Original Article

Radiological Assessment of Alignment of Knee and Prosthesis after Primary Total Knee Arthroplasty

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Abstract

Background: Total knee arthroplasty (TKA) is procedure which is widely performed to give functional improvement and pain relief in advanced knee arthritis patients. Nonanatomic component placement often results in component loosening. Hence, correct sizing and placement are important for optimal functional and long-term results.

Objectives: The aim of this study is to evaluate alignment of knees and placement of prostheses in post-operative knee roentgenograms.

Materials and Methods: This is retrospective study of patients who underwent TKA using various types of prostheses in a tertiary care institute. Various angles were measured to evaluate limb alignment, placement of the tibial and femoral prostheses according to roentgenographic knee evaluation system endorsed by the knee society[1] and also roentgenographic index was calculated as suggested by Lotke *et al.*[2]

Results: We evaluated 100 post-operative knee roentgenograms in a tertiary care institute. Out of which, 88 knees showed acceptable, overall knee alignment calculated by tibiofemoral angle. A total of 82 knees showed normal placement of femoral component calculated by femoral component alignment angle. A total of 85 knees had tibial component placement within normal range calculated by tibial component alignment angle. Totally, 90 knees showed roentgenographic index score in normal range.

Conclusion: In this study, we conclude that total knee arthroplasties were done without using navigation and with proper technique also give fairly good amount of radiological alignment and placement of prostheses.

Key words: Alignment, Prostheses, Roentgenographic index, Total knee arthroplasty

INTRODUCTION

Total knee arthroplasty (TKA) is widely performed procedure that has been demonstrated to provide functional improvement and pain relief for most of patients with advanced knee arthritis.[1] Successfulness of this procedure depends on many factors including pre-operative condition of patient, the design and materials of components, and surgical technique.[2]

Nonanatomic component placement or ligamentous instability often results in components loosening. Tibial component more frequently loosens than others. Various surgical techniques and systems of instrumentation have been devised to obtain optimal post-operative alignment of components. The importance of correct sizing of components and putting them in correct axial alignment and angular positioning for TKA for optimal functional and long-term result has been stressed. Radiologic evaluation is done to assess the alignment and early diagnosis of loosening, instability, polyethylene wear, patellar complications, infection, etc. The present study focuses on the radiological evaluation post-operatively by a roentgenographic knee evaluation system endorsed by the knee society[3] which encourages uniform reporting of the results of TKA. In addition to measurement of

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knee alignment and component position, the system has a numerical score for the prosthetic interface that assesses the quality of fixation.

Aims and Objectives

The aim of this study is to evaluate alignment of knees and placement of prostheses in post-operative roentgenograms.

MATERIALS AND METHODS

This is a retrospective study of patients who underwent TKA using various types of prostheses in a tertiary care institute from 2010 to 2016. A total of 100 knees in 62 females and 38 males were included in this study for evaluation. Patients with primary knee osteoarthritis, secondary osteoarthritis with pain, and requiring TKA were included, whereas grossly deformed knees requiring stem extenders and revision TKA were excluded from this study. Informed consent was obtained from each patient. Both anteroposterior and lateral plain radiographs are taken in standing position in post-operative status. All measurements were carried out by trained investigator and radiological parameters were studied. The position of a prosthesis was evaluated by reviewing the initial post-operative roentgenogram and grading it on a previously developed scoring system suggested by Lotke *et al*.[4] (Table1).

Mean values of the angle between the individual axes obtained by taking measurements were used in following statistical analysis.

Roentgenographic index[4] of our patients was calculated and grouped into five groups. The Pearson's correlation coefficient (p) was calculated to measure the significance of the correlation. Statistical significance for all tests was set at $P < 0.05$.

RESULTS

We studied 100 knees out of which 62 were female and 38 were male. We analyzed overall limb alignment with tibiofemoral angle (δ) (angle between tibial anatomical axis and femoral anatomical axis). A total of 68 knees had normal alignment (Table 2) and 88 knees had alignment from 3° varus to 10° valgus. For the femoral component alignment, there were 82 knees which were having placements within 3° varus/valgus of normal placement and 18 knees which having prosthesis with >3° varus/valgus placement (Table 3). For the tibial component alignment, there were 85 knees with tibial components placement within 3° varus/valgus of normal placement, and 15 knees had prosthesis with >3° varus/valgus placements (Table 4).

On lateral view, the average femoral flexion angle was 6.32 ± 6.80° and average tibial flexion angle (σ) was 91.56 ± 3.80°.

We evaluated postoperative placement of prosthesis radiologically with roentgenographic index as suggested by Lotke *et al*.[1-4] Mean roentgenographic index was 85.2 ± 9.32. Range was 50 to 100. Around 9 knees had roentgenographic index of 100, i.e., had perfect placement of prosthesis.

