

Original Research Article

Anterior referencing versus posterior referencing in total knee arthroplasty: a prospective observational study

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ABSTRACT

Background: Femoral component rotation in total knee arthroplasty (TKA) is essential for patella-femoral tracking, flexion gap balance and normal kinematic function of the knee. The two referencing techniques used for sizing and adjudging the femoral rotation are anterior referencing (AR) and posterior referencing (PR). The current study was designed so as to identify which referencing system determines the femoral rotation more accurately.

Methods: This study involved 34 consecutive patients (22 females and 12 males) with 60 osteoarthritic knees (bilateral=26; unilateral =8) who satisfied the inclusion criteria. The trans-epicondylar axis, was taken as gold standard to adjudge the correct femoral rotation and was marked as E. The axis of rotation as per anterior instrumentation (A), and as per posterior instrumentation (P) were marked and compared as to which of the axis (A or P) was parallel to E.

Results: A was always parallel to E, however P was parallel to E in 42 knees. In 18 knees (6 with valgoid deformity, 12 with hypertrophic osteoarthritis involving the medial femoral condyle), P and E tend to converge laterally, suggestive of excessive internal rotation.

Conclusions: Anterior referencing determines femoral rotation more accurately than posterior referencing for knees with severe valgoid deformity or those with hypertrophic osteoarthritis involving the overgrowth of medial femoral condyle.

Keywords: Femoral rotation, Anterior referencing, Posterior referencing, Valgoid deformity, Osteoarthritis, Total knee arthroplasty

INTRODUCTION

In total knee replacement the two techniques used for sizing the femur and adjudging the femoral rotation are anterior referencing (AR) and posterior referencing (PR).^{1,2} Both these techniques have met with acclaim and criticism. Posterior referencing maintains the posterior condylar offset and thus aids in attaining good flexion, but there exists a possibility of notching and overstuffing the patella-femoral joint. These drawbacks are addressed

with the AR technique, but with it there remains a chance for excessive posterior condylar resection.¹⁻⁵

Whichever referencing system is used, the target is to attain appropriate sizing and accurate rotational alignment of the femoral component. Mal-rotated femoral component is known to cause poor patellar tracking, anterior knee pain, loss of motion, and implant failure.¹⁻³ The guide to the correct rotational alignment is the referencing system used and hence it becomes mandatory

to choose the right referencing technique.^{2,9-11} Our hypothesis is that anterior referencing determines the femoral rotation more accurately than posterior referencing.

METHODS

This prospective study involved patients with advanced degenerative joint disease involving one or both knees who presented to the outpatient department of our hospital from August 2014 to December 2014. Exclusion criterion was a prior high tibial osteotomy, cruciate ligament reconstruction or patellectomy of the surgical knee. There were a total of 34 patients (22 females and 12 males) with 60 knees (bilateral 26 and unilateral 8) who satisfied the above said criterion and formed the study cohort. The mean age of the patients at the time of surgery was 60.8 years (range 49-72 years).

The study was approved by the institutional ethical committee. After detailed clinic-radiological examination, the patients were taken up for surgery after obtaining written informed surgical consent.

The surgery was performed under general anaesthesia, in supine position and under tourniquet control. Standard, medial parapatellar arthrotomy was performed to expose all our knees. The instrumentation set used in our knees was Nexgen anterior referencing system and Nexgen 4 in 1 cutting block (Zimmer Holdings Inc, Warsaw, Indiana, USA). After medial parapatellar arthrotomy, anterior and distal femoral cuts were made. The transepicondylar axis was drawn between the lateral epicondyle and the origin of the medial collateral ligament, which is found at the bottom of a sulcus in the medial epicondyle, and was labeled as (E).² Using the anterior referencing system the position of the peg holes was marked and a line connecting them was drawn to mark the axis of rotation as per anterior instrumentation (A). After this the sizing guide of 4 in 1 was used to mark the axis of rotation as 3° of external rotation and a line was drawn connecting the marks, which formed the axis of rotation of femur as per

posterior instrumentation (P). The trans-epicondylar axis, was taken as gold standard to adjudge the correct femoral rotation. We compared and recorded as to which of the axis (A or P) was parallel to E. We used the rotational axis E, for marking our final femoral rotation and making our further femoral cuts and hence definitive implantation.

