Effect of the axial alignment of knee prothesis – relation of patient's satisfaction with clinical observations

Abstract

Introduction: Correct axial positioning of the prosthetic knee components remains challenging. In the current study, the effects of the axial alignment of the components on patient's satisfaction and functional outcomes after total knee arthroplasty (TKA) were investigated. It was investigated whether parallel axial axes of the components can affect the outcomes.

Materials & Methods: There were 89 TKA patients with correct coronal alignment investigated at least 1 year after the operation. Using CT scanning, the axial alignment of the components and prosthetic joint were evaluated. To measure the mismatch angle between the two axes, the related CT images were superimposed. The criteria for the correct axial alignment of the prosthetic joint included: 1) correct axial alignment of the femoral component; 2) correct axial alignment of the tibial component; and 3) parallel rotational axes of the components. Patient satisfaction was measured using the visual analogue scale (VAS). Further, the Knee injury and Osteoarthritis Outcome Score (KOOS) was completed.

Results & Discussion: The correct axial alignment of the femoral components and tibial components was found in 80.9% and 67.4% of knees, respectively. The correct axial alignment of the prosthetic joint was found in 35 patients (39.3%) and was not related to better KOOS and VAS scores. However, a mismatch >10° significantly decreased the KOOS and patient satisfaction (p<0.05).

Conclusion: The current study showed that a rotational mismatch > 10° between the axial axes of the prosthetic knee components is associated with poor functional outcomes and decreased satisfaction.

Keywords: Osteoarthritis of Knee- Total Knee Replacement- Patient Satisfaction- Knee Prosthesis.

Accepted: 41 days before printing

Dr. Ali Akbar Esmailiejah[1], Dr. Ali Mavaeian[1], Dr. Seyed Morteza Kazemi[1], Farshad Safdari[1,2], Dr. Babak Shekarchi[3]

1. Bone, Joint and Related Tissues Research Center, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
2. Department of Orthotics and Prosthetics, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.
3. Radiologist, AJA University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Dr. Ali Mavaeian
Email address:
dr.a.mavaeian@mail.com

Introduction

In spite of good outcomes of total knee arthroplasty (TKA), dissatisfaction after the surgery had been reported in one fifth of the patient[(1)]. Several factors may affect the results of TKA including patient factors, surgeon factors, types of prosthesis implantation, and alignment. Achieving the proper prosthesis alignment during TKA including the rotational alignment is essential for the stable function of the prosthetic knee and good outcomes[(2-4)].

Rotational malalignment of the components may result in altered knee biomechanics followed by poor outcomes, patellofemoral complications, pain, extension deficit, increased prosthetic wear and decreased survival rates[(5-8)]. Several anatomic landmarks and articular axes introduced to be used for correct implantation of the prosthetic knee components. However, correct positioning of the components in the axial plane, especially in the case of tibial component, is challenging and technically demanding.

Unfortunately, none of the anatomic references or intraoperative techniques has gained worldwide popularity and the most useful one resulting in the least rate of the rotational outlier and/or the least amount of the rotational mismatch between the two components remains controversial [(9-11)].

Currently, in spite of attempts made to optimize the component positioning, some patients may be found in orthopedic clinics who are not satisfied with the outcomes of TKA and malplacement, especially in the transverse plane (rotational alignment), can be clearly found on radiological evaluations.

It has been reported that 20% of TKA patients experience pain and functional disability[1-12], however, there are limited studies examining the effect of malalignment on the subjective outcomes[9-13]. The current limited knowledge regarding the clinically important amount of rotational mismatch between the components necessitate conduction of more studies. Furthermore, the effects of rotational alignment of the components or rotational mismatch on functional and subjective outcomes of TKA remains unknown.

The main goal of the current study was to investigate the relationship between the rotational mismatch of the components and the functional outcomes and satisfaction after TKA. The authors hypothesized that rotational malalignment has a direct effect on the patient satisfaction. Furthermore, it was attempted to determine the clinically important amount of the rotational mismatch which may affect the patient's satisfaction.

Materials & Methods

Between January 2016 and March 2017, 212 TKA surgeries were performed on 212 patients with a history of knee osteoarthritis (OA). The patients were operated on by two experienced knee surgeons through the anteromedial parapatellar or midvastus approaches using a posterior stabilized prosthesis (Zimmer, Warsaw, IN, US). All of the surgeries were performed based on the mechanical concept of knee arthroplasty. Before the operation the following angles were measured on x-rays: the varus angle, the medial proximal tibial angle, the lateral distal femoral angle and joint line convergence angle. One year after the operation, the patients were recalled and 153 of them volunteered to participate in the study. Of them, 59 patients were excluded due to secondary OA, a history of previous knee surgery, development of postoperative infection or ligamentous laxity and revision TKA. Finally, 109 patients were eligible and were asked to sign the informed consent.

Coronal alignment of the limb and components was measured on AP alignment view. The criteria for an acceptable coronal alignment were as follows:

- Hip-Knee-Ankle angle (HKAA)=180°±3°
- Horizontal joint line
- Parallel prosthetic articular lines.

Acceptable coronal alignment was found in 89/109 patients (81.6%) who were referred for CT scanning. The others were excluded. The CT scan was performed in supine position from the distal femoral metaphysis to the tibial tubercle in a thickness of 0.6 mm. The knees were fully extended. The feet were threaded together in a way to ensure the vertical alignment of the second ray.

Parameters measured on CT images

1. *Axial alignment of the femoral component:* the angle between the posterior condylar line (PCL) of the femoral component and the anatomical transepicondyle axis (aTEA). The correct axial positioning of the femoral component was defined as the parallelism between the PCL and the aTEA (Figure 1). 0° to 3° of external rotation was accepted as parallelism. The components with > 3° of external rotation or those with any degrees of internal rotation were recorded as outliers.

