



E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2022; 8(1): 282-285
© 2022 IJOS
www.orthopaper.com
Received: 28-11-2021
Accepted: 30-12-2021

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Post operative correlation of femoral & tibial components with knee alignment using roentgenographic index in patients undergoing total knee arthroplasty in a tertiary referral centre

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DOI: <https://doi.org/10.22271/ortho.2022.v8.i1d.3031>

Abstract

Total knee arthroplasty is the leading surgical treatment for advanced osteoarthritis of the knee. Despite its efficiency, approximately twenty percent of the cases are dissatisfied with the outcome. Mal positioning of components results in loosening, which has long-term consequences. As a result, proper sizing and placement are important for optimal functional and long-term outcomes. Achieving limb alignment, good soft tissue balance and pain relief are the primary goals of the surgeon upon completion of total knee replacement (TKA). The aim of this study was to determine the accuracy of placement of femoral and tibial components post-operatively in relation to knee alignment using a roentgenographic index. This is a prospective study conducted in a tertiary care referral hospital, we included a total of fifty cases who underwent total knee arthroplasty from the year 2019 to 2020. Post-operative radiographic parameters were measured using digital software and compared using roentgenographic indexes as described by Lotke *et al.* Out of the fifty Total Knee Arthroplasty cases, twenty-eight knees had perfectly positioned tibial and femoral prosthesis, fifteen cases had good position of both the components. Tibial component alignment angle ($\beta = 90^\circ$) in relation to mechanical axis in coronal plane was seventy six percent; fourteen percent of the cases were in native knee varus. Femoral component alignment angle (α) with acceptable anatomical valgus ($0-7^\circ$) were more than eighty percent of the cases. 85.5 was the mean roentgenographic index which was strongly correlatable with other similar studies. With good clinical acumen and using conventional alignment system, near to normal knee alignment in total knee arthroplasty is achievable.

Keywords: total knee arthroplasty, roentgenographic index, femoral-tibial angle, femoral component alignment angle

Introduction

The Total Knee Arthroplasty (TKA) is a widely performed procedure that has been demonstrated to offer functional enhancement and pain relief to most patients with advanced knee arthritis. Excellent outcome following this procedure depends on many factors including preoperative condition of patient, the design and material components and various surgical techniques [2, 6]. Survival rates of TKA prosthesis on an average is 15 years in almost 90% of the cases and it keeps improving with newer designs and technology [7]. Radiological imaging plays a vital role in the management, in diagnosing various complications, and for further follow up. Implant loosening and infections are the most troublesome complications of TKA, but several others such as component malposition, polyethylene wear, particle disease or osteolysis, periprosthetic fractures, bursitis and tendon pathology may also result in hardware failure and or pain [8].

A conventional radiograph is the first line of imaging study in the evaluation of TKA post operatively as well as in symptomatic knees [8-9]. The American College of Radiology appropriateness criteria for the evaluation of a patient with hip or knee arthroplasty (2000) gives conventional radiographs as informative, quick, and relatively inexpensive method of evaluation of both the prosthetic components and the native bone.

Post-surgery evaluation of the components can be assessed with an anterior-posterior radiography of the knee obtained in the recovery room immediately after surgery [10]. Anterior-Posterior views on standing, lateral, and tangential patellar views are obtained routinely before the patients are discharged or within three months of the surgery [8]. One of the goals of TKA is to restore physiological knee alignment to a neutral to 7° valgus tibiofemoral coronal angle [11]. The native proximal tibia is in a varus of 3° [10]. Presently studies are showing good results with a re-creation of this tibial joint surface alignment or the kinematic alignment within 3° of varus and long term are yet to be published [11]. Widely accepted tibial component placement is perpendicular to the mechanical axis of the tibia, which is the same as an anatomical axis to improve load distribution evenly across the implant [11]. Achieving normal knee alignment with navigation in total arthroplasty is well documented, Stockl *et al.* in his study, suggested better rotational alignment of the femoral component with image free navigation systems [10]. Sound clinical knowledge, precise surgical cuts and using a conventional alignment system can provide good to excellent component positions in total knee arthroplasty. In this proximity, the present study attempts to investigate and assess the radiological correlation of knee alignment with both components in TKA surgery by using post-operative radiographs and knee index as described by Lotke *et al.* [1] and knee society (2011).

Materials and Methods

The present study was undertaken, with patients who underwent Total Knee Arthroplasty using a single radius femoral type of prosthesis in a tertiary care institute from 2019-2020. Patients with primary degenerative osteoarthritis, secondary osteoarthritis who required Total Knee Arthroplasty were included, whereas grossly deformed knees

requiring stem extenders and revision Total Knee Arthroplasty were excluded from this study. Fifty knees fulfilled the inclusion criteria, out of which twenty-five were males and twenty-five were females. Informed consent and institutional clearance were obtained as per the standard operating protocol. All the cases were performed using posterior ligament-substituting type prosthesis and the femoral component was single radii type. All Total Knee Arthroplasty cases were performed by senior surgeons through a medial parapatellar approach and using measured resection techniques. Conventional intramedullary instrumentation for distal femoral resection and extramedullary instrumentation for tibial resection was used. Anteroposterior radiographs are taken in the supine position after the surgery. A Scannogram of the lower limb, lateral views of the knee, and other special views are taken 2 days after the procedure. The radiological review was done at three months and six months. A qualified interviewer performed all measurements and radiological parameters were investigated and verified with the help of a radiologist. Digital software was used for calculating knee alignment angles.

