Comparison of overall component alignment and functional outcome between navigation and conventional total knee arthroplasty

Dr. Savith V Shetty, Dr. Mohammed Azhruddin A, Dr. Deepak Rai and Dr. Akbar Ali AM

DOI: https://doi.org/10.22271/ortho.2019.v5.i3l.1614

Abstract

Aim: of the study was to compare the functional outcome in patients undergoing navigation and conventional total knee replacement. secondly to compare the component alignment in patients undergoing navigation and conventional Total Knee Replacement.

Materials and methods: Total 80 patients were included in study out of which 40 patients were in each group. All the surgeries were done by single surgeon and subvastus approach was used for all the total knee replacements.

Pre-operative functional assessment was done by KSS score14. Preoperative radiological grading of osteoarthritis was done using AHL back. Post operatively all patients were followed upto 1,3 and 6 months and at the end of 6 months radiological assessment of the components was done by measuring Alpha, beta, gamma and sigma angles.

Conclusion: Navigation TKR significantly improves the alignment of both femoral and tibial components when compared with the conventional TKR. However there was no significant difference in functional outcome between the two methods. Probably a long term study might highlight on if navigation has a role in improving the longevity of the implant.

Keywords: TKR- Total knee replacement, SV- Subvastus, KSS- Knee Society Score

Introduction

Total Knee Arthroplasty (TKR) has evolved since the total condylar knee was introduced in 1973. A procedure performed for severe disability from pain and deformity of Osteoarthritis, Rheumatoid Arthritis and other form of knee arthritis [3]. Outcome of TKR depends on various factors, viz. alignment of the prosthesis, soft tissue balancing and the post op rehabilitation [3]. Among these factors the alignment and positioning of the prosthesis can be improved by the use of navigation system. In Conventional TKR usually an intramedullary rod and extramedullary jig for femur and tibia respectively is used for distal femur and proximal tibial cuts. Here there could be some error in the alignment and placement of prosthesis as it is not precise like navigation system.

The survival of a total knee arthroplasty depends on the precise placement of the components to obtain the ideal mechanical axis and patella tracking [4, 5]. This in turn, depends on the accuracy of the bone cuts and careful soft tissue balancing [3]. Computer navigation can aid the surgeon in the better placement of these components. Initial navigation systems were computed tomography (CT)-based which required a preoperative CT scan which added to the cost of the surgery and exposed the patient to radiation from the CT scan [1]. Current technology allows for kinematics-based navigation which does not require a preoperative CT scan [3]. This imageless system utilizes an infrared camera which detects markers which are placed at the articular surface of the tibia and the femur. Previous navigation system the trackers were placed on the shaft of the tibia and the femur which in some patients lead to stress fractures at the site of the insertion of the pins for mounting navigation trackers. With the advent of articular surface navigation system this complication is avoided. Also the additional advantage of the navigation system is there is no need to drill intramedullary for the femoral component.
The Purpose of the Study
To compare the component alignment and functional outcome following navigation and conventional Total Knee Replacement.

Objective of the Study
▪ To compare the functional outcome in patients undergoing navigation and conventional total knee replacement.
▪ To compare the component alignment in patients undergoing navigation and conventional Total Knee Replacement.

Hypothesis
Navigated Total Knee Replacement would have been better component alignment and would give better functional outcome.

Methodology
Study Design: Retrospective study
Materials and Methods
The medical records of the patients from December 2016 to December 2018 who underwent Total knee arthroplasty with or without navigation were utilised to collect the data of the patient from the yenepoya and allied hospital. All the surgeries were done by single surgeon and subvastus approach was used for all the total knee replacements. Pre-operative functional assessment was done by KSS score [14]. Preoperative radiological grading of osteoarthritis was done using AHL back. Post operatively all patients were followed upto 1,3 and 6 months and at the end of 6 months radiological assessment of the components was done by measuring Alpha, beta, gamma and sigma angles. These angles were calculated by a radiologist who was blinded about the patient information (ie conventional or navigated TKR).