2. *Axial alignment of the tibial component:* the angle between Akagi's line (8) and the posterior tibial component line (PTCL). The positioning was correct if the angle measured 90° (Figure 2). Any internal rotation and >3° of external rotation was considered outlier.

3. *Rotational alignment of the two components related to each other:* two CT images showing the PTCL and PCL were superimposed. Parallelism was recorded if the angle between the two lines was measured 0°±3° (Figure 3). Other than two components were considered divergent.

The correct axial alignment was recorded if all the 3 measurements on CT were within the acceptable limits. All of the measurements were performed by one radiologist and two orthopedic surgeon using the specialized software of the CT system. The final value was the average of three measurements. In a pilot study, the intra- and inter-observer reliability of the examiners was >0.8. On the final visit, the Knee injury and Osteoarthritis Outcome Score (KOOS) was completed. Patient satisfaction was measured by visual analogue scale (VAS) ranged from 0 to 10. The higher numbers indicated higher satisfaction. These scales were compared between the patients with and without correct axial alignment. The patients were assigned into three groups of rotational mismatch: 0-3° (parallel group), 3-10° (moderate mismatch group) and >10° (severe mismatch group). KOOS and VAS scales were compared between these three groups.

Although the internally rotated femoral or tibial components were included in determining the incidence of outliers, however, these cases were excluded when the KOOS and VAS scores were compared.

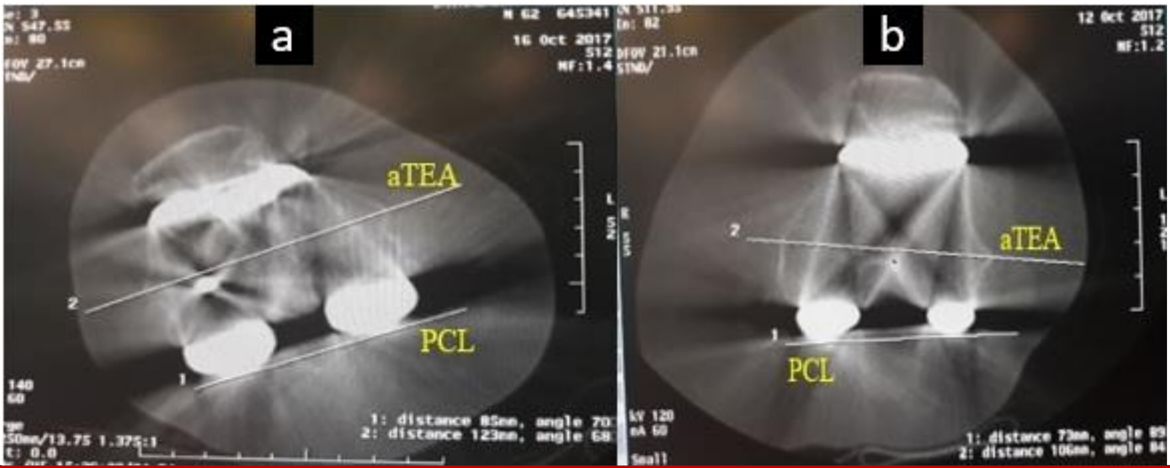

Figure 1: a) Correct rotational alignment of the femoral component: parallel posterior condylar line (PCL) and anatomical transepicondyle axis (aTEA). b) Incorrect rotational alignment of the femoral component: divergent PCL and aTEA.

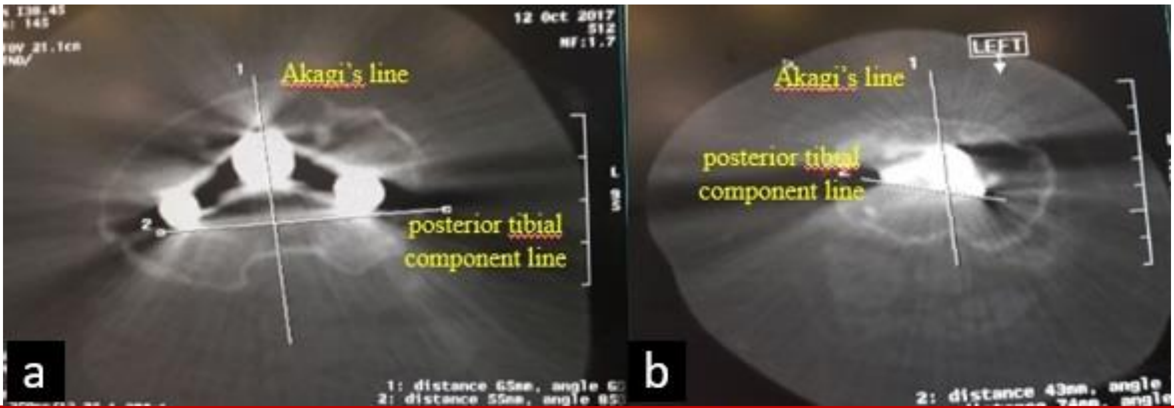

Figure 2: a) Correct rotational alignment of the tibial component: Akagi's line is perpendicular to the posterior tibial component line (PTCL). b) The angle between Akagi's line and the PTCL is less than 90 degrees.

