Determination of restoration of posterior condylar offset along with an analysis of risk of anterior femoral notching in total knee replacement by utilizing posterior referencing techniques

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Abstract
Objectives: Total knee replacement surgery has been the definitive management for any type of severe grade osteoarthritis. Anterior referencing and posterior referencing are two definitive techniques for positioning the femoral components and balancing the sagittal plane during the surgery of total knee replacement (TKR). The purpose of this study was to evaluate the changes in medial and lateral posterior condylar offset (PCO) after TKR using posterior referencing (PR) system. Literature shows that posterior referencing accurately restores posterior condylar offset relative to anterior referencing. However, there are still chances of anterior femoral notching and this anterior femur notching in turn may lead to periprosthetic fracture. Various studies have shown that anterior referencing technique affects the flexion gap tightness. This particular study is intended to assess the restoration of posterior condylar offset and the chances of anterior femoral notching in total knee replacement using posterior referencing technique by analyzing the pre-operative and post-operative knee x-ray in a true lateral view.
Materials and Methods: This was a prospective observational study of 50 consecutive cases of severe knee joint osteoarthritis. Posterior condylar offset was measured using picture archiving and communication systems (PACS). Post-operative X-rays of knee joint in their true lateral views were analyzed for anterior femoral notching.
Results: In 49 knee replacements, Posterior Condylar Offset was restored within 0 cm to +0.3 cm. In one case, however the PCO increased beyond +0.3cm. None of the cases witnessed a decline in PCO. No Anterior Femoral Notching was seen in any of the cases. Hence, restoration was observed to be a very common phenomenon.
Conclusion: This study concludes that in total knee replacement using posterior referencing technique, Posterior Condylar Offset is restored in majority of the cases and chances of Anterior Femoral Notching are negligible.

Keywords: Posterior condylar offset, Anterior femur notching, Total knee replacement.

Introduction
Posterior Condylar Offset is defined as a vertical distance from most prominent point of the posterior femoral condyle to the tangent of posterior cortex of the femoral shaft as seen on true lateral Knee X rays. An appropriate femur component postioning and sizing is extremely essential for proper kinematic function in Total Knee Replacement (TKR). Anterior or posterior referencing (AR or PR) are two major techniques for setting center of rotation and for balancing the sagittal plane in arthroplasty. Both techniques have their own advantages and disadvantages.[1]

In anterior referencing, the size of the component is directly related to the amount of posterior femoral condyle that has been removed. Thus, the size of the flexion gap which has been created after posterior condyle resection will differ from anatomic ONLY if the exact amount of the resected condyle does not equal the amount replaced by femoral implant.[2]

Although with this posterior referencing, following posterior condylar resection, the flexion gap is constant, the variability in sagittal size creates a risk of notching the anterior femoral cortex as observed in a few studies.[2] Anterior femoral notching can also increase the risk of per prosthetic fracture.[3-6] Precision of posterior condylar cut & restoration of this posterior condylar offset (PCO) is one of the most important concepts in obtaining a successful and well functioning high flexion TKR. Either ways, an under-resection or over-resection of the posterior femoral condyle has significant impaction the amount of flexion that can be achieved after a successful TKR. For every milli meter of posterior offset lost, flexion is reduced by 6 degrees.[7]

Increased posterior condylar offset (PCO) in turn also leads to an increase in the clear space behind the femoral condyle. So, during flexion, the posterior edge of the tibia needs to move into this space to allow flexion that leads to early abutment and reduced range of flexion.[7]

Aims and Objectives
This study is an observational study. By using a posterior referencing technique in Total Knee Replacement (TKR), we aim:
1. To analyze and evaluate the difference in both pre and post-operative posterior condylar offset following a successful total knee replacement.
2. To accurately establish the risk of anterior femoral notching.

Materials and Methods
Source of data
Data was collected from patients undergoing Total knee arthroplasty at Ruby Hall Clinic, Pune from October 2017 to July 2019.
Sample size
50

Study design
A prospective observational study.