To reduce the inter observer bias all the angles were reassessed by the author. Post operatively at 6 months functional outcome was also assessed using the KSS score [14]. The choice of navigation was given to all the patients but those who had affordability issues conventional TKR was done in them.

Statistical Analysis
Analysis collected data was summarized by mean and standard deviation of Functional score, KSS score, Alpha angle, Beta angle, Gamma angle and Delta angle. Categorical data such as Age, Gender was summarized by frequency and percentage comparison of group A and group B at various time point and for various parameters unpaired t test was performed. To compare the change with the group was done.
by repeated measures a nova followed by Bonferroni post HOC analysis.

Inclusion criteria
All patients who underwent Total knee replacement by conventional method and computer assisted navigation will be included in this study. Knee society score (KSS) \(^{[14]}\) will be utilised for functional outcome and plain x-rays are used for mechanical alignment.

Surgical technique
Anterior midline incision, Subvastus approach was used, medial soft tissue release done and lateral genicular artery cauterised. Osteophytes were excised and remnants of medial meniscus ACL and PCL were resected out. Lateral meniscus resected and tibia subluxated forward. Femoral tracker applied to the articular surface and distal resection jig applied after navigating the distal femur with nav-3 stryker navigation. Appropriate bone cuts were taken medially and laterally. Tibial tracker applied on the articulating surface of the tibia and resection of the proximal tibia was done. Need for the intramedullary jig was not there as the femur is computer navigated. Extension gap stable and trial prosthesis was put and patella tracking was done. Final implantation done and wound closed in layers over drain. Post operatively the rehabilitation was started on the day of the surgery in the evening, all patients were made to walk on the same day and knee bending and SLR was started.

Results

Table 1: 35% of the respondent in Group A belong to the age group 45-60 and 65% belongs to Above 60 Whereas in Group B 45% of the respondent belongs to the age group 45-60 and 55% belongs to the age group Above 60. Group A consist of 15 males and 25 females whereas in Group B 8 males and 32 females. However there was no significant difference between age and sex distribution.

|             | Group A |             | Group B |             |
|-------------|---------|-------------|---------|-------------|
|             | Count   | Column N %  | Count   | Column N %  |
| Age         |         |             |         |             |
| 45 - 60     | 14      | 35.0%       | 18      | 45.0%       |
| Above 60    | 26      | 65.0%       | 22      | 55.0%       |
| Total       | 40      | 100.0%      | 40      | 100.0%      |
| Sex         |         |             |         |             |
| M           | 15      | 37.5%       | 8       | 20.0%       |
| F           | 25      | 62.5%       | 32      | 80.0%       |
| Total       | 40      | 100.0%      | 40      | 100.0%      |
| Side        |         |             |         |             |
| B/L         | 1       | 2.5%        | 0       | 0%          |
| LT          | 15      | 37.5%       | 20      | 50.0%       |
| RT          | 24      | 60.0%       | 20      | 50.0%       |
| Diagnosis   |         |             |         |             |
| B/L OA      | 7       | 17.5%       | 1       | 2.5%        |
| OA          | 32      | 80.0%       | 38      | 95.0%       |
| RA          | 1       | 2.5%        | 1       | 2.5%        |

Fig 1: Bar Chart of Age distribution

Table 2: p value shows no significance between both groups

|             | chi square/Fishers exact test p |
|-------------|--------------------------------|
| Age         | 0.361                          | NS    |
| Sex         | 0.084                          | NS    |
| Side        | 0.354                          | NS    |
| Diagnosis   | 0.082                          | NS    |
Fig 2: Bar Chart of Sex distribution

