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ORIGINAL STUDY

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Which design tolerates rotational mismatch better in unicompartmental knee arthroplasty: fixed or mobile bearing?

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Unicompartmental knee arthroplasty is an effective method for the treatment of medial compartment osteoarthritis. However, appropriate surgical technique and optimum implant positioning are crucial for a satisfactory outcome. This study aimed to demonstrate the relation between the clinical scores and the alignment of the components in UKA. A total of 182 patients with medial compartment osteoarthritis and treated by UKA between January 2012 and January 2017 were enrolled in this study. Computed tomography (CT) was used to measure the rotation of components. Patients were divided into two groups according to the insert design. These groups were divided into three subgroups according to the angle of the tibia relative to the femur (TFRA) (A): TFRA 0° to 5° either internal or external rotation; (B): TFRA >5° internal rotation, and (C): TFRA >5° external rotation. There was no significant difference between the groups in terms of age, body mass index (BMI) and follow-up period. KSS scores increased as the tibial component rotation (TCR) external rotation increased, but there was no correlation for WOMAC score. (P: 0,039 r: 0,207; P:0,347 r:0,095, respectively) Post-operative KSS and WOMAC scores decreased as TFRA external rotation was increased. (p: 0,001; p:0,001, respectively) No correlation has been observed between femoral component rotation (FCR) internal rotation and post-operative KSS and WOMAC scores. (p: 0,261; p: 0,502, respectively) Any mismatch between the components is better tolerated by mobile-bearing designs compared to fixed-bearing designs. Orthopedic surgeons should take care of rotational mismatch of components, not only the axial alignment of the components.

Keywords: Unicompartmental knee arthroplasty; component rotation; tibiofemoral; rotational mismatch.

INTRODUCTION

Unicompartmental knee arthroplasty (UKA) is an effective method for the treatment of medial compartment osteoarthritis of the knee *(1,2)*. How-

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ever, appropriate surgical technique and optimum implant positioning are crucial for a satisfactory outcome *(3,4)*. Negligence of technical steps may end up in catastrophe. Particularly appropriate rotational positioning of implants is required for long-term survival and a mispositioned implant is a risk factor for early failure *(5,6)*. UKA has two basic designs: fixed and mobile bearing. Each design has its unique advantages and disadvantages *(7,8)*.

Studies on tibial and femoral rotations in UKA have demonstrated various results about the effect of fixed or mobile bearing designs on clinical results *(9,10)* The relation between tibiofemoral rotational mismatch and clinical results of UKA has been less studied. Inui et al. examined the correlation between tibiofemoral rotational mismatch and clinical results of UKA in mobile-bearing design and reported that tibiofemoral rotational mismatch in flexion has a considerable effect *(11)*.

In this study, we aimed to analyze the effect of rotation of femoral and tibial components relative to bony landmarks and mismatch of these components on clinical scores. We also evaluated the effect of the UKA insert design on clinical results in the presence of a rotational mismatch.

MATERIALS AND METHODS

The patients with medial compartment osteoarthritis of the knee who were treated by UKA between January 2012 and January 2017 were retrospectively evaluated. The patients were divided into two groups according to the insert design as fixed-bearing (ZIMMER®, Warsaw, Indiana, USA) and mobile-bearing (BIOMET®, Warsaw, Indiana, USA). Patients with shorter than 3 years follow-up period, patients who had wound problems and bilateral UKA, patients who had incomplete records, knees with fixed flexion of more than 15°, active knee joint infection, and patients who needed reinterventions due to complications or failure were excluded from the study. All patients enrolled in the study had varus knee alignment with medial compartment osteoarthritis and intact anterior cruciate ligament.

After exclusions, a total of 182 patients that met the eligibility criteria have been called for the last follow-up and computed tomography (CT) of their knees in full extension were obtained to measure the rotation of femoral and tibial components. Group I included 98 patients (70 female, 28 male) treated with fixed-bearing design and followed for a mean period of 4.3 years and Group II included 84 patients (58 female, 26 male) treated with mobile-bearing and followed for a mean period of 4.2 years. Both groups were divided into three subgroups according to the optimal angle of the tibia relative to the femur (TFRA) (A): TFRA 0° to 5° either internal or external rotation; (B): TFRA >5° internal rotation, and (C): TFRA >5° external rotation.

