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# ROTATIONAL ALIGNMENT OF THE FEMORAL COMPONENT IN TOTAL KNEE ARTHROPLASTY FOR VARUS OSTEOARTHRITIS OF THE KNEE; A RETROSPECTIVE STUDY

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**ABSTRACT**

**Background and Aims:** Achieving proper axial rotational alignment of the femoral component for varus knees is a critical step in total knee arthroplasty (TKA). Trans epicondylar axis (TEA) is the most reliable reference for alignment of femoral component. Yet, finding the exact location is sometimes difficult and time consuming. The aim of this study was to determine the correlation between the TEA and posterior condylar line reference (PCL) in varus knees. Besides, the other aim of this study was to find the relationship between lateral distal femoral angle (LDFA) and femoral component external rotation (ER) measured intraoperatively.

**Material and Methods:** This retrospective study was conducted on patients who were candidates for total knee arthroplasty from May 2016 to December 2019. LDFA, VA were calculated based on hip-to-ankle (HTA) radiographs before the surgery. All patients underwent TKA through an anterior midline incision. ER was calculated by determining TEA intraoperatively. All data were entered into SPSS software for data analysis.

**Results:** One hundred and four patients were included in the final analysis. Nineteen patients (18.3%) were male and 85 out of 104 (81.7%) were female. (P value = 0.001). No significant relationship between the amount of ER measured during surgery and the amount of varus angle in varus knees was observed. Furthermore, there were no correlations between ER and LDFA in varus knees.

**Conclusion:** Adjusting femoral component in 3 degrees external rotation relative to posterior condylar line reference achieves proper rotational alignment of the femoral component in the axial plane in varus knees. Also, the lateral distal femoral angle measured preoperatively from knee radiographs is not a predictor of ER in varus knees.

**KEYWORDS :** Total Knee replacement, knee prostesis, Genu varus , Rotation

## INTRODUCTION

Total knee arthroplasty (TKA) is the most effective treatment for progressive osteoarthritis of the knee (1). Therefore, orthopedic and knee surgeons are searching for some ways to reach more optimum results and minimize TKA complications such as malalignment and malrotation (2-5).

The distal femur anatomy plays a critical role in the normal motion of the knee joint (6).

For attaining proper flexion stability and patellar tracking in total knee arthroplasty, proper rotational alignment of the femoral component is essential (7).

Patient specific cutting based on the patient's specific anatomy during TKA is one of the useful approaches to prevent from malalignment after TKA (8). Numerous previous studies have shown that femoral trans epicondylar axis (TEA) is the most reliable reference for alignment of femoral component (9-11). TEA is defined as the connecting axis between medial and lateral epicondyles (9,10,12). In addition to that, the other landmark that is used is posterior condylar line reference (PCL) (13,14). Since identifying TEA is not always easy during the operation and is often a time consuming process, it seems that it may not be necessary to use this reference in all cases(12-14) and due to the fact that it is easier to find the PCL, in cases in which the use of TEA is not necessary, it is more appropriate to utilize PCL.

The current concept recommended that setting external rotation (ER) of the femoral component a few degrees relative to the posterior condyles makes it parallel to TEA (15,16). Recent studies have proven that medial condyle in Varus knees does not show severe deformities such as severe wear or hypoplasia compared with normal knee (15,17). Thus, the orthopedic surgeons can use PCL as a reliable reference to determine the femoral component rotation in varus and normal knees. However, this does not apply to valgus knees (15). Posterior and distal surface of the lateral condyle in the valgus knees are associated with severe deformities. Therefore, for achieving proper rotational alignment of the femoral component in valgus knees, it is essential to use TEA intraoperatively (14,15). The aim of the present study is to determine the relation between the severity of varus angle and the femoral components in axial plane during the surgery.

Another purpose of this study is to investigate the relationship between lateral distal femoral angle (LDFA) and femoral component rotation in varus knees. LDFA is defined by the angle between the femoral mechanical axis and the line connecting the distal ends of the medial and lateral femoral condyles of the femur. (18,19). Studies have shown that the determination of the LDFA before setting the rotational position of a femoral component would be useful in valgus knees )14). However, no studies have been conducted on varus knees.

## MATERIAL AND METHODS

### *Study Design*

This retrospective study was conducted on patients who were candidates for total knee arthroplasty and admitted to Tehran Taleghani hospital from May 2016 to December 2019. All patients who were eligible for total knee arthroplasty and aged between 40-80 were included in the study. In addition, patients with valgus knees, had revision surgery for TKA, had the history of tibial osteotomy, and the ones who had active infection following the surgery were excluded from the study. Furthermore, convenience sampling was used for patient selection. This study was approved by institutional review board of authors' hospital and the written informed consent was waived by the board.

### *Preoperative And Operative Assessment*

A triple joint alignment view was requested for patients before the surgery. Lateral distal femoral angle (LDFA), varus angle (VA) and inter mechanical anatomical angle (IMA) was revealed based on the triple joint view. All the surgeries in this study were performed by one surgeon via using an anterior midline incision. The incision was made from 2cm proximal to the patella to the anterior tibial tuberosity.

After that, medial arthrotomy was done and distal femoral cut was conducted by taking IMA into consideration. Furthermore, posterior cut of distal femur was done during the surgery based on the TEA. All external rotation angles were documented. The proper external rotation angles were evaluated by flexion stability and patellofemoral maltracking intraoperatively.

### *Statistical Analysis*

All data were entered into SPSS software version 15 for analysis. Kolmogorov Smirnoff test was used for exploring the normality of the

data. In addition, Pearson and Spearman correlation tests were used for parametric and non-parametric data respectively. Furthermore, Quantitative data were reported as numerical and percentage statistics.

