoperative slope			8.42°±3.333°	8.10°-8.88°				9.57°±3.196°	9.44°-9.73°		>0.05
Desired slope					7					5	
Postoperative slope			2.66°±2.001°	0°-7°				2.46°±2.277°	0°-7°		>0.05
Percentage of knees within ± 3 degrees of desired slope		62					71				>0.05
Variances of two methods (precision)	4,004					5.184					0.234

SD: Standard deviation.

and without a spike were found in the identical accuracy in terms of achieving a desired posterior slope angle. Moreover, we did not find any effect and contribution of a spike embedded to the external guide for the precision of the system. Although our idea did not changed regarding the difficulties in the application of spikeless cutting system, we even did not find any effect of high body mass index to the final posterior tibial slope angle within and between two groups. We think that implementation of the system carefully and resetting the tibial cutting depth and parallelism in case of doubt will reduce the risk of error. Additionally, we found the accuracy of both systems low so the question mark appears about which system should we use instead for best sagittal alignment of the tibial component even some authors found the accuracy of external cutting guides low in terms of getting a desired posterior tibial slope.[16] Although some authors used computer navigation system and it seems to be good alternative over extra-medullary systems.[16] However controversy exists on the accuracy of the navigation systems over conventional ones. Thus, Kuzyk et al.[17] compared computer navigation and extramedullary guides for sagittal alignment of tibial components. They found that cutting block method (conventional system) was more accurate than the navigation system. Also they reported that the navigation system offers the highest precision. Similarly, several authors did not find any benefit of navigation system over extramedullary guides in terms of getting desired posterior slope.[18,19] In our study, we think that low accuracy of both cutting systems is a result of surgeon bias to avoide damage to the insertion point of posterior cruciate ligament.

The present study is unique in that all the surgeries were done during one decade by the senior surgeon (MB). However, it has some limitations. First, this is a retrospective study and relied on radiological evaluations based on lateral tibial radiographs, which cannot reproduce real planes for determining mechanical or other reference axes.[20,21] Second, the anterior bow of the tibia has the potential risk for errors in determination of its longitudinal axis. Positional factors, such as internal and external rotation and knee flexion, also affect the accuracy of alignment determined using simple radiographs.[22] Manual measurements of alignment on radiographs are also prone to errors.

In spite of these limitation, we believe that our study results sufficiently indicate that two different extra-medullary tibial cutting guides with and without a spike that anchors to the intercondylar eminentia can reproducibly impart a desired posterior tibial slope in TKA; however a spiked guide was considered user-friendly.

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