



ISSN (P): 2521-3466
ISSN (E): 2521-3474
© Clinical Orthopaedics
www.orthoresearchjournal.com
2018; 2(4): 37-42
Received: 28-08-2018
Accepted: 29-09-2018

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Prospective study to determine restoration of posterior condylar offset and the risk of anterior femoral notching in total knee arthroplasty using posterior referencing technique (With Biomet, Vanguard Implant)

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Abstract

Objective: Total knee replacement surgery has been definitive management for severe grade osteoarthritis. Literature shows that posterior referencing accurately restores posterior condylar offset relative to anterior referencing but there are chances of anterior femoral notching and anterior femoral notching in turn may lead to peri-prosthetic fracture. Various studies show that anterior referencing technique affects the flexion gap tightness. This 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 observing pre-operative and post-operative knee x-ray true lateral view. **Methodology:** This is a prospective observational study of 50 consecutive cases of knee joint osteoarthritis. Posterior condylar offset was measured using picture archiving and communication systems (PACS). Post-operative X-rays knee joint true lateral views were observed for anterior femoral notching.

Results: In 49 knee replacements posterior condylar offset was restored within 0 cm to +0.3 cm. In one case pco increase beyond +0.3cm. In none of the cases pco decreased. In none of the cases anterior femoral notching was seen.

Conclusion: This study concludes that in total knee replacement using posterior referencing technique, most of the cases posterior condylar offset is restored and chances of anterior femoral notching is negligible. Further studies needed with larger number of cases.

Keywords: Posterior referencing, femoral notching, anterior referencing, total knee replacement

Introduction

Appropriate femoral component positioning and sizing is essential for proper kinematic function in total knee arthroplasty (TKA). Anterior or posterior referencing (AR or PR) are two major techniques for setting center of rotation and for balancing the sagittal plane of the arthroplasty. Both techniques have advantages and disadvantages^[1]

With anterior referencing the size of the component is based on the amount of posterior femoral condyle that is removed. Thus, the size of the flexion gap after the posterior condylar resection will differ from anatomic if exact amount of resected condyle does not equal the amount replaced by the femoral implant^[2].

Although with posterior referencing, following the posterior condylar resection the flexion gap is constant but variability in sagittal size creates a risk of notching the anterior femoral cortex as per few studies^[2]. Anterior femoral notching can increase risk of peri prosthetic fractures^[3-6]. Precision in the posterior condyle cut and restoration of the posterior condylar offset (PCO) is one of the most important concepts in obtaining a high flexion TKA. Both under-resection and over-resection of the posterior femoral condyle have significant impact on the amount of flexion that can be achieved in the TKA. For every millimeter of posterior offset lost, flexion is reduced by 6 degrees^[7].

Higher 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

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into this space to allow flexion that leads to early abutment and reduced range of flexion [7].

A very few studies have been done to determine the restoration of PCO and the incidence of anterior notching using posterior referencing system for TKA.

Aims & Objectives

This study is an observational study using posterior referencing technique with Biomet, Vanguard implant in total knee arthroplasty (TKA) :

1. To determine the difference between pre and post-operative posterior condylar offset following total knee arthroplasty.
2. To determine the risk of anterior femoral notching.

Material & Methods

Source of Data: Data was collected from patients undergoing Total knee arthroplasty at a tertiary care hospital. Sample size: 50. Study Design: A prospective observational study.

Inclusion Criteria: 1. Patient should be between 40-85 years of age. 2. Patient requiring cemented primary total knee replacement and giving consent for the same. 3. Patient is able and willing to participate in the study according to the protocol. 4. Patient has failed to respond to conservative treatment modalities.

Exclusion Criteria: 1. Patient has had a prior procedure of high tibial osteotomy, cruciate ligament reconstruction or patellectomy of the surgical knee. 2. Patient has an active or suspected latent infection in or about the knee joint. 3. Patient has a malignancy in the area of the involved knee joint. 4. Patient's bone stock is compromised by disease or infection. 5. Patient not willing to be included in the study. Method of collection of data : 50 consecutive TKA 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 perfect true lateral and true size knee X-rays would be taken. Using picture archiving and communication system (PACS), the posterior condylar offset to be determined from pre-operative and post-operative X-rays and the difference between the pre and post-operative PCO to be calculated. Also using the Tayside classification the post-operative anterior femoral notching to be determined using PACS system.

