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Posterior Cruciate Ligament-preserving (CR) and Posterior Cruciate Ligament-cutting (PS) Total Knee Arthroplasty Surgery: Effects on Tibiofemoral Angle and Tibial Slope

Arka Çapraz Bağı Koruyan (CR) ve Kesen (PS) Total Diz Artroplasti Cerrahisi: Tibiofemoral Açı ve Tibial Eğim Üzerindeki Etkileri

Cengizhan Kurt[1], Mehmet Akdemir[2], Erol Kaya[3], Sercan Çapkin[1], Ali İhsan Kılıc[1]

[1]Izmir Bakirçay University Faculty of Medicine, Department of Orthopedics and Traumatology, Izmir, Türkiye
[2]Ekol International Hospitals, Clinic of Orthopedics and Traumatology, Izmir, Türkiye
[3]Medicana International Izmir Hospital, Clinic of Orthopedics and Traumatology, Izmir, Türkiye

Abstract

Objective: Discussions on optimal implant selection and surgical approaches in total knee arthroplasty (TKA) surgery are ongoing. There are differing opinions, particularly regarding the clinical and radiological outcomes of TKA procedures performed with preservation or resection of the posterior cruciate ligament (PCL). The aim of the study is to contribute to the surgical decision-making process in TKA based on the findings obtained.

Materials and Methods: The data of patients who underwent cruciate preserving (CR) or cutting (PS) TKA due to knee osteoarthritis in our clinic were retrospectively analyzed. Age and gender distribution, as well as radiological measurements taken from preoperative and postoperative radiographs, were evaluated. A total of 66 patients (ages 55-79) who underwent TKA (31 CR, 35 PS) between January 2017 and January 2023 were included in the study. Measurements were performed on preoperative and postoperative standing radiographs of the patients. Tibiofemoral angle and tibial slope values were evaluated.

Results: When the results of our study were analyzed, a statistically significant difference was found between the two groups in terms of age distribution (p=0.006), preoperative tibiofemoral angle (p=0.009) and postoperative tibial slope values (p<0.001).

Conclusion: The findings suggest that patient-specific evaluation is necessary when selecting the surgical technique, and that both methods can achieve successful outcomes in appropriately selected patient groups. Retaining the PCL to replicate the native knee may preserve proprioception and lead to improved knee scores in theory. So, the rehabilitation team needs to know this and act accordingly.

Keywords: Total knee arthroplasty, posterior cruciate ligament, tibiofemoral angle, tibial slope

Öz

Amaç: Total diz artroplastisi (TDA) cerrahisinde optimal implant seçimi ve cerrahi yaklaşımlar konusundaki tartışmalar devam etmektedir. Özellikle arka çapraz bağın (AÇB) korunması veya kesilmesi ile yapılan TDA uygulamalarının klinik ve radyolojik sonuçları üzerine farklı görüşler bulunmaktadır. Çalışmanın amacı elde edilen bulgularla, TDA uygulamalarında cerrahi karar sürecine katkı sağlamaktır.

Gereç ve Yöntem: Kliniğimizde diz osteoartriti nedeni bağ koruyan (CR) veya kesen tipte TDA uygulanmış hastaların verileri retrospektif olarak incelenmiştir. Yaş, cinsiyet dağılımları ile ameliyat öncesi ve sonrası dönemde çekilmiş grafileri üzerinde radyolojik ölçümler yapılmıştır. Çalışmaya Ocak 2017 ile Ocak 2023 tarihleri arasında TDA (31 CR, 35 PS) uygulanan 55-79 yaş aralığındaki toplam 66 hasta dahil edilmiştir. Hastaların ameliyat öncesi ve sonrası ayakta radyografilerinde ölçümler yapılarak, tibiofemoral açı ve tibial eğim değerleri değerlendirildi.

Bulgular: Çalışmamızın sonuçları incelendiğinde, ameliyatında AÇB'yi koruyan ve kesen tipte total diz protezi kullanılmış olan bu iki grup hastanın, yaş grubu (p=0,006), ameliyat öncesi tibiofemoral açı (p=0,009) ve ameliyat sonrası tibial eğim değerleri (p<0,001) arasında istatistiksel anlamda fark bulunmuştur.

Sonuç: Elde edilen bulgular, cerrahi teknik seçiminde hastaya özel değerlendirme yapılması gerektiğini ve her iki yöntemin de uygun hasta grubunda başarılı sonuçlar sağlayabileceğini göstermektedir. AÇB'yi koruyarak doğal dizi taklit etmek, propriosepsiyonun korunmasına ve teoride diz skorlarının iyileşmesine yol açabilir. Dolayısıyla, rehabilitasyon ekibinin bunu bilmesi ve buna göre hareket etmesi gerekir.