Fifty four out of the 60 knees received Nexgen CR knee (Zimmer Holdings Inc, Warsaw, Indiana, USA) implants, and the rest 6 knees in 4 patients had a deficient PCL and underwent Nexgen LPS knee (Zimmer Holdings Inc, Warsaw, Indiana, USA). We did not perform patellar resurfacing in any of our patients. The final confirmation of correct rotation was made by proper tracking of the patella and unconstrained movement of the tibio-femoral articulation.

RESULTS

In the present study total participants were 34, out of which males were 22 (64.7%) and females were 12 (35.3%). The mean age of study participants was 60.8 years (SD 11.5) as shown in Table 1. The mean BMI was 28.28 (SD 5.98). There were a total of 34 patients (22 females and 12 males) with 60 knees (bilateral 26 and unilateral 8) who satisfied the above said criterion and formed the study cohort as in Table 1.

Table 1: Demographic particulars of the study participants (n=34).

Characteristics	N(%) or mean ± SD
Male	22 (64.7%)
Female	12 (35.3%)
Age (years)	60.8 ± 11.5
BMI measured, (kg/m²)	28.28 ± 5.98
Bilateral knee joint involvement	26
Unilateral knee joint involvement	8

Table 2: Percentage of anterior referencing and posterior referencing were done in total knee arthroplasty (n=60).

	No of knees (60)	Parallel to epicondylar axis E (no internal rotation)	Excessive internal rotation	Remark
Anterior referencing (A)	18 (30%)	100%	Nil	
Posterior referencing (P)	42 (70%)	70%	30%	30% (18) of total knee using posterior referencing had excessive internal rotation (6 knees valgoid deformity and 12 knees was due to hypertrophic osteoarthritis)

Fifty four out of the 60 knees received Nexgen CR knee (Zimmer Holdings Inc, Warsaw, Indiana, USA) implants, and the rest 6 knees in 4 patients had a deficient PCL and

underwent Nexgen LPS knee (Zimmer Holdings Inc, Warsaw, Indiana, USA). The axis of rotation marked using anterior referencing (A) was always parallel to the

axis of epicondylar axis (E). However, the axis of rotation as marked using the posterior referencing (P) was parallel to epicondylar axis (E) in 70% of the knees (n=42) as given in Table 2.

Out of the remaining 18 knees, the two axis of rotation tend to converge laterally, suggestive of excessive internal rotation. It was analysed that out of these 18 knees, 6 patients had a valgoid deformity with hypoplastic lateral femoral condyle and in remaining 12 patients there was hypertrophic osteoarthritis of the knee, with overgrowth of the medial femoral condyle as in Table 2. In both these conditions the axis of rotation (P) was in internal rotation as compared to the axis of rotation of epicondylar axis (E). At the end of the procedure, correct rotational alignment was confirmed as patellar tracking was normal in all the cases and there was unconstrained movement of the tibio-femoral articulation.²

DISCUSSION

Total knee arthroplasty is a surface replacement in the soft tissue envelope that surrounds the knee. A knee which is well aligned will therefore have a balanced force transmission to the soft-tissues, and any mal-alignment will induce mechanical stress on the bearing surfaces and tension in the ligaments, leading to aberrant kinematic behavior inducing stiffness, instability and early loosening.¹⁻¹⁰

Mochizuki and Schurman in their study of complications involving the patella following total knee arthroplasty in eighty-six knees, identified that In twenty-three patients these complications were associated with patellar mal-alignment and that inverse rotational alignment leads to poor patellar tracking and suboptimal postoperative function.⁶ Berger et al compared 30 knees with isolated patella-femoral complications after total knee arthroplasty to 20 patients with well-functioning total knee replacements without patello-femoral complications. They observed that the group with patello-femoral complications had excessive internal rotation, which was directly proportional to the severity of the patella-femoral complications. While a little degree of internal rotation (1°-4°) led to lateral tracking and patellar tilting, moderate internal rotation (3°- 8°) caused patellar subluxation and highly excessive internal rotational (7°- 17°) resulted in patellar dislocation or late patellar prosthesis failure. The authors concluded that there is a high degree of correlation between internal rotation and the severity of the patella-femoral complication in patients with otherwise normal axial alignment after TKA. He also used the transepicondylar axis as rotational landmarks for the femoral component.⁷ Anouchi et al. performed a cadaver experiment in changing femoral component position from neutral (according to the PCL) to 5° internal and 5° external rotation. Patellar tracking was closest to normal in the group that was externally

rotated. Internal rotation caused severe patellar mal-tracking to the medial side.⁸