## RESULTS

### *Descriptive Results*

One hundred and four patients were included in the final analysis. Nineteen patients (18.3%) were males and 85 of 104 (81.7%) were females. The mean age of patients was 66.8 ± 7.07 with the range between 52 to 80. Rotational alignment of the femoral component was assessed 3 degrees external rotation in all, except three patients in whom 5 degrees were determined. The results of femoral cut variables are presented in Table 1.

### *Correlation Analysis*

One-Sample Kolmogorov-Smirnov Test was used for exploring the normality of the data. Study variables including ER, LDFA and VA were not normal; thus, Spearman correlation test was used for assessing the correlations. The results of Spearman test are presented in Table 2. As seen in table 2, LDFA and VA are significantly correlated together (P value = 0.001). There were not correlations observed between ER and LDFA in varus knees.

**Table 1. Femoral Components**

| Range | Results (Mean ± SD) | Variable |
|---|---|---|
| 3-5 | 3.06 ± 0.03 | ER |
| 85-110 | 91.95 ± 3.73 | LDFA |
| 5-46 | 15.39 ± 6.87 | VA |

**Table 2. The results of Spearman test**

| VA | | LDFA | ER | Variable |
|---|---|---|---|---|
| -0.070 | -0.077 | 1.00 | Correlation Coefficient | ER |
| 0.483 | 0.435 | - | P value | |
| 1.00 | 0.318 | -0.070 | Correlation Coefficient | LDFA |
| - | 0.001 | 0.483 | P value | |
| 0.318 | 1.00 | -0.077 | Correlation Coefficient | VA |
| 0.001 | - | 0.435 | P value | |

## DISCUSSION

In the present study, we aimed to demonstrate that in varus knees and normal knees, femoral component rotation can be set to three degrees. Which, with a high approximation, fulfills our expectations of proper distal femoral rotation. Due to the difficulty of finding TEA during the operation and also the time consuming process, not only does setting 3 degrees external rotation for varus knees save time but it also achieves good rotation with a high approximation owing to lack of hypoplasia in the medial condyle in the varus knees compared with normal knees.

But due to the deformities of the lateral condyle in the valgus knees, it is essential to use TEA intraoperatively.

Proper distal femoral rotational alignment during TKA is a necessary step and axial rotational malalignment can be related to flexion instability, patellofemoral maltracking, postoperative pain and changing the knee kinematic (20).

Some previous studies suggested that the axial femoral component rotation should be inserted parallel to the TEA (21,22). However, the determination of the exact location of epicondyles is not always easy (23,24). The study reported by Akagi et al indicated that setting the axial rotation of femoral component between 3° to 6°external rotation based on the posterior condylar axis is proper to set it parallel to the TEA in varus and normal knees. (16). Which is almost identical to the results of this study.

These findings are consistent with the results of previous studies, in which the TEA is externally rotated 3-6 degrees related to the posterior condylar reference line )9,15,16(. These numbers are for varus and normal knees and do not apply to valgus knees with lateral condyle deformities (9,16). Setting axial rotation of femoral components nearly 3° from PCA in valgus knees can cause considerable malrotation in large proportion cases. (17).

In the study designed by Matsuda et al, it was shown that the TEA was externally rotated against posterior condylar line axis approximately 11.5 degrees in the valgus knees. As a result, setting femoral component, 3 degrees external rotation relative to posterior condyles results in 8.5 degrees excessive internal rotation (9). This result shows that in order to accurately determine the rotation of the femoral component in the valgus knees, it is required to use TEA intraoperatively.

It seems that in the articles which stated that the 3 degrees of external rotation will be associated with the distal femoral axial plane malrotation, the varus and valgus knees were not separated. In our study, in 101 patients out of a total of 104 patients, setting 3 degrees external rotation for femoral component relative to the posterior condyle line reference, provided suitable axial alignment in all cases. However, the patients' varus angles were very variable (between 5 and 46 degrees). There were no cases of flexion instability and patellofemoral maltracking. In our study, the femoral component was placed in 5 degrees of external rotation in three cases, which seems to have been due to less accurate determination of the exact location of the medial and lateral epicondyles.

We also intended to describe possible correlation between TEA, and LDFA in varus knees. It was concluded that LDFA cannot predict TEA during TKA in varus knees. Despite the wide range of LDFA, in almost all cases, ER was embedded around 3 degrees and there was no significant relation between these two variables. There has been no study on the relation between LDFA and ER in varus knees. In the study designed by Lee et al, LDFA has been suggested as a predictor of ER in valgus knees (14). This may be due to involvement of the lateral femoral condyle in the valgus knees and its association with LDFA. Nonetheless, such a relationship does not seem to exist in the varus knees.

The present study has some limitations. First of all, the members of the study population were Iranian. These findings may not apply to other populations. As a result, it seems necessary to conduct studies in different populations. The second limitation in this study is that since most of the population studied were women, it seems segregation of the study population by gender is necessary. Although setting the femoral component in 3 degrees of external rotation provides a suitable axial alignment, further studies on the extent of deformity in the medial femoral condyle in the varus knees appear to be necessary.

## CONCLUSION

This study aims to indicate that, despite the great importance of TEA in determining the amount of femoral component rotation, it does not seem necessary to use this landmark in all cases.

The knee surgeons can use PCL as a valuable landmark in varus knees. Setting the femoral component in 3 degrees external rotation relative to PCL prepares the appropriate femoral rotational alignment in varus knees. Using this method with relatively high accuracy not only provides a suitable alignment in the axial plane for the femoral component, but It is also easier than determining the exact location of the TEA, as a result, the operation time is reduced remarkably.

Besides, this study shows that, preoperative assessing LDFA cannot be a predictive factor for TEA during the surgery in varus knees.

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