Inclusion criteria
1. Patient should be between 40-85 years of age.
1. Patient requiring cemented primary total knee replacement and giving consent for the same.
2. Patient is of sound mind and consenting to participate in the study agreeing to the protocol.
3. Patient is unable to respond to conservative treatment modalities and there is documented proof of trial of some conservative methods.

Exclusion criteria
1. Patient has had a prior procedure of high tibial osteotomy, anterior or posterior cruciate Ligament Reconstruction or patellectomy of the operative knee.
2. Patient has an active or suspected latent infection n or about the knee joint.
3. Patient has a malignancy in the area of the involved knee joint.
4. Patient has a bone stock which has been compromised by disease or infection or severe osteoporosis.
5. Patient not willing to be included in the study.

Method of collection of data
50 consecutive TKR fitting the inclusion criteria done by single surgeon using posterior referencing system for femoral cuts to be reviewed and considered for inclusion in our study. Pre- and post-operative True lateral and True size knee Radiographs would be taken. Using PACS, the posterior condylar offset to be determined from pre-operative and post-operative X- Rays & also, the difference in the pre and post-operative PCO to be calculated. Upon using the Tays de classification, the post-operative anterior femoral notching to be determined using PACS system.

Investigations required
True size Knee X-ray, True lateral view- Pre-operative and post-operative.[8,9]

The posterior condylar offset was measured pre-operatively and post-operatively on true lateral knee X-Rays by the determination of the shortest distance between the l ne tangent to posterior femoral cortex and most posterior point of the femur condyle or femur prosthesis (postoperatively) respectively (Fig. 1). PCO alteration was calculated from these respective measurements. PCO alteration is simply defined as the value obtained after subtraction of the amount of Preoperative PCO from the amount of postoperative.

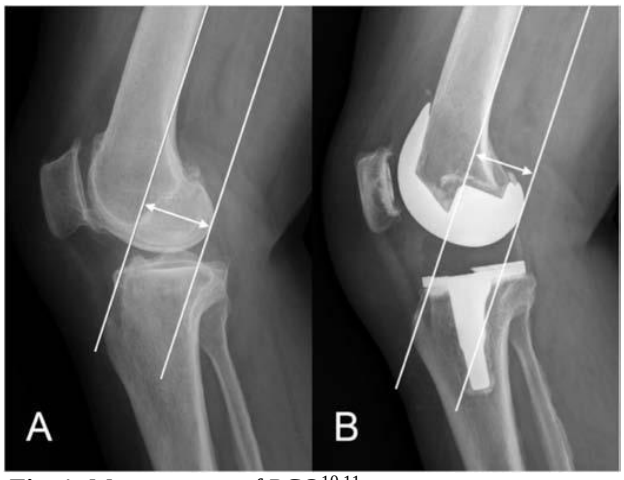

Fig. 1: Measurement of PCO[10,11]

Discussion

The vertical distance from the contact point of the tibiofemoral components to the patella is the moment arm for knee extension, which was believed to be able to affect quadriceps and patellofemoral forces. In total knee replacement, an accurate positioning of the femoral component is very important. The key reference for this is the trans-ep condylar axis, which lies in the coronal plane with the knee extended and flexed. It is perpendicular to the mechanical axis as well as perpendicular to 'Whiteside's line' or antero posterior axis, a line drawn along the deepest part of the trochlear groove.[12]

The trans-ep condylar axis can be difficult to reliably define in up to 50% of cases, whereas Whites de's line is more reliably found. The exception can be in cases where there has been significant patellofemoral wear, which can alter the normal anatomy of the trochlear groove.

Identifying these landmarks is key to the determination of rotation of the femur component, which is in turn controlled by anterior and posterior cuts made to the distal femur after apply ng the femoral cutting block.

In most knee systems, the sizing jig is first applied directly to the distal femur, which can be referenced from the anterior or posterior aspects of the femoral condyle.

It is well known that there are some advantages and disadvantages of both methods, but in either of the case, pins are used to define the rotation of the femur cutting block. The line connecting these pinholes should always be perpendicular to the Whites de's line and parallel to the trans-ep condylar axis.