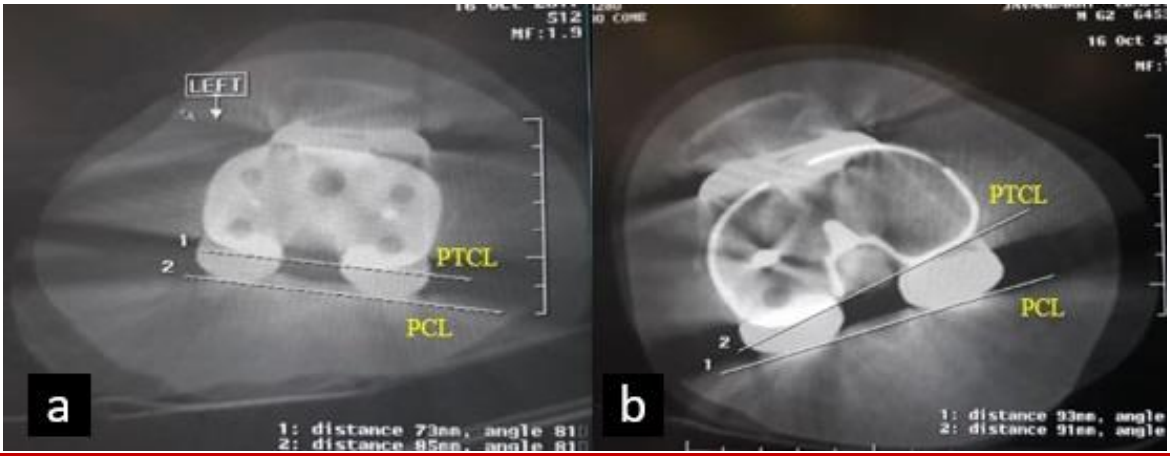

Figure 3: a) Parallel axial planes of the two components; the posterior condylar line (PCL) of the femur is parallel to the posterior tibial component line (PTCL). b) Divergent axial planes of the two components

Statistics

Data analysis was performed using SPSS statistical software ver.15.0. Intra- and inter-observer reliability was measured using Kapa coefficient. Independent-samples t-test was utilized to compare KOOS scales between the patients with and without correct axial alignment. KOOS scales were compared between the three mismatch groups using One-way ANOVA. VAS scores was compared using Mann-Whitney U test. Chi-square test was used to compare the nominal variables. P < 0.05 was significant.

Results

Table 1 summarizes the characteristics of the patients. Based on the CT measurements, 72/89 (80.9%) of femoral and 60/89 (67.4%) of tibial components were placed in the correct axial position. The incidence of femoral and tibial outliers was 19.1% and 32.6%. In 48/89 patients (53.9%), both of the components were placed in the correct position. In seven patients, the components were internally rotated (2 femoral components and 5 tibial components) which were excluded.

Table 1: The characteristics of the patients

No. patients		89
Age (y)		68.8 ± 6.3
Gender	Male	26 (29.2%)
	Female	63 (70.8%)
Body Mass Index (Kg/m^2)		29.4 ± 4.1

Figure 4 shows the incidence of parallel axial axes of the components among those patients with (48 patients) and without (41 patients) correct axial positioning of the both components. Parallelism was significantly higher when both components were in the correct position (72.9% Vs 24.4%, p<0.001). As is shown, the correct axial alignment was found in 35/89 patients (39.3%).

The KOOS scores were compared between 35 patients with and 47 patients without correct axial alignment. Although KOOS scores were higher in patients with correct alignment, the difference was not statistically significant (84.5±4.6 Vs 82.4±6, p=0.088). The same results were found when the VAS scores were compared (8±0.8 vs 7.6±1; p=0.068).

The mismatch angle ranged from 0-18°. There were 45/89 patients (50.6%), 29/89 (32.6%) patients and 15/89 patients (16.8%) in parallel, moderate mismatch and severe mismatch groups, respectively. After exclusion of patients with internally rotated components, KOOS scores were compared between the three groups as follows: parallel group (45 patients), moderate mismatch group (24 patients) and severe mismatch group (13 patients). The average KOOS was significantly lower in severe mismatch group (76.8±3.9) compared to the parallel group (84±5) and moderate mismatch group (85.6±4.5) (p<0.001). However, there was no significant difference between the patients in parallel group and moderate mismatch group (p=0.396) (Figure 5). Similar findings were achieved in term of patient satisfaction (VAS). The VAS score was significantly lower in the patients with severe mismatch group (6.9±0.9) compared to those without mismatch (7.9±0.8; p<0.001) and those with moderate mismatch (7.8±1; p=0.01). The VAS scores were the same in the latter two groups (p=0.703) (Figure 6).

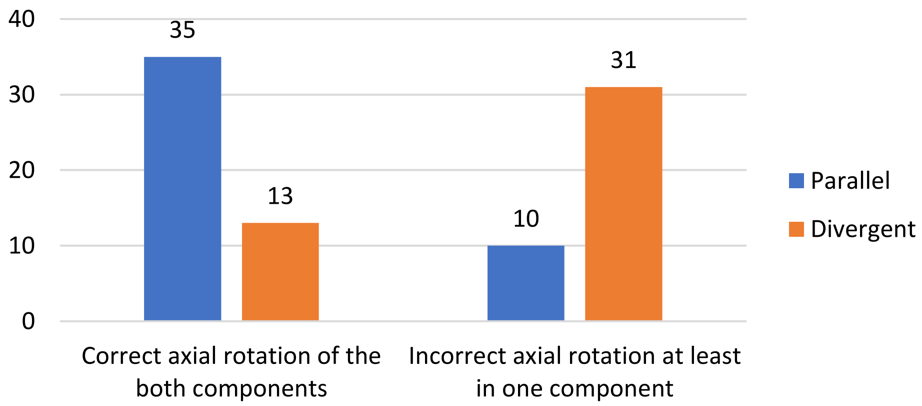

Figure 4: The frequency of the parallel axial planes in patients with the correct axial rotation of both components and those with incorrect axial rotation at least in one component.