Fig 3: Bar Chart of side distribution

Table 3: Comparison between the groups

| Functional | N   | Mean  | Std. Deviation | Lower Bound | Upper Bound | t test | p value |
|------------|-----|-------|----------------|-------------|-------------|--------|---------|
|            |     |       |                |             |             |        |         |
| PRE OP     | Group A | 47 | 52.38 | 14.824 | 48.03 | 56.74 | .786 | NS      |
|            | Group B | 41 | 51.59 | 12.249 | 47.72 | 55.45 |        |         |
| 3 Months   | Group A | 47 | 72.98 | 7.985 | 70.63 | 75.32 | .378 | NS      |
|            | Group B | 41 | 71.59 | 6.561 | 69.51 | 73.66 |        |         |
| 6 Months   | Group A | 47 | 84.47 | 7.463 | 82.28 | 86.66 | .056 | NS      |
|            | Group B | 41 | 81.59 | 6.368 | 79.58 | 83.60 |        |         |
| KSS        | PRE OP | Group A | 47 | 65.51 | 12.409 | 61.87 | 69.15 | .522 | NS      |
|            | Group B | 41 | 63.63 | 14.936 | 58.92 | 68.35 |        |         |
| 3 Months   | Group A | 47 | 64.89 | 7.891 | 62.58 | 67.21 | .012 | sig     |
|            | Group B | 41 | 61.12 | 5.496 | 59.39 | 62.86 |        |         |
| 6 Months   | Group A | 47 | 70.04 | 6.118 | 68.25 | 71.84 | .035 | sig     |
|            | Group B | 41 | 67.44 | 5.182 | 65.80 | 69.07 |        |         |
| ROM        | PRE OP | Group A | 47 | 92.34 | 15.067 | 87.92 | 96.76 | .449 | NS      |
|            | Group B | 41 | 94.39 | 8.958 | 91.56 | 97.22 |        |         |
| 3 Months   | Group A | 47 | 96.38 | 6.733 | 94.41 | 98.36 | .092 | NS      |
|            | Group B | 41 | 98.78 | 6.401 | 96.76 | 100.80 |        |         |
| 6 Months   | Group A | 47 | 109.79 | 8.206 | 107.38 | 112.20 | .151 | NS      |
|            | Group B | 41 | 112.20 | 7.250 | 109.91 | 114.48 |        |         |
Table 4: Comparison within the Group

|          | N   | Mean  | Std. Deviation | Lower Bound | Upper Bound | Repeated measures Anova p value |
|----------|-----|-------|----------------|-------------|-------------|---------------------------------|
| **Functional** |     |       |                |             |             |                                 |
|          | Pre-op | 47    | 52.38          | 14.824      | 48.03       | 56.74                           | .000               | HS       |
|          | 3 Months | 47    | 72.98          | 7.985       | 70.63       | 75.32                           |                     |          |
|          | 6 Months | 47    | 84.47          | 7.463       | 82.28       | 86.66                           |                     |          |
|          | Pre-op | 41    | 51.59          | 12.249      | 47.72       | 55.45                           | .000               | HS       |
|          | 3 Months | 41    | 71.59          | 6.561       | 69.51       | 73.66                           |                     |          |
|          | 6 Months | 41    | 81.59          | 6.368       | 79.58       | 83.60                           |                     |          |
| **KSS**  | Pre OP | 47    | 65.51          | 12.409      | 61.87       | 69.15                           | .000               | HS       |
|          | 3 Months | 47    | 64.89          | 7.891       | 62.58       | 67.21                           |                     |          |
|          | 6 Months | 47    | 70.04          | 6.185       | 68.25       | 71.84                           |                     |          |
|          | Pre OP | 41    | 63.63          | 5.496       | 61.12       | 62.86                           |                     |          |
|          | 3 Months | 41    | 81.12          | 6.368       | 79.58       | 83.60                           |                     |          |
|          | 6 Months | 41    | 87.44          | 5.182       | 85.80       | 89.07                           |                     |          |
| **Rom**  | Pre-op | 47    | 92.34          | 15.067      | 87.92       | 96.76                           | .000               | HS       |
|          | 3 Months | 47    | 96.38          | 6.733       | 94.41       | 98.36                           |                     |          |
|          | 6 Months | 47    | 109.79         | 8.206       | 107.38      | 112.20                          |                     |          |