All patients were evaluated by KSS and WOMAC score preoperatively and at the last follow-up. The KSS and WOMAC questionnaires were applied by the same physiotherapist. The clinical evaluations were made at the preoperative period and the last follow-up. Each variable was compared between groups and subgroups. There were no selection criteria or randomization for using either fixed or mobile UKA.

All patients were operated by the same surgical team with the same surgical technique. All components were cemented for all knees. Patelloplasty and patellar denervation was preferred for all patients. No patellar implants were used for any of the patients. We used first generation instrument for mobile-bearing UKA. Firstly, a proximal tibial cut perpendicular to the mechanical axis was performed. Akagi line, tibial crest, and the midpoint of the ankle were used as references for tibial component rotation *(12)*. For tibial sizing, the tibial trial was placed against the osteotomized tibial plane to visually determine the maximum coverage of the osteotomized tibial plateau. Maximum cortical contact was aimed at the anterior-posterior and mediolateral planes when placing the tibial component. Trial components were used to check rotation. After the distal femoral cut was made, chamber and posterior femoral cuts were performed while the knee was in 90° of flexion.

All patients received identical rehabilitation protocols. Drains were removed 24 hours after the surgery. Range of motion (ROM) and walking exercises were commenced on the first postoperative day. Patients were followed for 3 months by phy-

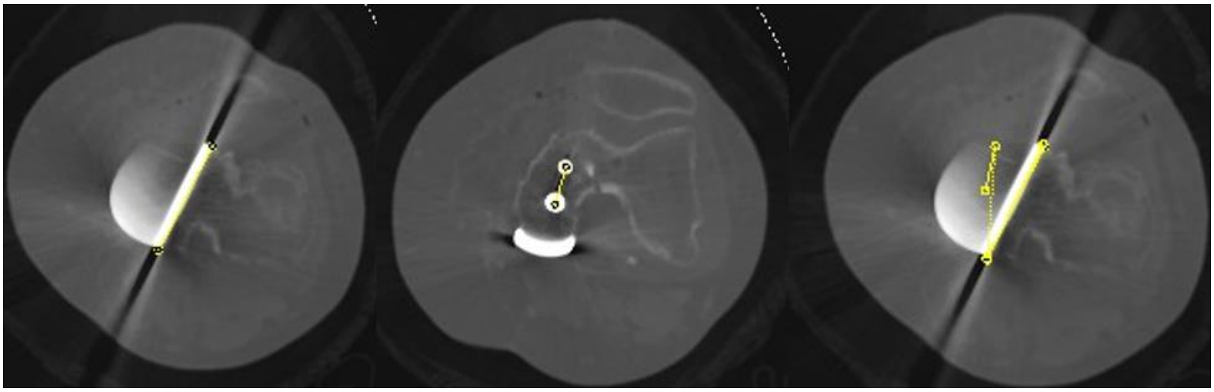

Figure 1. — The relative angle between the components; namely tibia-femur relative angle (TFRA) (the angle between the line combining two femoral pegs and the line formed by the lateral wall of tibial tray).

siotherapists using standard rehabilitation protocol.

Rotation of the tibial and femoral components was digitally measured from the images retrieved from CT scans obtained at the last follow-up and recorded as degrees. The slice thickness of CT scans was 0.6 mm, and a metal artifact removal software was utilized (256 slices multidetector scanner: Siemens®, Erlangen, Germany). Each CT image was evaluated by a radiologist specialized in the musculoskeletal system using Leonardo Dr/Dsa Va30a software (Siemens®, Erlangen, Germany). All images were also evaluated by double-blinded two orthopedic surgeons to decrease inter-observer and intra-observer errors. The femoral component rotation (FCR) angle was defined as the angle between the line combining two femoral pegs and the perpendicular line to the epicondylar axis *(11)*. Tibial component rotation (TCR) angle was defined as the angle between the line combining the medial border of the patellar tendon to posterior cruciate ligament (PCL) footprint (Akagi axis) and the lateral wall of the tibial tray *(12)*. The relative angle between the components; namely tibia-femur relative angle (TFRA) (the angle between the line combining two femoral pegs and the line formed by the lateral wall of the tibial tray (Fig. 1). TFRA >5° either internal or external rotation was accepted as a tibiofemoral mismatch. Positive values represented external rotation whereas negative values represented internal rotation.