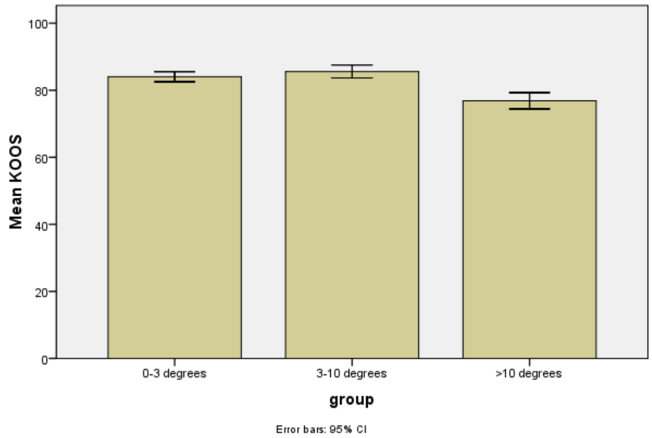

Figure 5: Comparing the KOOS scales between the patients with different degrees of axial mismatch between the two components ($p < 0.001$).

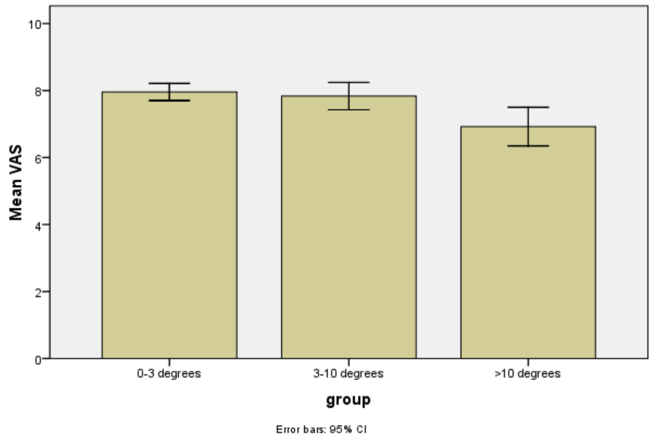

Figure 6: Comparing patient satisfaction (VAS) between the patients with different degrees of axial mismatch between the two components ($p < 0.001$).

Discussion

In recent decades, the attitude to the proper prosthetic knee joint have changed dramatically. Lotke and Ecker, in 1977, concluded that optimal results were obtained when the limb was at 3°-7° valgus after TKA[2]. In 1978, Denham and Bishop reported that the weight-bearing line should pass through the center of the tibia, the femoral component should be placed at 7°±4° of the valgus relative to the femoral anatomical axis and the tibial component at 90°±4°[14].

After that, neutral alignment was challenged. In a retrospective cohort, Salzmann et al., in 2017, showed that 3-6° of residual varus had no negative effect on TKA outcomes in individuals with varus OA[15].

There is ample evidence that the varus component position causes a reduction in the survival rate[2,8]. Fang et al. are proponents of valgus alignment in the range of 3.5°-7.5°[16]. But limb residual valgus may increase the revision rate by increasing MCL laxity[16]. Anyway, the components should be parallel to the horizontal line in the coronal plane and perpendicular to the mechanical axis of the limb, even in the kinematic alignment. The neutral coronal alignment was considered as a prerequisite for enrollment in the current study resulted to exclusion of about 19% of the patients.

The normal sagittal alignment was found in all of our patients. None had femoral bowing and consequent flexion contracture[17]. Moreover, the femoral component was not placed in excessive flexion (>3°). The tibial component had a suitable slope considering the type of prosthesis implanted.

Several landmarks and techniques introduced for femoral component placement in axial plane. Unfortunately, the problem of malrotation persists despite the introduction of new techniques such as patient-specific instrumentation (PSI) and computer-assisted surgery. Victor has compared the component positioning and knee stability between the measured resection technique (anatomical landmarks) and gap technique. The author points to the changing anatomic landmarks with the progression of OA and the effects of femoral condyle hypoplasia on the placement of the femoral component and recommended using both techniques and some key points included maintaining the medial joint line, avoiding the overcorrection of existing deformity and oversizing and more precise measurement[18]. In the current study, the gap technique, measured resection technique and other landmarks were considered depending on the patient A common method for measuring femoral component rotation is to measure the angle between the component PCL and TEA, which was used in the current study. It was tried to fix the femoral component in 3° of external rotation but 0-6° external rotation was acceptable. The femoral component axial alignment was acceptable in 80.9% and the outlier rate was 19.1%. It should be noted that only in 2 patients (2.2%), the femoral component was internally rotated. Table 2 compares the rate of femoral component outlier between the current study and some of the previous studies[9-11,19-21].

Table 2: Summary of some of the previous studies in which the rate of femoral component outlier in axial plane was investigated.

Author (year)	The Main Purpose	No. patients	Method of axial placement of the femoral component	Method of FCR measurement	Definition of outlier	Percentage of outlier or mean of axial rotation	Comments
Abdelnasser et al (2019)[9]	To determine if there is correlation between primary TKA malalignment and early patient-reported outcome measures	60 patients	-	The angle between sTEA and PCL of the femoral component (posterior condylar angle)	Neutral rotation of the femoral component was defined as 0.3° to 3.5° Int. Rot. in relation to the sTEA. Posterior condylar angle outside this range was defined as outlier.	neutral: 16 (26.7%) Int. outliers: 16 (26.7%) Ext. outliers: 28 (46.6%)	-
Yau et al (2007)[16]	Comparing the precision of TEA, Ext. Rot from PCL, Whiteside line and gap technique	25 TKAs using computer navigation System	TEA, Ext. Rot from PCL, Whiteside line and gap technique	-	An error of >5° from neutral alignment	TEA: 56% PCL: 72% WSL: 60% GAP method: 20%	The outcomes was derived based on navigation system.