Anahtar kelimeler: Total diz artroplastisi, arka çapraz bağ, tibiofemoral açı, tibial eğim

Corresponding Author/Sorumlu Yazar: Lec, Cengizhan Kurt, MD, Izmir Bakirçay University Faculty of Medicine, Department of Orthopedics and Traumatology, Izmir, Türkiye
E-mail: cengizhankurt@yahoo.com **ORCID ID:** orcid.org/0000-0001-6395-5443
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Introduction

Osteoarthritis is a degenerative disease characterized by progressive cartilage destruction, osteophyte formation, subchondral sclerosis, synovium and a series of biochemical and morphological changes in the joint capsule, especially in weight-bearing joints, due to the effects of genetic, mechanical and biochemical factors. The knee is the most frequently affected joint symptomatically in osteoarthritis. Epidemiological studies conducted in various parts of the world have reported that 10-30% of people over the age of 65 have symptomatic knee osteoarthritis. Therefore, knee osteoarthritis is a significant health problem worldwide and this problem is increasing with the aging population (1,2).

Total knee arthroplasty (TKA) is a commonly used surgical method aimed at reducing pain and restoring joint function in patients with advanced-stage knee osteoarthritis. Advances in surgical techniques continue discussions on optimal implant selection and surgical approaches. In particular, there are different opinions regarding the preservation or resection of the posterior cruciate ligament (PCL) in TKA applications and their clinical and radiological outcomes (3,4).

Surgeons advocating for PCL preservation argue that this ligament supports natural knee biomechanics, providing more stable joint movements and a more natural knee functions for patients (5). On the other hand, some studies report advantages such as easier surgical application and long-term prosthesis stability when the PCL is resected. Among these approaches, whether factors like tibiofemoral angle and tibial slope play a role remains debated (6).

In this study, we retrospectively examined demographic and radiological data of patients who underwent both CR and PS TKA in our clinic. The statistical comparison of their effects on tibiofemoral angle and tibial slope has been conducted.

Materials and Methods

Ethical approval was obtained for the clinical study (Izmir Bakirçay University, decision no: 1210, research no: 1190, date: 27.09.2023).

Patients who underwent total knee prosthesis surgery in our clinic between January 2017-January 2023 and were diagnosed with primary knee osteoarthritis were retrospectively included in the study. AP and lateral knee radiographs were taken preoperatively and postoperatively.

Patients who underwent surgery outside of our clinic, underwent revision knee replacement surgery, underwent knee replacement surgery due to rheumatologic involvement or secondary osteoarthritis secondary to trauma, or lacked appropriate preoperative and postoperative radiographs were excluded from the study. A review of the criteria used to select patients at the clinic ensured that the patients who underwent total knee replacement surgery constituted a homogeneous group.

Demographic data (age, gender, side) of the patients were determined from hospital records. Measurements were made using the picture archiving and communication system on direct radiographs. Measurements were conducted on radiographs taken while standing preoperatively and postoperatively by two different physicians who participate in this study. The tibiofemoral angle and tibial slope values were evaluated (Figure 1).

Statistical Analysis

Statistical comparisons were made between the patients who underwent cruciate-retaining (CR) and posterior-stabilized (PS) knee prosthesis surgeries. The chi-square test was used to compare categorical data. The normality of numerical data distribution was tested (Shapiro-Wilk test). In cases like normal distribution criteria were met, parametric tests were applied; otherwise, non-parametric tests were used.

Results

A total of 66 patients were included in the study, consisting of 11 men (16.7%) and 55 women (83.3%). PS knee prosthesis was used in 31 patients (47.0%), while CR knee prosthesis was used in 35 patients (53.0%).

The average age of the patients was 66.89 years (range: 55-79). A total of 33 patients underwent surgery on the right side, 22 on the left side, and 11 on both sides (bilateral). Statistical comparisons revealed a significant age difference between the two groups. Patients who underwent CR knee prosthesis surgery were significantly younger (p=0.006, Mann-Whitney U test).

There was no significant difference in gender and side distribution between the two groups (p=0.912 and 0.225, Pearson chi-square test) (Table 1).