Mean values of angles between the individual axis (which includes femoral-tibial angle, mechanical axis of the femur and tibia) were obtained using digital software (as shown in the figure1) and was used in the descriptive, logistic regression statistical analysis. The position of the components was assessed by examining the initial post-operative roentgenogram and categorizing it according to a previously developed scoring system suggested by Lotke *et al.* [1]. Roentgenographic index of recruited patients was determined and classified based on findings at six months post-surgery. The person correlation and two tailed t test were used to test the significance of the research findings and all test was set at $p < 0.001$.

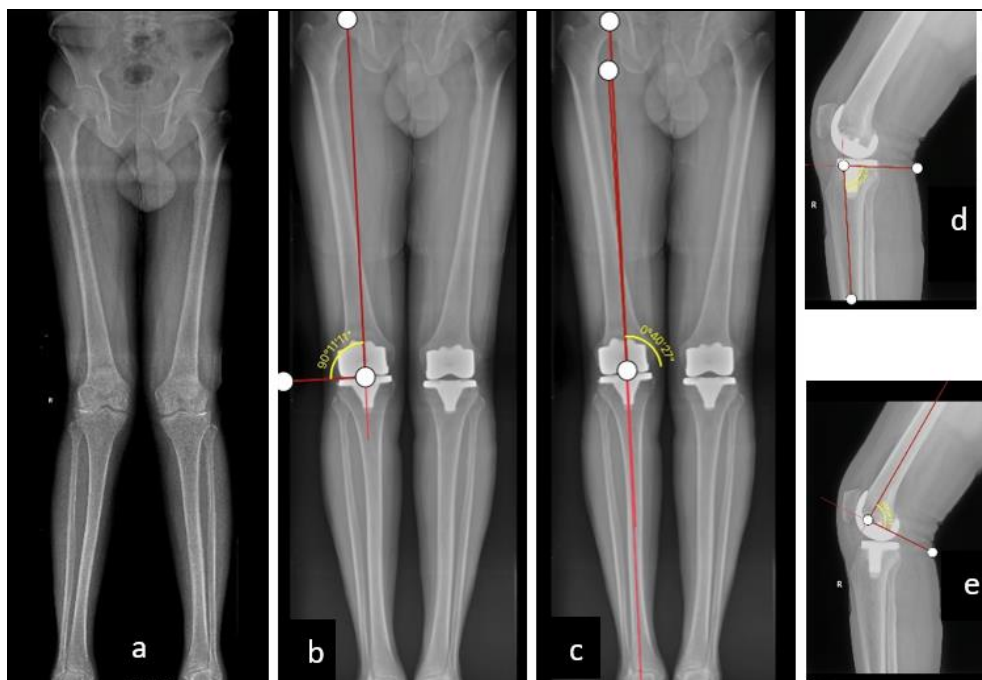


Fig 1: a) Scanogram of a bilateral secondary OA case, (b) Post-op radiograph showing mechanical axis of right femur, (c) post-op radiograph showing femoral-tibial angle of right lower limb (d & e) sagittal alignment of femur and tibia (right lower limb) post-op radiographs.

Results

The clinical results were summarised in the following tables, Roentgenographic index of forty-five knees had a score above

seventy-five and eighteen knees showed excellent scores between 91-100 as shown in table 1.

Table 1: Roentgenographic index

RI	No of Knees	P-value
50-60	01(2.00%)	≥ 0.001
61-70	01(2.00%)	≤ 0.001
71-80	09(18.00%)	≤ 0.001
81-90	21(42.00%)	≤ 0.001
91-100	18(36.00%)	≤ 0.001
Total	50(100.00%)	

Table 2: Tibial component alignment angle (β)

Range	No of Knees	P-value
$< 87^\circ$	0(0.00%)	-
$87^\circ - 89^\circ$	10(20.00%)	≥ 0.001
90° (Normal)	28(56.00%)	≤ 0.001
$91^\circ - 93^\circ$	10(20.00%)	≤ 0.001
$> 93^\circ$	02(4.00%)	≤ 0.001

Tibial component alignment angle of thirty-eight knees were between $90^\circ - 93^\circ$, and twenty-eight knees showed perfect alignment at 90° , as depicted in table 2.

Table 3: Femoral component alignment angle

FC A	No of Knees	P-value
0° Varus	05(10.00%)	≤ 0.001
$0 - 3^\circ$ Valgus	18(36.00%)	≤ 0.001
$4 - 6^\circ$ Valgus (Normal)	20(40.00%)	≤ 0.001
$7 - 9^\circ$ Valgus	05(10.00%)	≤ 0.001
$> 9^\circ$ Valgus	02(4.00%)	≥ 0.001

Table 3 shows the femoral component angle of thirty-eight cases between 0 and 7° of valgus. Tibio-femoral angle of thirty-five knees were between 4° and 7° .