Victor et al (2014)[17]	Comparing the component alignment and overall coronal mechanical alignment between PSI and CVI	64 patients in each group	FCR was set parallel to sTEA.	The angle between the sTEA and the tangent to the PCA on CT.	More than 3° from the target in any plane	PSI: 23% CVI: 17.2% Total: 20.3%	-
Woolson et al (2014)[18]	Comparing the postoperative component alignment in a RCT between PSI and CVI	PSI: 22 knees CVI: 26 knees	CVI: a plane parallel to the posterior femoral condyles or to TEA on CT. PSI: N. E.	TEA	More than 3° from the correct orientation in each direction	PSI: 27% (6/22) CVI: 46% (12/26) Total: 37.5% (18/48)	-
Paratte et al (2013)[19]	Comparing the rotation between CVI and PSI	20 patients in each group	TEA	-	-	PSI: 20% in Int. Rot. CVI: 35% in in Int. Rot. Total: 17.5% in in Int. Rot.	In other patients the femoral component was placed in 0 to 3 degrees of external rotation.
Aunan et al (2017)[20]	Evaluating the accuracy and variability of the clinical rotational axis method	80 knees	Clinical rotational axis method	The FCR was compared with the sTEA on CT	-	Int. Rot. in 36%.	Deviation > 1° was found in more than half of the patients.
The current study	Evaluating the relation between axial alignment of the components and the outcomes of TKA	89 patients	Different methods including the gap technique, measured resection technique	The angle between PCL of the femoral component and cTEA on CT	- Deviation > 3° of Ext. Rot - Any degree of internal rotation	19.1%	-

RCT: randomized clinical trial; PSI: patient specific instrumentation; CVI: conventional instrumentation; TEA: transepicondylar axis; sTEA: surgical transepicondylar axis, cTEA: clinical transepicondylar axis; PCL: posterior condylar line; PCCPTC technique: the posterior-condylar-cut-parallel-to-the-tibial-cut technique; N.E.: not explained

Positioning the tibial component is more complicated. Anatomic landmarks and intraoperative techniques had been proposed. Among the anatomic landmarks, the tibial tubercle (medial edge or medial one-third), Akagi's line (medial tibial tubercle to the middle of the posterior cruciate ligament insertion), the mediolateral transverse axis (the most prominent point of the medial arch to the most prominent point of the lateral arch) and the anterior tibial border (ATB) are more prevalent[5,22-24]. Although it remains controversial, however, Popescu et al demonstrated that Akagi's line and anterior tibial cortex are the most accurate and reliable anatomical landmarks[25]. The problem while the anatomic landmarks are used is the variability of the tibial tubercle location in knee deformities. Also, the level of bone cut during the operation may change the desired points. ATB seems to be more reliable than others. However, this line is also difficult to find and is mostly used when symmetric components are inserted. This line is often obscured in advanced osteoarthritis due to the formation of numerous osteophytes and a deformed plateau of the tibia.

All intraoperative methods are based on the creation of conformity in sagittal plane between the tibial and femoral components. The results depend on the accurate positioning of the femoral component[5]. Furthermore, it is possible that some unknown factors such as the tension of the soft tissues affect the alignment of the tibial component in addition to the femoral component. Dynamic methods are more suitable for knees with low deformity and PS prostheses. Recently, Innocenti et al described a technique using a smart insert sensor for rotational placement of the tibial component reciprocally to a fixed femoral component rotation. The authors demonstrated that this technique reduced the rate of rotational outliers[4]. In the current study, any of the possible methods or a combination of them were used.

Several methods had been introduced for measurement of the tibial component rotation including measurement of the angle between the femoral TEA and the mediolateral axis of the tibial baseplate, the angle between the tibial TEA and the line tangent to the tibial keels, Burger method and the anteroposterior axis (Akagi's line to the posterior border of the tibial component)[9,23,26-30]. However, in the current study, the last one was utilized.

Currently, there is no method known as the gold standard for measuring the rotation of the tibial component which is more important in a painful TKA revision surgery.

The outlier of the tibial component was 32.6%. In five patients, the tibial component was internally rotated (5.6%). In the previous studies utilizing different methods for implantation of the tibial component and measurement of its rotational alignment has been reported between 5.4% and 95% (Table 3)[9,20,22,28,31].

Table 3: Summary of some of the previous studies in which the rate of tibial component outlier in axial plane was investigated.

Author (year)	The Main Purpose	No. patients	Method of component placement	Method of TCR measurement	Definition of outlier	Percentage of outlier or mean of axial rotation	Comments
Abdelnasser et al (2019)[9]	To determine if there is correlation between primary TKA malalignment and early patient-reported outcome measures	60 patients	-	Berger's protocol; The angle between the tibial tuberosity axis and the tibial component axis	The angle out of 18° of Int. Rot.	- Normal Rot: 28 (46.6%) - Int. Rot outliers: 22 (36.6%) - Ext. Rot outliers: 10 (16.8%)	-
Indelli et al (2015)[21]	The effects of modern tibial baseplate designs on rotational alignment of the tibial component was investigated	Group 1: 40 patients with a PS symmetric tibial baseplate Group 2: 40 patients with a PS anatomical tibial component	anterior tibial cortex	sTEA	-	Symmetric: 1.3° of ext.rot 91% placed in 0±3° internally rotated in 20% Anatomical: 4.1° of ext.rot 47.5% placed 0 ± 3ο externally rotated in 100%	-