The mean preoperative tibiofemoral angle of the patients was 3.37° varus (range: -19° to +18°), while the mean postoperative angle was 5.56° valgus (range: -9° to +3°). Statistical analysis showed a significant difference in preoperative tibiofemoral angle values between the two groups. Patients who underwent PS total knee

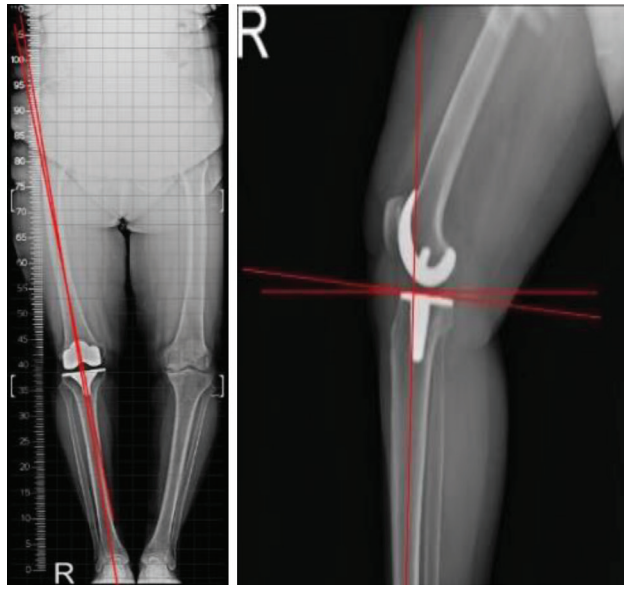

Figure 1. Measurement of tibiofemoral angle and tibial slope

prosthesis had a significantly higher tibiofemoral angle (p=0.009, Mann-Whitney U test). However, there was no significant difference in postoperative tibiofemoral angle measurements between the two groups (p=0.224, Mann-Whitney U test).

The preoperative tibial slope angle averaged 6.82° (range: 0-16°), while the postoperative angle averaged 2.91° (range: -3° to +11°). There was no significant difference between the two groups in terms of preoperative tibial slope measurements (p=0.941, Mann-Whitney U test). However, a statistically significant difference was found in postoperative tibial slope values between the two groups. Patients who underwent PS prosthesis had significantly higher postoperative tibial slope values (p<0.001, Mann-Whitney U test) (Table 2).

In summary, in our study, a statistically significant difference was found between the two patient groups who underwent posterior cruciate retaining (CR) and posterior stabilized (PS) total knee prosthesis in terms of preoperative tibiofemoral angle and postoperative tibial slope values in our study.

Discussion

This study focused on the evaluation of radiological results in patients who underwent CR and PS TKA. Our findings help us to choose the appropriate prosthesis for the patient during the preoperative evaluation and to plan the correct surgery, as well as to understand the potential effects of the selected prosthesis type on the radiological and functional outcomes of the patients in the postoperative period.

Different designs have been used during the development of knee prostheses, some of these designs were abandoned according to their clinical results, while some of them continued to be used, and their design and development continued to determine their current forms.

We can classify knee prostheses in different ways. They can be classified as protecting, cutting or stabilizing the PCL; cemented or uncemented, restrictive, semi-restrictive or non-restrictive, fixed or movable insert, patella-replacing or non-replacing, modular or non-modular (7).

It is difficult to say that there is a serious consensus on the necessity of preserving the cruciate ligaments and replacing the patellar component.

There is no significant difference in functional outcomes in terms of proprioception and gait analysis between prosthesis designs that preserve or cut the PCL. The type of prosthesis to be used in the patient's surgery depends on the surgeon's experience, preference and habit of using implants (8).

Some advantages of models that preserve the posterior cruciate ligament are the ligament's contribution to proprioception, greater preservation of bone stock, better imitation of knee kinetics, and less load on the prosthetic bone junctions due to less joint compliance (9).

Since prostheses that preserve the PCL allow for roll-back and have flatter insert designs, they offer a wider range of motion than prostheses that cut the PCL (10).

Table 1. Demografic features of the patients

		PS TKA		CR TKA		Total		p-value
Number of patients		31	47.0%	35	53.0%	66	-	-
Age		69.00	5.556 SD	65.03	5.628 SD	66.89	5.899 SD	**0.006***
Gender	Male	5	16.1%	6	17.1%	11	16.7%	0.912**
	Female	26	83.9%	29	82.9%	55	83.3%	
Side	Right	19	61.3%	14	40.0%	33	50.0%	0.225**
	Left	8	25.8%	14	40.0%	22	33.3%	
	Bilateral	4	12.9%	7	20.0%	11	16.7%	

SD: Standard deviation, *: Mann-Whitney U test, **: Pearson chi-square test, p-value <0.05 is considered statistically significant, PS: Posterior-stabilized, TKA: Total knee arthroplasty, CR: Cruciate-retaining