Data were analyzed by SPSS 21.0 software. Percentiles with mean ± standard deviation were used for descriptive statistics. Student t-test was used for comparison of independent variables and paired t-test was used for comparison of dependent variables between the groups. A Chi-square test was used for the comparison of categorical variables. Pearson correlation test was used to evaluate the correlation of two continuous numeric variables $p<0{,}05$ was set for the level of statistical significance.

RESULTS

No significant difference was observed between the groups for age, body mass index (BMI), and follow-up period (Table I). There was no significant difference in gender distribution in the groups. (p= 0.726). A comparison of preoperative scores is given in Table II.

KSS scores increased as the TCR external rotation increased, but there is no correlation for WOMAC score. (p: 0,039 r: 0,207; p: 0,347 r: 0,095, respectively). Post-operative KSS and WOMAC scores are decreased as TFRA external rotation is increased (r: -0,815 p: 0,001; r:-0,667 p: 0,001, respectively) (Fig. 2). The best clinical results are observed in Subgroup A and worst clinical results in Subgroup B when compared to TFRA values (Table III). Subgroup 2b showed significantly higher clinical scores compared to that of subgroup 1b. (p: 0,001)

Table I. — Comparison of the groups in terms of age, body mass index (BMI) and follow up time

	Group	N	Mean	Standard. Deviation	*P value*
Age	Group 1	98	64,5306	5,28800	0,632
	Group 2	84	64,1548	5,24460	
BMI	Group 1	98	26,0622	1,75126	0,639
	Group 2	84	25,9488	1,51001	
Follow up time	Group 1	98	4,3265	0,91691	0,418
	Group 2	84	4,2262	0,75012	

Table II. — Comparison of the groups in terms of functional scores

	Group 1 (n=98)	Group 2 (n=84)	*P value*
Preoperative WOMAC score	30,9449	31,1702	0,743
Preoperative KSS score	32,1633	34,5238	0,002
Final control WOMAC score	86,4714	89,3357	0,001
Final control KSS score	84,9898	87,5119	0,015

Table III. — Comparison of the subgroups in terms of functional scores

	WOMAC SCORE			KSS SCORE		
	Group 1	Group 2	P Value	Group 1	Group 2	P Value
Subgroup A	91,2212	91,9404	0,168	90,6346	92,2128	0,001
Subgroup B	78,3765	83,2188	0,001	71,2353	78,1250	0,001
Subgroup C	82,7000	88,1667	0,001	82,9310	84,1429	0,127

Table IV. — Correlation of internal and external rotation of the femoral component with the KSS score

			Femur Rotation	Postoperative KSS score
External Rotation	Femur Rotation	Pearson Correlation	1	0,004
		Sig. (2-tailed)		0,960
		N	141	141
	Postoperative KSS score	Pearson Correlation	0,004	1
		Sig. (2-tailed)	0,960	
		N	141	141
İnternal Rotation	Femur Rotation	Pearson Correlation	1	-0,180
		Sig. (2-tailed)		0,261
		N	41	41
	Postoperative KSS score	Pearson Correlation	-0,180	1
		Sig. (2-tailed)	0,261	
		N	41	41

Post-operative WOMAC and KSS scores impro-ved as TCR internal rotation decreased (Fig. 3) (p: 0,001 r: 0,566; p: 0,001 r: 0,631, respectively). Similarly, post-operative WOMAC and KSS scores decreased as TFRA internal rotation is increased. (r: 0,918 p: 0,001; r: 0,847 p:0,001, respectively) (Fig. 2).