Berhouet et al (2011)[27]	To measure the tibial baseplate positioning in the transverse plane with respect to the femoral component	- 50 varus knees (7.8◦ varus deformity) - 44 valgus knees (8.7◦ valgus deformity)	self-positioning technique	1) The angle between aTEA and the posterior marginal axis of the tibial prosthesis; 2) The angle between the posterior marginal axis of the tibial prosthesis and the posterior marginal axis of the tibial bone	-	Genu varum group: 1) 1.9◦ int.rot relative to aTEA; 2) 6.1◦ ext.rot relative to the native tibia Genu valgum group: 1) 3° int.rot relative to aTEA; 2) 12.5° ext.rot relative to the native tibia	-
Paratte et al (2013)[19]	Comparing the rotation between CVI and PSI	20 patients in each group	the anterior tibial tuberosity and according to best fitting with the anterior cortex	-	-	PSI: 75% in Int. Rot CVI: 95% in Int. Rot Total: 85% in Int. Rot	In others the tibial component was placed in 0-15° of Ext. Rot.
Heyse and Tibesku (2015)[25]	Investigating the effects of using PSI in positioning of tibial components in optimal rotational alignment	PSI group: 30 patients CVI group: 28 patients	-	The angle of three lines with a tangent to the tibial keel was used: 1. A tangent to the dorsal tibial condyles; 2. The tibial TEA; 3. The tibial tubercle	> 9° ext.rot or > 1° int.rot	Method 1: - CVI group: 28.6% in Ext. Rot and 5.4% in Int. Rot - PSI group: 6.7% in Ext. Rot Method 2: - CVI group: 21.4% in Ext. Rot and 4.4% in Int. Rot - PSI group: 6.7% in Ext. Rot Method 3 showed poor reproducibility.	-
The current study	Evaluating the relation between axial alignment of the components and the outcomes of TKA	89 patients	Self-range of motion technique while considering anatomic landmarks and curve-on-curve technique	Akagi's line	- Deviation >3° of Ext. Rot - Any degree of internal rotation	32.6%	-

Iranian Journal of Orthopaedic Surgery
Vol. 21, No. 4 (Serial No. 83), Autumn 2023, p. 122-133

There was no preoperative evaluation performed to predict patient satisfaction. In addition, the patients were not asked about why they accepted to undergo TKA; pain intensity or disability[1]. At the last postoperative visit, the two questionnaires were completed by a neutral orthopedic researcher.
The data were analyzed in two manners. At first, data were compared between those with and without correct axial alignment (correct rotation of the femoral and tibial components, parallelism of the two components). Although, KOOS and VAS scores in the first group were better than the second one, but the difference was not statistically significant. This finding indicates that there may be other factors affecting the patient satisfaction, such as perioperative factors, patient-related factors and patient expectation.
In recent years, much attention has been paid to the parallelism between the rotational axis of the femoral and tibial components. Since, in the second analysis, the effects of rotational mismatch on KOOS and VAS scores were investigated. The scores were compared between the parallel, moderate mismatch and severe mismatch groups after exclusion of patients with internally rotated components. The average KOOS score in the severe mismatch group was significantly lower than the other two groups. Furthermore, comparison of VAS scores (patient satisfaction) obtained similar results. The VAS score was significantly lower in the severe mismatch group indicating that a considerable rotational mismatch can decrease the patient satisfaction. However, there was no statistically significant difference between the other two groups in terms of KOOS and VAS scores. This finding shows that rotational mismatch can influence TKA results, only when it is >10°.
In previous studies, with different definitions and methods of measuring the rotation, the frequency of rotational mismatch has been reported up to about 38%[32]. Recently, Kawaguchi et al found that the mean rotational mismatch between components was 1.8° of internal rotation of the tibial component relative to the femoral component (range: 11.3° of internal rotation to 7.3° of external rotation)[33]. In 2012, Harman et al. showed that 0-5° of rotational mismatch in any direction had no effect on knee function, while values outside this range could seriously affect knee kinematics[34]. Like to the current study, Lutzner et al. showed that rotational mismatch above 10° could adversely affect knee kinematics and clinical outcomes[35]. Nicoll and Rowley reported that a mismatch >11° may result in a painful TKA[32]. Hernandez-Hermoso et al demonstrated that the presence of minimal rotation between the two components, small femoral component external rotation and small tibial internal rotation predicts a successful TKA[30]. However, the knowledge about the effects of rotational mismatch on the results of TKA is still limited and more studies should be conducted.
When the data of the current research was completed at 2017, the authors decided to use the rotational mismatch above 10° as a cut-off point for revision surgery, but for some reasons, they were not able to publish their results. However, to date there is no consensus about the amount of mismatch necessitating the revision surgery.
There may be several factors other than prosthetic and limb alignment affecting the patient satisfaction after TKA. Several perioperative factors and patient factors, specially the patient's expectations, may contribute to the final outcomes. However, many of the patient factors such as age, BMI, personality, gender and severity of the OA are not in the surgeon's authority, while the patient insight to the surgery and his/her expectations of the surgical outcomes can be manipulated and guided in the right direction before the operation. There are some reports indicating the importance of patient expectation as the main factor affecting the postoperative patient satisfaction[1,36].
However, the current study showed that one of the perioperative factors which may negatively affect the patient satisfaction is the mismatch >10° while mismatch up to 10° may not be important. These values of mismatch may necessitate early revision surgery if their adverse effects are exacerbated by other adverse factors. Accordingly, although it is necessary to improve the surgical techniques and perioperative setting and respect the surgical indications, but preoperative talking to the patient about the goals of the surgery and the amount of improvement which may be achieved is crucial to bring his/her expectations closer to reality.
Finally, the following points should be considered as the key points of the discussion:

- TKA is a major orthopedic surgery with good outcomes and high patient satisfaction which can be improved.
- Surgeons are more satisfied than patients in TKA surgery.