Table 2. Radiologic findings of the patients

	PS TKA	SD (range)	CR TKA	SD (range)	Total	SD (range)	p-value
Preoperative tibiofemoral angle	5.40	6.700 (-19, 18)	1.75	4.952 (-9, 12)	3.37	6.034 (-19, 18)	**0.009***
Preoperative tibial slope	6.86	3.499 (1-16)	6.80	3.897 (0, 16)	6.82	3.703 (0, 16)	0.941*
Postoperative tibiofemoral angle	-5.23	1.987 (-9, -1)	-5.82	2.285 (-9, 3)	-5.56	2.165 (-9, 3)	0.224*
Postoperative tibial slope	4.11	2.610 (-3, 11)	1.95	2.542 (-3, 10)	2.91	2.774 (-3, 11)	**<0.001***

PS: Posterior-stabilized, TKA: Total knee arthroplasty, SD: Standard deviation, *: Mann-Whitney U test, p-value <0.05 is considered statistically significant

Since soft tissue balance can be achieved more easily in prostheses that cut the PCL, they can be considered advantageous in this respect (11).

Posterior cruciate ligament incision is considered as a general principle in cases of knee arthrosis developing on the basis of rheumatoid arthritis, in cases with extreme varus-valgus deformity or extreme extension limitation, and in patients who have previously undergone patellectomy or high tibial osteotomy surgery (12).

TKA is an effective method for treating advanced-stage knee osteoarthritis. However, there is still ongoing debate about whether the PCL should be retained or sacrificed (13-16). In our study, we compared the tibiofemoral angle, tibial slope, and demographic characteristics of patients who underwent CR and PS knee prosthesis and revealed significant differences between the two groups.

In our study, the average age of patients who underwent CR prosthesis surgery was lower (p=0.006). Similarly, literature suggests that preserving the PCL in younger and more active patients provides more natural joint biomechanics and enhances knee stability (17). Conversely, it has been emphasized that the surgical technique for PS prostheses is more standardized, and especially in elderly patients, the need for ligament preservation is lower (18,19).

Radiological evaluation revealed a significant difference in preoperative tibiofemoral angle between the two groups (p=0.009). Patients who underwent PS prosthesis exhibited greater preoperative varus deformity. However, it was observed that this difference decreased in the postoperative values and was corrected regardless of the type of prosthesis. This situation reveals that in cases with high varus values in the preoperative measurements, it is necessary to plan with a prosthesis that primarily cuts the PCL. Our study also provided results that support the studies recommending the use of a prosthesis that cuts the PCL in the presence of advanced varus deformity (20).

Correct prosthesis selection and being compatible with the studies recommending cutting the PCL during surgical technique, eliminating the effect of the ligament against the correction of the deformity (21) and performing a very good medial release (22) are other similarities. Similarly, Bellemans et al. (23) observed that PS prostheses had more pronounced varus deformities. However, in the postoperative period, tibiofemoral angle correction was successfully achieved in both groups. In our study, no significant difference was found between the two groups regarding postoperative tibiofemoral angle values (p=0.224), suggesting that both techniques can yield successful outcomes with appropriate surgical planning.

Regarding postoperative tibial slope, patients with PS prosthesis had higher tibial slope values (p<0.001). This finding indicates that tibial cuts were made at a greater angle when the PCL was sacrificed. Bellemans et al. (23) reported that an increased tibial slope may compromise posterior stability and affect long-term outcomes. However, it has also been suggested that the greater tibial slope in PS prostheses could enhance postoperative range of motion (24,25).

Retaining the PCL to replicate the native knee may preserve proprioception and lead to improved knee scores in theory. So, the rehabilitation team needs to know this and act accordingly.

Study Limitations

Our study has some limitations. First, due to this retrospective method, ensuring complete homogeneity in patient selection and surgical techniques was not possible. Second, since our study focuses on radiological evaluation, future studies assessing long-term functional and clinical outcomes in different patient groups would be beneficial.

Conclusion

These findings suggest that surgical technique selection should be tailored to the patient, and both methods can yield successful outcomes in appropriate patient groups.

Ethics

Ethics Committee Approval: Ethical approval was obtained for the clinical study (Izmir Bakirçay University, decision no: 1210, research no: 1190, date: 27.09.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: C.K., Concept: C.K., E.K., Design: M.A., E.K., A.İ.K., Data Collection or Processing: E.K., A.İ.K., Analysis or Interpretation: M.A., S.Ç., Literature Search: C.K., S.Ç., Writing: C.K., M.A.

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