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The radiological alignment of components after total knee arthroplasty and its relation to functional outcome

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Abstract
Aim: The main aim of this study is to radiologically assess the components alignment in various planes in total knee replacement and to assess its relationship to the functional outcome using the knee society score.
Materials and Methods: This hospital based prospective observational study of 30 patients was conducted in the department of Orthopaedics at Maharaja Agrasen Hospital, New Delhi on patients who underwent elective primary Total Knee Arthroplasty and the period of study being 24 months from June 2016 to May 2018. All patients were assessed clinically and functionally using the Knee Society Score pre and post operatively for a follow up period of 6 months.
Results: The mean coronal alignment and rotational alignment of femoral component in our study was 5.87 degrees and 2.99 degrees of external rotation respectively. The mean tibial component coronal and rotational alignment in our study was 90 degrees and 17.77 degrees respectively. The mean preoperative flexion of 81.33 degrees increased to 113.5 degrees postoperatively with a significant p value of <0.001. There was significant improvement of Knee Clinical Score and Knee Functional Score following Total Knee Arthroplasty with a p value <0.001.
Conclusion: In our study the use of conventional extra medullary guide for tibia and intramedullary guide for femur to align a total knee replacement provided acceptable alignment and gives a good functional outcome as measured by knee society score.

Keywords: Total knee arthroplasty, rotational alignment, coronal alignment, knee society score

Introduction
Osteoarthritis is the most prevalent chronic joint disease affecting ambulation of a person. Total Knee Arthroplasty is one of the most successful surgical procedures with over 90% survival rate at 10-15 years [1-4]. However, the incidence of early failure following Total Knee Arthroplasty is as high as 4% to 20% [5-6]. Excluding infection, malalignment and instability are the two most important causes of an early revision.
The geometry of the proximal tibia and distal femur is intimately linked with the biomechanics of the tibiofemoral and patella femoral joint. In the field of Total Knee Arthroplasty, positioning of the implant in different planes is referred to as 'rotational alignment'. Restoration of the neutral mechanical alignment is one of the prerequisites for long term TKA survival. Failure to restore neutral leg alignment can be caused by altered alignment of femoral component, tibial component or both. The clinical consequences of rotational malalignment are significant and often lead to important functional impairment. The current literature lacks a uniformity of opinion on precise range of values for postoperative overall anatomical knee alignment or coronal, sagittal and rotational alignment of the femoral and tibial components to achieve the best possible functional outcome.
It is therefore important to address the issues related to achieving the alignment and balance for the surgical procedure of Total Knee Arthroplasty. Therefore this study was undertaken to assess the components alignment post operatively using traditional jigs and study its relation to functional outcome of Total Knee Arthroplasty.

Materials and Methods
This was a prospective hospital based study conducted in the Department of Orthopaedics at

at Maharaja Agrasen hospital, New Delhi. For this study we recruited 30 patients (Male or Female) who underwent elective primary Total Knee Arthroplasty at our hospital. Patients were selected on the basis of inclusion criteria (All patients with arthritis knee undergoing primary total knee replacement.) and exclusion criteria (Paralytic conditions which affects early mobilization, Post traumatic knee, Psychiatric illness, Ipsilateral hip and ankle pathology, Infection)

On admission to the hospital, all patients involved in the study were assessed clinically for any fixed varus or valgus deformities or presence of any fixed flexion contracture, radiologically by anteroposterior and lateral views of bilateral knees in standing position and CT scannogram of both lower limbs from hip to ankle and functionally using the Knee Society Score [7].

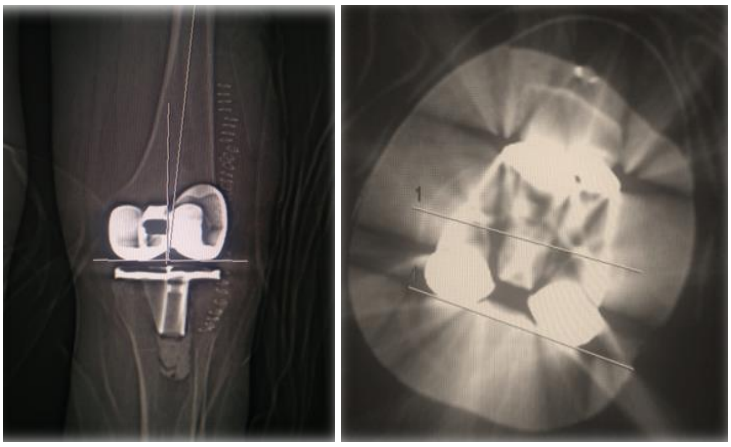
Femoral component alignment

Axial alignment of femoral component

The angle between the distal portion of the femoral component and the femoral anatomical axis. The acceptable axial alignment of the femoral component is 5 ± 3° valgus to the long axis of femur. (Fig.1)