Investigations Required: True size Knee Xray, True lateral view- Pre and post-operative.

How to do Xray True Lateral View of Knee [8, 9]

1. Purpose and Structures Shown to get clear image of patella in lateral profile. Structures shown are the distal end of femur, patella, knee joint, proximal ends of tibia and fibula, and adjacent soft tissue.
2. Position of patient Patient lying on affected side. Pelvis not rotated. Affected knee forward and extend other limb behind it.
3. Position of part epicondyles perpendicular to IR (image recipient). Patella will be perpendicular to plane of the IR. Knee flexion of 20 to 30 degrees is usually preferred - this position relaxes muscles and shows maximum volume of the joint cavity.
4. Central ray 5 to 7 degrees cephalad at knee joint 1 inch (2.5 cm) distal to medial epicondyle. Slight angulation of CR (computed radiograph) will prevent joint space from being obscured by magnified image of medial femoral condyle. In lateral recumbent position, medial condyle will be slightly inferior to lateral condyle.



Fig 1: Positioning of patient while doing x ray knee true lateral view



Fig 2: Positioning of patient while doing x ray knee true lateral view

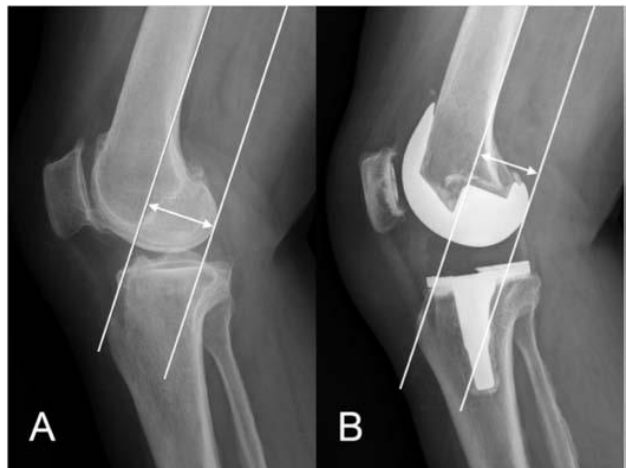


Fig 3: Standard Method of Measuring Posterior condylar Offset (PCO) [10, 11].

The posterior condylar offset (PCO) was measured pre- and post-operatively on true lateral knee radiographs by determining the shortest distance between the line tangent to posterior femoral cortex and the most posterior point of the femoral condyle (pre operatively) or femur prosthesis (postoperatively) respectively as shown above. PCO alteration was calculated from the respective measurements. PCO alteration was defined as the value obtained by subtracting the amount of Preoperative PCO from the amount of postoperative PCO.