- The rate of patient satisfaction largely depends on the surgeon and can be raised with more care and research.
- Among the patient factors, the patient expectation seems more important than the others. Unreasonable expectations can negatively affect the patient satisfaction.
- Preoperative informing of the patients about the surgical goals and outcomes play an important role in prevention of postoperative patient dissatisfaction.
- It is necessary to perform TKA before destruction of the anatomic landmarks due to the progression of osteoarthritis.

The main limitation of the current study was that the patient motivation for TKA was not investigated. Furthermore, there is still no completely valid and reliable instrument to investigate the patient satisfaction after the surgery. Although the scales used in the current study are prevalent, however they bear their own flaws.

Conclusion

Axial malrotation was found in a considerable percentage of tibial components. It seems that rotational mismatch >10° may lead to the impaired functional outcomes and decreased patient satisfaction. However, rotational mismatch up to 10 degrees is acceptable.

References

1 Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop Relat Res 2010;468(1):57–63. doi: 10.1007/s11999-009-1119-9.
2 Lotke PA, Ecker ML. Influence of positioning of prosthesis in total knee replacement. J Bone Joint Surg Am 1977;59(1):77–79.
3 Gromov K, Korchi M, Thomsen MG, Husted H, Troelsen A. What is the optimal alignment of the tibial and femoral components in knee arthroplasty? An overview of the literature. Acta Orthopaedica 2014; 85(5):480–487. doi: 10.3109/17453674.2014.940573.
4 Innocenti M, Secci G, Zanna L, Sani G, Stimolo D, Matassi F, Carulli C, Civinini R. Following the anatomy of the proximal tibia with a standard anatomic technique and the use of an asymmetrical tibial base plate can lead to a mismatched internal components' rotation in mechanically aligned total knee arthroplasty. Arthroplast Today 2024;28:101464. doi: 10.1016/j.artd.2024.101464.
5 Baldini A, Indelli PF, De luca L, Mariani PC, Marcucci M. Rotational alignment of the tibial component in total knee arthroplasty: the anterior tibial cortex is a reliable landmark. Joints 2013; 1(4):155-160. doi: 10.11138/jts/2013.1.4.1455.
6 Abdelnasser MK, Adi MM, Elnaggar AA, Tarabichi S. Internal rotation of the tibial component in total knee arthroplasty can lead to extension deficit. Knee Surg Sport Traumatol Arthrosc 2019; 28:639-647. doi: 10.1007/s00167-019-05695-w.
7 Valkering KP, Breugem SJ, van den Bekerom MPJ, Tuinebreijer WE, van Geenen RCI. Effect of rotational alignment on outcome of total knee arthroplasty; A systematic review of the literature and correlation analysis. Acta Orthopaedica 2015;86(4):432-439. doi: 10.3109/17453674.2015.1022438
8 Kim Y-H, Park J-W, Kim J-S, Park S-D. The relationship between the survival of total knee arthroplasty and postoperative coronal, sagittal and rotational alignment of knee prosthesis. Int Orthop 2014;38:379-385. doi: 10.1007/s00264-013-2097-9.
9 Abdelnasser MK, Elsherif ME, Bakr H, Mahran M, Othman MHM, Khalifa Y. All types of component malrotation affect the early patient-reported outcome measures after total knee arthroplasty. Knee Surg Relat Res 2019;31:5. doi: 10.1186/s43019-019-0006-2.
10 Victor J, Dujardin J, Vandenneucker H, Arnout N, Bellemans J. Patient-specific guides do not improve accuracy in total knee arthroplasty; a prospective randomized controlled trial. Clin Orthop Relat Res 2014;472:263–271. doi: 10.1007/s11999-013-2997-4.
11 Woolson ST, Harris AHS, Wagner DW, Giori NJ. Component alignment during total knee arthroplasty with use of standard or custom instrumentation. a randomized clinical trial using computed tomography for postoperative alignment measurement. J Bone Joint Surg Am 2014;96:366-72. doi: 10.2106/JBJS.L.01722.
12 Suda AJ, Seeger JB, Bitsch RG, Krueger M, Clarius M. Are Patients' Expectations of Hip and Knee Arthroplasty Fulfilled? A Prospective Study of 130 Patients. Orthopedics 2010;33(2):76-80. doi: 10.3928/01477447-20100104-07.
13 Hadi M, Barlow T, Ahmed I, Dunbar M, McCulloch P, Griffin D. Does malalignment affect patient reported outcomes following total knee arthroplasty: a systematic review of the literature. Springer Plus 2016;5:1201. doi: 10.1186/s40064-016-2790-4.
14 Denham RA, Bishop RE. Mechanics of the knee and problems in reconstructive surgery. J Bone Joint Surg [Br] 1978;60-B:345–352. doi: 10.1302/0301-620X.60B3.355258.
15 Salzmann M, Fennema P, Becker R, Hommel H. Does Postoperative Mechanical Axis Alignment Have an Effect on Clinical Outcome of Primary Total Knee Arthroplasty? A Retrospective Cohort Study. Open Orthop J 2017;11:1330-1336. doi: 10.2174/1874325001711011330.
16 Fang DM, Ritter MA, Davis KE. Coronal alignment in total knee arthroplasty: just how important is it? J Arthroplast 2009;24(6 Suppl):39–43. doi: 10.1016/j.arth.2009.04.034.
17 Kazemi SM, Shafaghi T, Minaei R, Osanloo R, Abrishamkarzadeh H, Safdari F. The Effect of Sagittal Femoral Bowing on the Femoral Component Position in Total Knee Arthroplasty. Arch Bone Jt Surg 2017;5(4):250–254.
18 Victor J. Optimising position and stability in total knee arthroplasty. EFORT Open Rev 2017;2(5):215–220. doi: 10.1302/2058-5241.2.170001.
19 Yau WP, Chiu KY, Tang WM. How precise is the determination of rotational alignment of the femoral prosthesis in total knee arthroplasty. An in vivo study. J Arthroplasty 2007;22(7):1042-1047. doi: 10.1016/j.arth.2006.12.043.