Rotational alignment of femoral component

Using CT scan, an axial image of the distal femur was chosen which most clearly demonstrated the medial epicondylar sulcus, when present, or the central point of the medial epicondyle when no sulcus was found, and the lateral epicondylar prominence and surgical epicondylar axis was drawn. A second line was drawn across the posterior condyles of the femoral component. The angle between these represented the rotation of the femoral component. Acceptable angle is 3.5 ± 1.2° internal rotation. (Fig.1)



A) B)

Fig 1: A) Axial alignment of femoral Component B) Rotational alignment of femoral Component

Tibial component alignment

Axial alignment of tibial component

The angle between the proximal portion of the tibial component and the tibial anatomical axis. The acceptable tibial component alignment is 90 ± 2° to the long axis of tibia. (Fig. 2)

Fig 2: Axial alignment of tibial Component

Rotational alignment of tibial component

Using CT scan, central point of tibial plateau was located and a line along the posterior aspect of the tibial tray was drawn. A line perpendicular to this through the center was drawn. Then it was superimposed at the level of tibial tubercle and a line drawn from the highest point on the tibial tubercle to the center. The angle between this two lines indicates the rotational alignment of tibial component. It is usually 18±2° of internal rotation. (Fig.3)

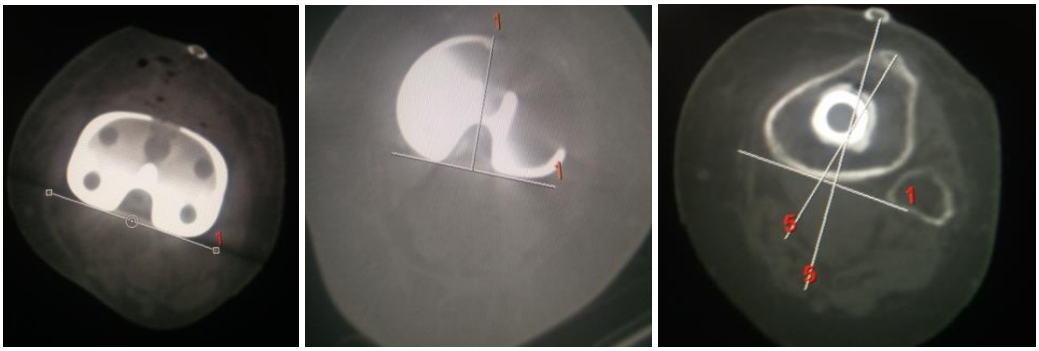


Fig 3: Measuring rotational alignment of tibial component

Knee flexion

Flexion was calculated by taking lateral radiograph with knee in full flexion. Flexion was calculated preoperatively and at the end of 6 months. (Fig. 4).

Fig 4: Measuring Knee flexion in lateral Radiograph

Implant used: All implants used in our study were NexGen LPS-Flex type knees by Zimmer.

Surgical technique: Under combined spinal and epidural anaesthesia and through medial parapatellar Retinacular approach knee joint was opened (for both varus as well as valgus knees) and patella was everted, patellofemoral plicae released and osteophytes removed.

The tibial and femoral cuts were taken with extra medullary tibial alignment jig and intramedullary jig for femur respectively. The flexion and extension gap were checked and soft tissue balancing was done. Then the femoral trial was placed and tibial trial was brought into place by self centring method after multiple rounds of flexion and extension. Varus valgus stability was checked in both flexion and extension. Patellar tracking was checked with trial implant and impant fixed with bone cement and articular surface insert of appropriate size was inserted. Thorough wound wash was given, drain kept and wound closed in layers. Sterile dressing was done.

Post - Op Protocol

Patient was taught static quadriceps exercises and patient was made to walk full weight bearing on second post op day within the limits of pain and advised to continue static quadriceps exercises. The knee was placed in a continuous passive motion machine.

Follow Up

The patient was assessed clinically, functionally using knee society score and radiologically at an interval of 3 months and 6 months.