Correct rotational alignment has been proven beyond doubt to be crucial for good postoperative functioning of the joint.¹⁻⁹ It is yet unclear as to which is the best rotational reference to which all other parameters can be compared.² The rotation of the femoral component can be described, relative to landmarks on the distal femur or relative to its relation with the tibia. Distal femoral references include the posterior condylar line (PCL) and the trans-epicondylar axis (E). References relating to the relative position of the tibia include the flexion gap symmetry and the tibial mechanical axis alignment in flexion. For the rotational alignment of the femoral component, trans-epicondylar axis (E), has been described as the key reference axis.^{2,7} The trans-epicondylar axis lies in the coronal plane and is perpendicular to the mechanical axis. This axis is perpendicular to 'Whiteside's line. To determine the rotation of the femoral component, either of the two referencing systems can be used.^{2,5,12-14} In most knee systems a sizing jig is first applied to the distal femur, which can be referenced from the anterior or posterior aspects of the femoral condyle. There are advantages and disadvantages of both methods, but in each case pins are used to define the rotation of the femoral cutting block. A line connecting the pinholes should be perpendicular to Whiteside's line and parallel to the trans-epicondylar axis.¹²⁻¹⁴ It has now been well established that use of posterior condylar referencing system for a valgus knee may lead to excessive internal rotation due to hypoplastic lateral femoral condyle. Therefore it is advised not to flush the paddle of the sizing jig on the posterior aspect of lateral condyle, so as bone resection on the lateral side may be reduced.^{1,2,15-17}

Griffin performed a clinical measurement during surgery on 107 arthritic patients and inferred that the posterior condyles are potentially unreliable references for femoral component rotation.¹⁰ Thienpont et al performed 2,637 CT scans and 3D reconstructions of knee for pre-operative planning of total knee arthroplasty. They concluded that there is a 41% risk of mal-alignment if a fixed posterior condylar line is used as a reference in total knee arthroplasty, with 9% requiring less and 32% requiring more than 4° of axial rotation.¹⁵ Schnurr et al in their study of 100 knee prostheses analysed using the navigated GAP method for flexion gap symmetry and femoral rotation concluded that if the PCA technique had been used, only 51% of the femoral components would have been implanted in correct femoral rotation; the remaining 49% would have implanted with flexion gap instability. In such a situation, it is wise to gauge the correct rotational alignment using the anatomical landmarks and anterior referencing.¹⁶ Matsuda et al compared 30 normal knees, 30 osteoarthritic knees with varus deformity and 30 osteoarthritic knees with valgus deformity. They examined the relation between the PCL and E.

In normal knees there was 6.4 degrees of internal rotation relative to E; 6.1 degrees internal rotation in the varus knees and 11.5 degrees in the valgus knees. They proposed that there was no hypoplasia of the medial condyle in the varus knees, but the lateral condyle in the valgus knees was severely distorted.¹⁷

Our findings are consistent with these studies, as we found our axis of rotation marked as per anterior referencing (A) to be always consistent with E; unlike axis of rotation marked as per posterior referencing (P), which showed a discrepancy in 30% cases, causing internal rotation.^{10,15-17} Our findings were consistent with Matsuda et al in the fact that 6 of our knees which showed excessive internal rotation, using posterior referencing had a valgoid deformity, however excessive internal rotation in the remaining 18 knees was due to hypertrophy of the medial condyle.¹⁷ This could be attributable to the late presentation of hypertrophic osteoarthritis in Indian population.

There are studies in which the two referencing techniques have been used in different knees and the results compared with each other, we do not know of any study in English literature, which has used both the referencing systems in the same knee so as to identify which our technique determines the femoral rotation more accurately.² Keeping this in mind we designed the current study so as to evaluate which referencing system is more precise in adjudging the correct femoral rotation. Our study has its own set of limitations. Firstly, the sample population was small. Secondly, the use of transepicondylar axis as a reference for rotational alignment of the femoral component might have introduced bias. Though there is growing consensus that appropriate rotational alignment of the femoral component is parallel to the transepicondylar axis the axis itself may alter in varus or valgoid knees or other pathological Variations.^{2,7,10,14,18,19} The strength of the study is that it is single institutional study with cases treated by the same experienced knee surgeon used a single implant design. The analysis of such kind of studies may formulate guidelines in favor of using anterior referencing for knees with severe valgoid deformity or those with hypertrophic osteoarthritis involving the overgrowth of medial femoral condyle.

CONCLUSION

Anterior referencing determines femoral rotation more accurately than posterior referencing for knees with severe valgoid deformity or those with hypertrophic osteoarthritis involving the overgrowth of medial femoral condyle.

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