20 Parratte S, Blanc G, Boussemart T, Ollivier M, Le Corroller T, Argenson JN. Rotation in total knee arthroplasty: no difference between patient-specific and conventional instrumentation. Knee Surg Sports Traumatol Arthrosc 2013;21(10):2213-9. doi: 10.1007/s00167-013-2623-8.
21 Aunan E, Østergaard D, Meland A, Dalheim K, Sandvik L. A simple method for accurate rotational positioning of the femoral component in total knee arthroplasty A prospective study on 80 knees with 3 years' follow-up with CT scans and functional outcome. Acta Orthop 2017;88(6):657–663. doi: 10.1080/17453674.2017.1362733.
22 Indelli PF, Graceffa A, Baldini A, Payne B, Pipino G, Marcucci M. Relationship between tibial baseplate design and rotational alignment landmarks in primary total knee arthroplasty. Arthritis2015;2015:189-294. doi: 10.1155/2015/189294.
23 Akagi M, Oh M, Nonaka T, Tsujimoto H, Asano T, Hamanishi C. An anteroposterior axis of the tibia for total knee arthroplasty. Clin Orthop 2004;420:213–219. doi: 10.1097/00003086-200403000-00030.
24 Kataoka T, Iizawa N, Oshima Y, Majima T. Difference in Rotational Alignment of the Tibial Component, as Determined by the Range-of-Motion Technique and Akagi's Line, is Influenced by Tibial Varus Deformity: A Cross-Sectional Study. J Nippon Med Sch 2024;91(5):480-487. doi: 10.1272/jnms.JNMS.2024_91-513.
25 Popescu R, Haritinian EG, Cristea S. Methods of intra- and post-operative determination of the position of the tibial component during total knee replacement. Int Orthop 2020;44(1):119-128. doi: 10.1007/s00264-019-04424-9.
26 Osano K, Nagamine R, Todo M, Kawasaki M. The effect of malrotation of tibial component of total knee arthroplasty on tibial insert during high flexion using a finite element analysis. Sci World J 2014;2014:695028. doi: 10.1155/2014/695028.
27 de Valk EJ, Noorduyn JCA, Mutsaerts ELAR. How to assess femoral and tibial component rotation after total knee arthroplasty with computed tomography: a systematic review. Knee Surg Sports Traumatol Arthrosc 2016;24(11):3517-3528. doi: 10.1007/s00167-016-4325-5.
28 Heyse TJ, Tibesku CO. Improved tibial component rotation in TKA using patient-specific instrumentation. Arch Orthop Trauma Surg 2015;135:697–701. doi: 10.1016/j.knee.2012.10.009.
29 Berger RA, Crossett LS, Jacobs JJ, Rubash HE. Malrotation causing patellofemoral complications after total knee arthroplasty. Clin Orthop Relat Res 1998;356:144-153. doi: 10.1097/00003086-199811000-00021.
30 Hernández-Hermoso JA, Nescolarde L, Yañez-Siller F, Calle-García J, Garcia-Perdomo D, Pérez-Andres R. Combined femoral and tibial component total knee arthroplasty device rotation measurement is reliable and predicts clinical outcome. J Orthop Traumatol. 2023;24(40):1-12. doi: 10.1186/s10195-023-00718-2.
31 Berhouet J, Beaufils P, Boisrenoult P, Frasca D, Pujol D. Rotational positioning of the tibial tray in total knee arthroplasty: A CT evaluation. Orthop Traumatol Surg Res 2011;97:699-704. doi: 10.1016/j.otsr.2011.05.006.
32 Nicoll D, Rowley DI. Internal rotational error of the tibial component is a major cause of pain after total knee replacement. J Bone Joint Surg Br 2010;92B(9):1238–1244. doi: 10.1302/0301-620X.92B9.23516.
33 Kawaguchi K, Inui H, Taketomi S, Yamagami R, Kono K, Sameshima S, Kage T, Tanaka S. Preoperative tibiofemoral rotational alignment is a risk factor for component rotational mismatch in total knee arthroplasty. Knee 2021;29:448-456. doi: 10.1016/j.knee.2021.02.028.
34 Harman MK, Banks SA, Kirschner S, Lützner J. Prosthesis alignment affects axial rotation motion after total knee replacement: a prospective in vivo study combining computed tomography and fluoroscopic evaluations. BMC Musculoskeletal Disorders 2012;13(8):1-6. doi: 10.1186/1471-2474-13-206.
35 Lützner J, Kirschner S, Günther K-P, Harman MK. Patients with no functional improvement after total knee arthroplasty show different kinematics. Int Orthop 2012;36:1841-1847. doi: 10.1007/s00264-012-1584-8.
36 Gibon E, Goodman MJ, Goodman SB. Patient satisfaction after total knee arthroplasty a realistic or imaginary goal? Orthop Clin N Am 2017;48(4):421-431. doi: 10.1016/j.ocl.2017.06.001.