Statistical methods

Statistical analysis was performed by the SPSS program for Windows, version 17.0(SPSS, Chicago, Illinois). Continuous variables are presented as mean ± SD, and categorical variables are presented as absolute numbers and percentage. Paired t test was used for comparison of components alignment in total knee replacement from pre- and post-intervention. $P< 0.05$ was considered statistically significant.

Results and Discussion

Total knee arthroplasty is a successful procedure and is associated with good functional improvement. There is good relief of joint pain, increased mobility, correction of deformity and an improvement in the quality of life of the patients following total knee arthroplasty.

While survival of primary TKAs is excellent, as most registries report 10-year survival of close to 95% for most implants (Graves *et al*.) [8], recent studies have indicated that patient satisfaction is substantially worse. Up to 20% of the patients are not satisfied with the outcome as assessed 1 year postoperatively (Bourne *et al*. Klit *et al*.) [9, 10].

Although patient related factors (such as age, preoperative knee scores, comorbidities, general health, depression, anxiety) have been found to influence patient-reported outcome, surgical factors such as implant alignment are also important (Longstaff *et al*. Choong *et al*.) [11, 12].

Implant malalignment following primary TKA has been reported to be the primary reason for revision in 7% of revised TKAs (Schroer *et al*.) [13] and it has been linked to both decreased implant survival (Ritter *et al*.) [14] and inferior patient-reported outcomes (Longstaff *et al*. Choong *et al*.) [11, 12].

The mean coronal alignment of femoral component in our study was 5.87 degrees which was within acceptable limits and was comparable to study by Gromov *et al*.[15] which concluded that the optimal distal femoral alignment is typically 2-7° of valgus as this alignment seems to result in optimal functional outcome.

In study by Kim *et al*. [16] when femoral component was neutrally aligned (2-8 degrees valgus), the revision rate was only 0.7% as compared to 5.0% and 1.7% in varus and valgus aligned group respectively showing good outcome when femoral component alignment was between 2-8 degrees of valgus.

The mean femoral component rotational alignment in our study was 2.99 degrees of external rotation (range 2-4) which is comparable to other studies by Kim *et al*. [16] (range 2-5) and Berger *et al*. [17] (range 3.5 degrees +/-1.2 degrees).

Thielemann *et al*. [18] concluded that external rotational of femoral component exceeding 3° is associated with significantly poorer subjective and objective outcome 5 to 7 years after TKA.

The mean tibial component coronal alignment in our study was 90 degrees which is comparable to other studies by Ritter *et al*. [14], Gromov *et al*. [15] and Kim *et al*. [16].

Ritter *et al*. [14] showed tibial component alignment in coronal plane less than or more than 90 degrees resulted in a higher rate of failure.

The mean rotational alignment of tibial component in our study was 17.77 degrees (range 16-20) which is well within acceptable range and the result is comparable to previous studies by Longstaff *et al*. [11] and Berger *et al*. [19].

Nicoll and Rowley [20] found that increased internal rotation of the tibial component in relation to neutral tibial tubercle axis (18 degrees) was a major cause of pain and functional deficit following TKA.

According to Longstaff *et al*. [11], Good Alignment of components in total knee arthroplasty leads to faster rehabilitation and better functional outcome. The most significant finding in our study was the positive correlation between accurate alignment of components after TKA and functional outcome as measured by knee society score.

A knee replacement surgery should aim to achieve normal or correct alignment of tibiofemoral components as a necessary condition for a successful outcome.

Conclusion

The clinical consequences of rotational malalignment are significant and often lead to important functional impairment. Correct rotational orientation of the components is important for the performance and longevity of total knee arthroplasty.

The current literature lacks a uniformity of opinion on precise range of values for postoperative overall anatomical knee alignment or coronal, sagittal and rotational alignment of the femoral and tibial components to achieve the best possible functional outcome. We believe that surgeon should aim to place the components in the position of: femoral component alignment, 2-7 degree valgus; tibial coronal alignment, 90 degrees; posterior tibial slope, 0-7 degrees; femoral rotational alignment, 2-5 degrees external rotation.

In our study the use of conventional extramedullary guide for tibia and intramedullary guide for femur and the use of self centring method to align tibial component in relation to femoral component provided acceptable alignment and the functional outcome as measured by knee society score increased significantly. Thus we conclude that component alignment within an acceptable range leads to a good functional outcome.

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