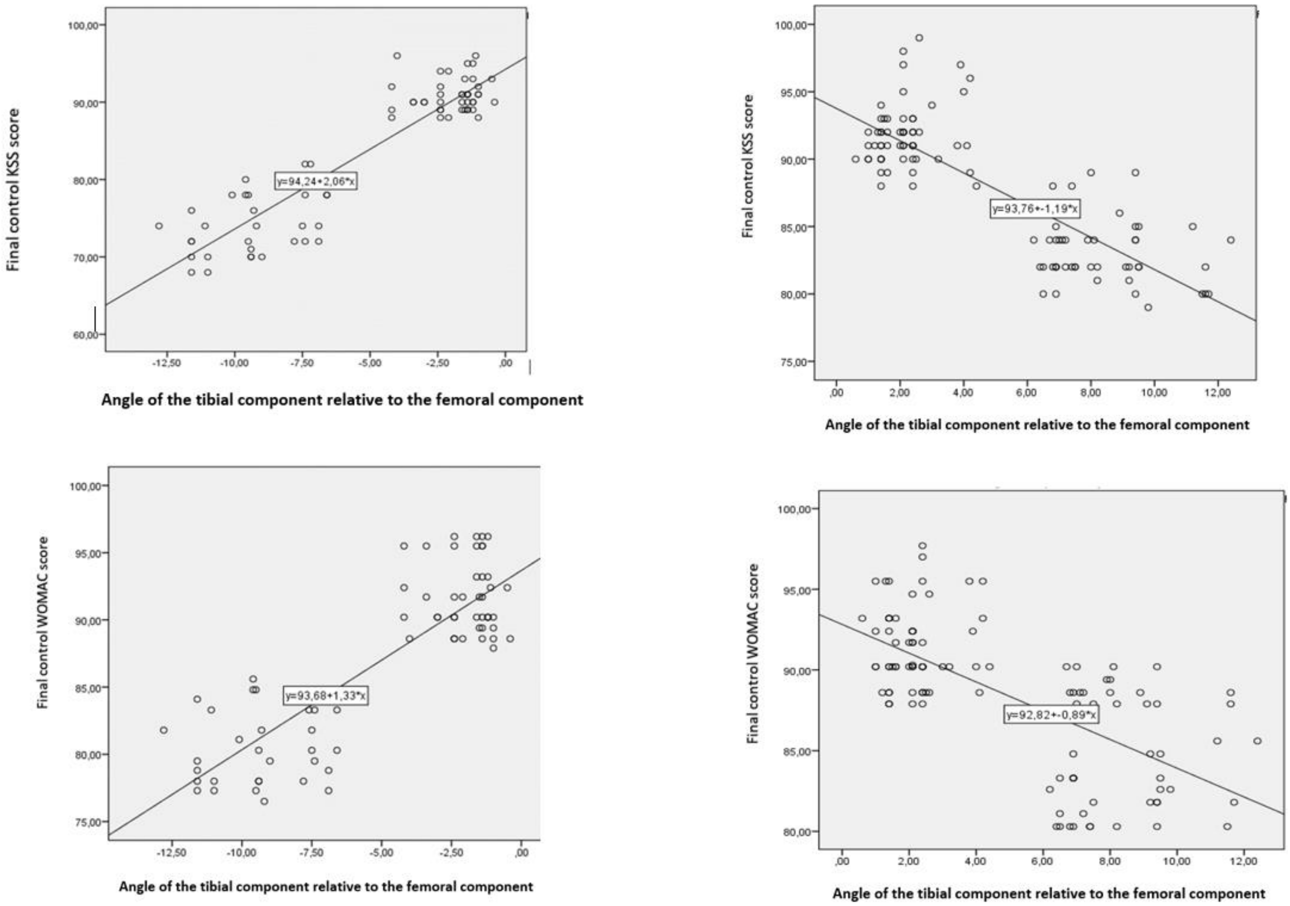

Figure 2. — The correlation between the angle of tibia relative to femur (TFRA) and clinical scores.