Fig 4: Posterior referencing technique intra operative pictures

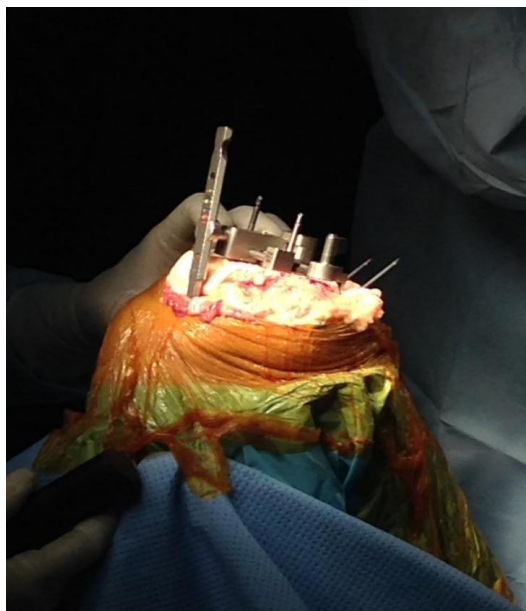


Fig 5: Posterior referencing technique intra operative pictures



Fig 6: Posterior referencing technique intra operative pictures

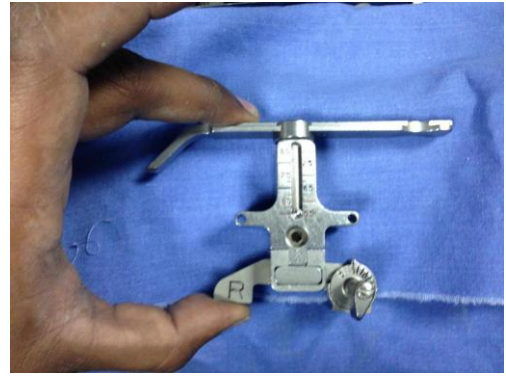


Fig 7: Posterior Referencing Jig (Biomet Vanguard Implant)

Case 1: Preop and Post Op Right Knee X rays Of 54 Years Female Patient.



Fig 8: Case 1 pre op knee x ray



Fig 9: Case 1 pre op knee xray

Case 2: Preop And Post Op Xrays Of Right Knee Of 71 Years Male Patient.



Fig 10: Case 2 pre op knee x ray



Fig 11: Case 2 post op knee x ray

Case 3: Preop and Post Op Xrays Left Knee of 67 Years Female Patient.



Fig 12: Case 3 pre op knee x ray



Fig 13: Case 3 post op knee x ray

Discussion

In total knee arthroplasty, accurate positioning of the femoral component is very important, the key reference for this is the trans-epicondylar 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-epicondylar axis can be difficult to reliably define in up to 50% of cases, whereas Whiteside’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 determining rotation of the femoral component, which is controlled by the anterior and posterior cuts made to the distal femur after application of the femoral cutting block.

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.

Anterior referencing

In Anterior referencing system, anterior femoral cortex of distal femur is taken as reference for taking cuts. Anterior referencing avoids anterior femoral notching, over stuffing of implants and improves kinematics. In anterior referencing posterior cut will be variable, i.e under sizing the implant can cause flexion instability and over sizing will cause stiffness and painful total knee arthroplasty.

Posterior referencing

In posterior referencing technique, posterior condyles are taken as reference for distal femoral cuts. It helps in accurate flexion gap balancing and 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 stuffing of patellofemoral joint.

If a posterior condylar referencing system is 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 attempting to equalise bone resection from both posterior condyles. The latter would result in an internally rotated femoral component, which has clear implications for patellar tracking.

When the block is applied for anterior and posterior femoral cuts, the femur can be relatively oversized or can be notched anteriorly. This latter problem can be a risk factor for periprosthetic fracture [13-15]

J. Bellemans, *et al.* did a study of 150 consecutive arthroplasties of the knee, they observed that the magnitude of posterior condylar offset (PCO) was found to correlate with the final range of flexion [7]

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

Ajay Malviya, *et al.* did study on TKA and concluded that posterior condylar offset had the greatest impact upon final range of movement highlighting this as an important consideration for the operating surgeon at pre-operative templating [18].

So in our prospective observational study of 50 consecutive cases of knee joint osteoarthritis admitted in a tertiary care hospital treated with standard total knee replacement using posterior referencing technique operated by single surgeon using same type of implants and instrumentation. Cases were chosen according to inclusion and exclusion criteria. X-ray knee joint true lateral view done pre-operatively and post-operatively. Posterior condylar offset was measured using picture archiving and communication systems (PACS). Post-operative X-rays knee joint true lateral views were observed for anterior femoral notching.

We observed that chances of anterior femoral notching are negligible by using posterior referencing technique in total knee replacement by doing it in appropriate way which in turn avoids periprosthetic fractures chances, where the advantages of posterior referencing like restoration of PCO and good flexion balancing can be utilised 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 kellgrenla wence 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 op and post op posterior condylar offset in study group:

Average mean preoperative PCO is 2.78 and average post

operative PCO is 2.91. And unpaired t test is -16.819. The p value is 0.00.

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	

Conclusion

This study concludes that in total knee replacement using posterior referencing technique, most of the cases posterior condylar offset is restored and chances of anterior femoral notching is negligible. Further studies needed with larger number of cases.

Source of Support: Nil

Conflict of Interest: Nil

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