Posterior referencing
In posterior referencing technique, the posterior condyles are taken as reference for distal femoral cuts. It helps in accurate flexion gap balancing and they more predictably restore posterior condylar offset and improved final flexion. During posterior resection posterior condyle remains thick but anterior cut is variable. Under sizing of femoral component leads to anterior notching and over-sizing of femoral component causes over stuff ng of patellofemoral joint.

Table 1: Comparison of pre op and post op posterior condylar offset in study group

Study Parameter	N	Mean	Std. Deviation	Unpaired T Test	P Value
Pre	50	2.78	0.29	-16.819	0.000
Post	50	2.91	0.29	Difference is Significant	

If a posterior condylar referencing systems used for a valgus knee with a relatively hypoplastic lateral femoral condyle, it may be necessary to keep the paddle of the sizing jig away from the posterior aspect of lateral condyle. This permits less lateral bone resection, compared with the more common situation seen with a varus knee.

It is more important to ensure correct alignment of the anatomical landmarks, rather than attempt ng to equal se bone resection from both posterior condyles. The latter would result in aninternally rotated femoral component, which has clear implication is for patellar tracking.

When the blocks applied for anterior and posterior femoral cuts, the femur can be relatively overs zed or can be notched anteriorily. This latter problem can be a risk factor for per-prosthetic fracture.[13-15]

Jethanandan R, *et al.* conducted a study to determine if the design of the femoral implant changes the risk for per prosthetic supracondylar femur fractures after anterior cortical notching[16] Zalzal, *et al.* did a finite analysis on risk of per prosthetic fractures which occured following anterior femoral notching. They concluded that the anterior notches which were greater than 3 mm with sharp edges located directly at the proximal end of the femoral implant produced the highest stress concentrations and may lead to a significant risk of per prosthetic femur fracture.[17]

Ajay Malviya, *et al.* did study on TKA and concluded that posterior condylar offset had the greatest impaction the final range of motion, which highlights that this is an important cons deration for the operating surgeon at pre-operative templating and del berationis.[18]

In this prospective observation al study, a total of 50 consecutive cases of knee joint osteoarthritis which presented to the OPD of Ruby Hall Clinic and were admitted in Ruby Hall Clinic, were treated with standard total knee replacement, using posterior referencing technique, and operated by single surgeon using same type of implants and instrumentation. Cases were chosen strictly in accordance with the inclusion and exclusion criteria. Radiographs of knee joint in True lateral view were done pre-operatively and post-operatively. Posterior condylar offset was measured and analyzed by using picture arch v ng and communication systems. Post-op radiographs of knee joint in their true lateral views were observed for anterior femoral notching.

We observed that the chances of anterior femur notching are also negligible if a posterior referencing technique has been utilized in total knee replacement by doing it in appropriate way which in turn avoids per prosthetic fractures chances, where the advantages of posterior referencing like restoration of PCO and good flexion balancing can be utilized simultaneously for better functional outcome of TKA.

Results

In our series of 50 knees (45 patients) with grade 4 osteoarthritis knee, there were 17 knee are between 51 to 60 years, 24 knee are between 61 to 70 years, and 9 knee are between 71 to 80 years. There were 22 were male knee and 28 were female knee (19 male patients and 26 female patients). There were 26 left knee and 24 right knee. All patients were grade 4 knee osteoarthritis as per Kellgrenlaiwence classification. PCO was restored in 49 knee with in 0 cm to +.0.3 cm and increased beyond 0.3cm in one knee. No anterior femoral notching noted.

Comparison of pre operative and post operative posterior condylar offset in study group:

Average mean preoperative PCO s 2.78 and average post operative PCO s 2.91. And unpaired t test is -16.819. The p value is 0.00.

Conclusion

On the basis of the above said results, we can conclude that in total knee replacement utilizing posterior referencing technique, most of the cases have their posterior condylar offset restored and the chances of anterior femoral notching are negligible. However, further studies are needed with a larger database of cases.

Conflicts of interest

None

Source of funding

None

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