No correlation has been observed between FCR internal rotation and post-operative KSS and WOMAC scores. (p: 0,261 r: -0,180; p: 0,502 r: -0,108, respectively) There has been no correlation with FCR external rotation and post-operative KSS scores either. (p:0,960 r:0,004) (Table IV)

DISCUSSION

The most remarkable finding of our study was the improvement of clinical scores by the increase of rotational tibiofemoral congruency. Clinical scores were improved in patients with external rotation of the tibial component relative to the Akagi line. When there was a mismatch between the components clinical scores decreased even if the tibial component in external rotation. The worst scenario is the internal rotation of the tibia relative to the femoral component. This mismatch is better tolerated by mobile inserts compared to fixed-bearing tibial components.

The rotational mismatch between femoral and tibial components has been reported as one of the causes for poor outcomes in total knee arthroplasty *(13)*. However, there are few studies in the literature focused on the relative rotation of components in UKA *(11,14)*. We have evaluated the rotation of femoral and tibial components both relative to bony landmarks and each other and observed that tibiofemoral rotational mismatch has affected clinical scores.

Rotational measurements on radiographs are limited and less reliable compared to 2D-CT scans *(15)*. Shakespeare et al. have measured the rotation

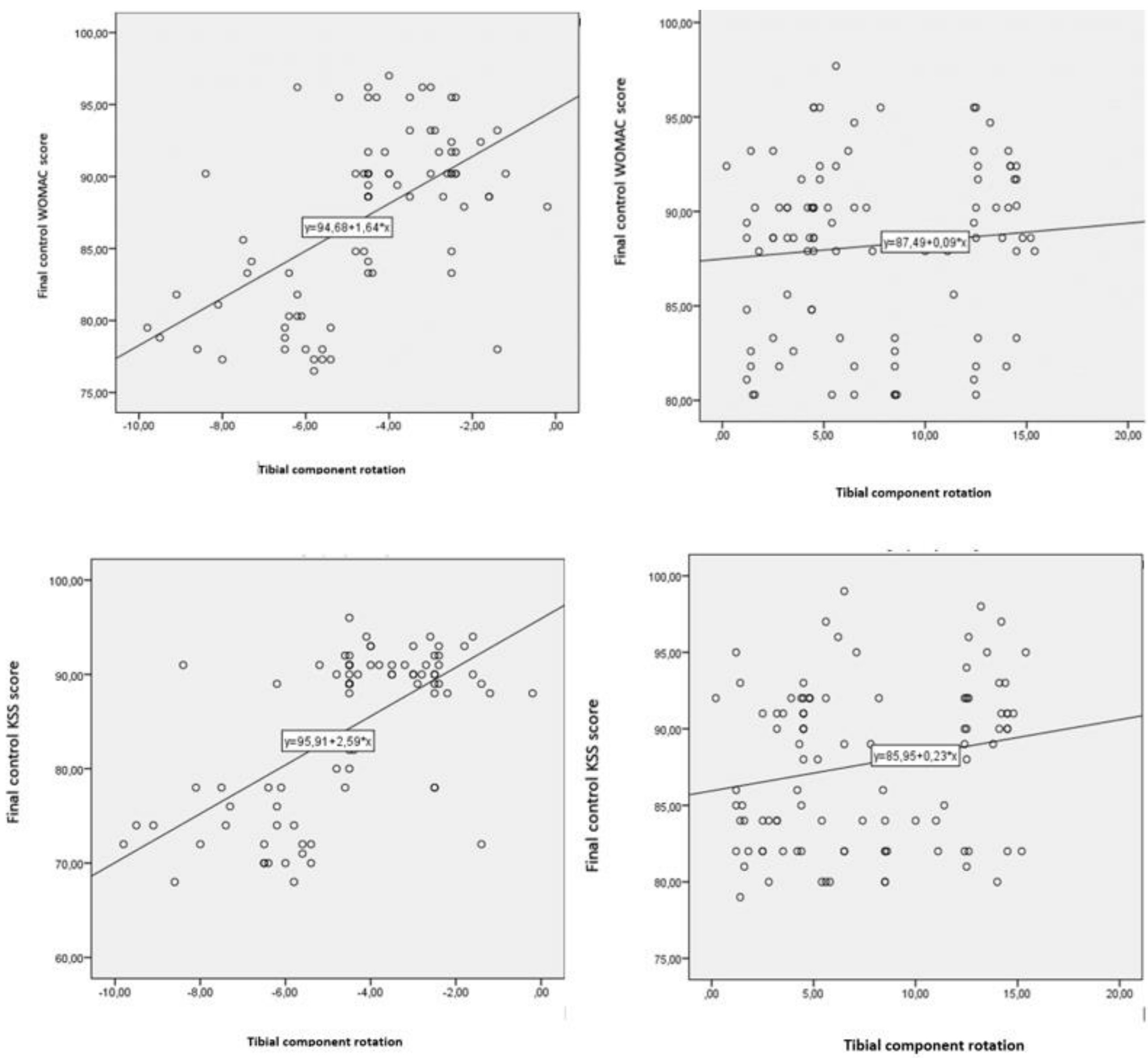

Figure 3. — The correlation between tibial component rotation and clinical scores.

of the tibial component indirectly from the position of the femoral component in full extension using simple radiographs *(14)*. In our study, we have used a CT scan with metal artifact removal software that allows more reliable measurement of component rotation. The images were obtained in full extension, and the rotational measurements were also performed in extension. In this study, clinical scores improved as the congruency of the tibial component relative to the femur has improved. The worst clinical scores are observed when the tibial component was in excessive internal rotation relative to both the Akagi line and femoral component. This mismatch is better tolerated by patients with mobile inserts compared to fixed inserts. However, in the study by Ozcan et al. fixed bearing design was reported to tolerate tibial rotation better *(9)*. In their study, Park et al. reported that mobile inserts were better tolerated this malalignment compared to fixed-bearing implants *(16)*.