Table 4: Femoral-Tibial angle

Tibiofemoral angle (δ)	No of Knees	P-value
$> 3^\circ$ Varus	01 (02.00%)	≤ 0.001
3° Varus to 0° (Neutral)	5 (10.00%)	≤ 0.001
0° (Neutral) to 3° Valgus	04 (08.00%)	≤ 0.001
4° Valgus to 7° Valgus	35 (70.00%)	≤ 0.001
7° Valgus to 11° Valgus	5 (10.00%)	≤ 0.001
$> 11^\circ$ Valgus	0(0.00%)	-

Discussion

Total knee arthroplasty is the last resort for end stage osteoarthritis (OA) of the knee. Despite its effectiveness, there are about 10-20% of cases who are dissatisfied with the outcome. Achieving normal tibio-femoral alignment is the ideal outcome after every total knee replacement. With the advent of new technologies, knee arthroplasty surgeries have scaled new pinnacles. Various modalities are available to evaluate knee alignment after total knee arthroplasty. Radiographs have become second to computed tomography scan in evaluating knee alignments, but it is still a cheaper and useful modality in assessing the immediate post-operative status. Orthopaedic surgeons can gather a lot of information from the present-day digital 2D radiographs.

The position of the components also plays a fundamental role in the function of a total knee arthroplasty by determining the alignment of the knee and the patellar-femoral tracking^[11].

The most important outcome variable after TKA is the coronal alignment of the limb. Due to the variable anatomy of the knee, TKA should be assessed by measuring mechanical alignment rather than anatomic alignment^[12].

Mizu-uchi *et al.*^[10] studied a total of 76 total knee arthroplasties, out of which 39 were done with the

conventional method and 37 were done with CT based navigation system. The mean tibial-femoral angle was 4.2° valgus. The mean femoral component alignment angle was 88.50° . The mean tibial components alignment angle was 89.7° and the mean femoral components was 85.50° .

Peterson and Engh^[13] in their study of 50 knees, reported that 74 percent of their knees had a tibio-femoral angle of $4^\circ - 7^\circ$ valgus.

J. Mahaluxmivala *et al.*,^[11] had shown similar results in 673 TKA s done with press-fit prosthesis. They had 75.3% of their cases having an ideal tibio-femoral angle of 4-7 valgus measured with radiographs.

A total of 76 TKAs were studied and reported by Brown in 2018. By reviewing of initial post-operative radiograph and grading system, he evaluated the position of the prosthesis, and research findings were correlated according to roentgenographic index^[4]. The Scores on the initial post-operative roentgenograms averaged 78.2 points. However, a perfect score of 100 points were seen with seven knees.

Puranik and Pravin^[14] in their study of 100 cases, they achieved a normal tibiofemoral angle of $4 - 10^\circ$ valgus in 65 knees and in 87 knees, the alignment was within 3° varus/valgus of normal alignment. Normal femoral component placement of $4 - 7^\circ$ valgus was seen in 35 knees and 82 knees had near-normal alignment. The mean femoral alignment angle (α) was $94^\circ \pm 3.92$. Similarly, tibial alignment angle of (β) 90° was appreciated in 52 knees and the mean tibial alignment angle was $91^\circ \pm 2.45$. They had $> 80\%$ TKA with good alignment in radiographs.

According to point score system and above cited reference for roentgenographic analysis by Lotke *et al.*, we analysed the positioning of prosthesis in total knee replacements in this present study. A total of fifty patients who underwent total knee arthroplasty for varus knees were assessed. We measured postoperative mechanical femorotibial angle, medial proximal tibial angle, and lateral distal femoral angle on standing anteroposterior and lateral x rays during follow-up. A perfectly positioned prosthesis was seen with a total of eighteen knees. We achieved a normal tibiofemoral angle of $4^\circ - 7^\circ$ valgus in 37 knees. The normal femoral component angle was $0 - 7^\circ$ in thirty-eight knees. The tibial component alignment angle (β) in our study was normal / 90° in twenty-eight cases, which is comparable with other results. 85.55 was the mean roentgenographic index, which is in the acceptable limits of the study intervention.

Conclusion

The present study concludes about the tibial and femoral components alignment as well as the overall limb alignment and surgical TKA is achieved well and comparable to the normal knee as done with other techniques. The radiographic findings as seen, by post op x-ray evaluation showed variations well within acceptable limits. Finally, we conclude that with good clinical acumen, proper technique and surgeon expertise, surgeon can give a fair amount of radiological alignment and placement of prosthesis, which is in par with computer-assisted TKA and other methods. However, a more accurate study comparing these results with CT scan would be beneficial to find out a rationale.

Conflict of interest

The authors declare no conflict of interest whatsoever arising out of the publication of this manuscript.

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