Table 1: Calculation of roentgenographic index

Roentgenographic index (100 points)	
Overall alignment (possible 25 points)	
Neutral±2°	20
Valgus	
3-7°	25
8-12°	15
13-20°	5
More than 20°	0
Varus	
3-7°	15
8-12°	5
13-20°	0
Tibial component placement	
AP View	
Horizontal	30
1-3° varus or valgus	25
4-6° varus or valgus	20
7-9° varus or valgus	10
>10° varus or valgus	0
Lateral view	
Horizontal	10
0-3° anterior or posterior tilt	8
4-6° anterior or posterior tilt	4
7-9° anterior or posterior tilt	2
>10° anterior or posterior tilt	0
Axial placement	
Central	10
Slightly offset	5
Markedly offset	0
Femoral component placement	
Valgus	20
Horizontal	
1-3°	20
4-6°	25
7-9°	15
10-15°	10
>15°	0
Varus	
1-3°	15
4-6°	10
7-9°	5
>10°	0

Table 2: Tibiofemoral angle

Tibiofemoral angle (δ)	Number of knees
>3° varus	3
3° valgus to 3° varus	20
4° valgus to 10° valgus (normal)	68
11° valgus to 17° valgus	9
>17° valgus	0

A total of 36 knees had index between 90 and 100 while 90 knees had roentgenographic index of >75 (Table 5).

DISCUSSION

Total knee replacement has become a very successful procedure due to improvements in prostheses and surgical techniques. However, malpositioning of components is likely to occur which has got long-term consequences.

Restoration of limb axial alignment affects long-term results of TKA. Many authors have investigated the effect of coronal alignment on implant survival and have suggested tolerable limits of component placement within 3° varus/valgus of ideal placement based on analysis of highest success rates.

In previous studies, Jakobi *et al.*[5] studied 1133 inner TKAs with post-operative radiographs for alignment. The average tibiofemoral angle (δ) was 5° valgus. On anteroposterior radiographs, femoral alignment (α) was 95°. Mean tibial alignment angle was (β) 93°. Lateral radiographs revealed femoral component flexion of 88°, i.e. γ angle of 2°. Average tibial component flexion angle (σ) measured was 86°.

The radiological follow-up of index TKA with minimum 2 years showed no complete radiolucent lines, and none of the component was radiographically loose as well.

Table 3: Femoral component alignment angle

Femoral component alignment angle (α)	Number of knees
<0° varus	10
0°-3° valgus	32
4°-6° valgus (normal)	35
7°-9° valgus	15
>9° valgus	8

Table 4: Tibial component alignment angle (β)

Tibial component alignment angle (β)	Nubmer of knees
<87°	0
87°-89°	4
90° (Normal)	52
91°-93°	29
>93°	15

Table 5: Roentgenographic index

Roentgenographic index	Number of knees
50-60	2
61-70	2
71-80	18
81-90	42
91-100	36

Mizu-uchi *et al.*[6] studied total 76 total knee arthroplasties, out of which 39 were done with conventional method and 37 were done with CT-based navigation system. Mean tibial femoral angle was 4.2° valgus. Mean femoral component alignment angle was 88.5°. Mean tibial component alignment angle was 89.7°. Mean femoral component flexion was 85.5°.

As per Lotke *et al.*,[4] normal tibiofemoral alignment is 4-10° valgus and normal femoral component (α) and tibial component (β) alignment angles are 4-6° valgus and 90° (perfect placement), respectively. As per Miza-uchi *et al.*,[6] normal femoral component flexion angle (γ) is 0-7° and tibial component flexion angle (σ)[6] is 90°.

In the present study, we studied 100 knees and their radiological analysis pre- and post-operatively in a tertiary care center in India. In 65 knees, normal tibiofemoral angle of 4-10° valgus has been achieved. However, in 87 knees, the alignment was within 3° varus/valgus of normal alignment. Mean alignment was 5° valgus ±5.10. This falls well within recommended range of alignment as described in literature.

We had 35 knees having normal femoral component placement of 4-6° valgus and 82 knees had alignment within 3° varus/valgus of normal alignment. Mean femoral alignment angle (α) was 94° ± 3.92. These findings are in agreement with current literature as well.

We had 52 knees with tibial alignment angle (β) 90° (normal) and 85 knees with alignment within 3° varus/valgus of normal alignment. Mean tibial alignment angle was 91° ± 2.45. These results are well within normal recommended range.

Thus, more than 80 percent TKA having overall alignment, femoral component placement, and tibial component placement in acceptable limits on lateral radiographs.

Mean femoral component flexion angle (γ) was 6.32° ± 6.80, i.e., femoral component flexion was 83.68°. Mean tibial component flexion angle (σ) was 91.5° ± 3.80. Thus, results of our study are comparable with literature above.

There were no radiolucent lines in post-operative radiographs after minimum 1 year follow-up. It suggests proper placement and fixation of prosthesis in a short-term follow-up.

Lotke *et al.*[4] in 1977 studied 76 TKAs done with geometric TKA. They evaluated position of prosthesis by reviewing initial post-operative radiograph and grading it according to roentgenographic index. Scores on initial post-operative

roentgenograms averaged 78.2 points. Seven knees received perfect score of 100 points.

According to point score system for roentgenographic analysis by Lotke *et al.*[4], we analyzed the positioning of prostheses in total knee replacements. A total of 9 knees had perfectly positioned prostheses. Mean roentgenographic index was 85.25. Totally, 90 knees had index >75 which is an acceptable limit.

Alignment obtained from conventional plain radiographs is of limited value because they might have poor reproducibility caused by tibial rotation in lateral view. In contrast, measurements based on computed tomography (CT) images are more accurate as variations in calculations are smaller.

CONCLUSION

In this study, we conclude that tibial and femoral component alignment as well as the overall limb alignment achieved is comparable to the normal knee anatomy using conventional method in most of the patients. However, more accurate study with CT scan would be beneficial to find out a rationale. Further randomized control trials are needed to compare results of TKA done by navigation system and mechanical alignment devices.

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