Kamenaga et al. found that the Oxford Knee Score showed a negative correlation with postoperative higher angel of external rotation of the tibial component *(17)*. Inui et al reported that FCR and TCR do not affect clinical results in mobile-bearing UKA and proposed that excessive rotational mismatch between femoral and tibial components in knee flexion has been related to poor clinical results *(11)*. In the same study, they recommended avoiding excessive external rotation of the tibial tray in UKA. Small et al. have shown that more than 10 degrees of external rotation resulted in a high strain on the tibia in their biomechanical study and suggested that it may be related to poor results in excessive external rotation *(18)*. Iriberri and Aragon reported a mean external rotation of 11.9° (-1° to 32°) tibial component *(19)*. They observed that a neutral or slightly external rotated tibial component showed better results compared to one in excessive external rotation. The highest external rotation in our study is 15,4°. As we did not observe further degrees of external rotation, it is not possible to evaluate the effect of excessive external rotation on clinical results. However, we have found a negative effect of external rotation on clinical results.

Rotation of the tibial component has been studied in many studies *(2,9,12,15,17)* but there are few studies on the femoral component rotation *(10,20)*. Shakespeare et al. have determined that rotation of the femoral component has no effect on knee function as the center of the spherical component come closer to the center of rotation of medial femoral condyle *(14)*. In our study, we have evaluated both the rotation of the femoral component and tibial component, we found that rotation of the femoral component does not affect clinical scores.

This study has some limitations. The retrospective design of this study is the major limitation. Additionally, a relatively short follow-up period and performing CT measurements only in full extension are other limitations. Metal artifact reducing software that helped better evaluation of rotation by CT is the strength of this study.

CONCLUSION

Congruency between femoral and tibial component rotation is also important for UKA as it is in total knee arthroplasty. Any mismatch between the components is better tolerated in mobile-bearing designs compared to fixed-bearing designs. Orthopedic surgeons should take care of rotational mismatch of components, not only the axial alignment of the components. The results are better when the TFRA is between 5° internal rotation and 5° external rotation. According to our results external rotation of tibial component is suggestible.

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