**Fig 5:** Group A and Group B shows significant improvement in KSS score

Table 5: Post hoc analysis

|          | Mean difference | S.D of difference | Bonferroni p value |
|----------|-----------------|-------------------|-------------------|
| **Functional** |                 |                   |                   |
|          | Pre Op – 3 months | -20.596           | 13.113            | .000               | HS       |
|          | Pre Op – 6 months | -32.085           | 14.768            | .000               | HS       |
|          | 3 Months – 6 Months | -11.489          | 4.026             | .000               | HS       |
|          | Pre Op – 3 months | -20.000           | 11.079            | .000               | HS       |
|          | Pre Op – 6 months | -30.000           | 11.435            | .000               | HS       |
|          | 3 Months – 6 Months | -10.000          | 2.236             | .000               | HS       |
| **KSS**  | Pre Op – 3 months | -4.532            | 11.749            | .011               | Sig      |
|          | Pre Op – 6 months | -5.149            | 3.470             | .000               | HS       |
|          | Pre Op – 3 months | 2.512             | 14.905            | .287               | NS       |
|          | Pre Op – 6 months | -3.805            | 14.980            | .112               | NS       |
|          | 3 Months – 6 Months | -6.317           | 3.771             | .000               | HS       |
| **Rom**  | Pre Op – 3 months | -4.043            | 12.625            | .199               | NS       |
|          | Pre Op – 6 months | -17.447           | 12.418            | .000               | HS       |
|          | 3 Months – 6 Months | -13.404          | 5.224             | .000               | HS       |
|          | Pre Op – 3 months | -4.390            | 8.077             | .001               | HS       |
|          | Pre Op – 6 months | -17.805           | 10.127            | .000               | HS       |
|          | 3 Months – 6 Months | -13.415          | 5.296             | .000               | HS       |

**Fig 5:** Group A and Group B shows significant improvement in KSS score
| Parameter | A: ALPHA | B: BETA |
|-----------|----------|---------|
|            | Mean     | Std. Deviation | 95% Confidence Interval for Mean | t test p value |
|            | Lower Bound | Upper Bound |          |            |
| Group A    | 90.23     | 3.02     | 89.96 | 91.17 | .000 | HS |
| Group B    | 92.54     | 2.78     | 91.69 | 93.40 | .007 | HS |
| Total      | 91.70     | 2.95     | 91.06 | 92.33 |        |

Fig 6: Coronal Femoral component alignment between groups (Alpha angle)

Fig 7: Coronal tibia alignment between both groups (Beta angle)
Table 8: Parameter A: Delta

|       | N  | Mean | Std. Deviation | 95% Confidence Interval for Mean | t test p value |
|-------|----|------|----------------|---------------------------------|---------------|
| Group A | 41 | 3.23 | 1.02           | 2.91 - 3.56                     | .000 HS       |
| Group B | 41 | 4.68 | 1.08           | 4.34 - 5.02                     | .027          |
| Total  | 82 | 3.96 | 1.28           | 3.68 - 4.24                     | .136          |

Fig 8: Sagittal Femoral component alignment between both the groups (Delta)

Table 9: Parameter A: Sigma

|       | N  | Mean | Std. Deviation | 95% Confidence Interval for Mean | t test p value |
|-------|----|------|----------------|---------------------------------|---------------|
| Group A | 41 | 4.73 | .90            | 4.45 - 5.01                     | .042 sig      |
| Group B | 41 | 5.02 | .16            | 4.98 - 5.07                     | .075          |
| Total  | 82 | 4.88 | .66            | 4.73 - 5.02                     | .356          |

Fig 9: Sagittal tibial component alignment between both the groups (Sigma)

Discussion
It has been reported that computer navigation improves the alignment in TKR and thereby increase the longevity of the implant. A well-aligned TKR is likely to function better whether it has been navigated or not. It might reasonably be assumed that a poorly aligned TKR might function less satisfactorily and might last for lesser duration. However, there have been no studies to indicate an improvement in functional outcome or rates of wear following the use of computer navigation. We found that after 6 months, there was no significant difference in functional outcome (Knee Society Score) and patient satisfaction between patients who underwent a computer-navigated or a conventional TKR.

While the mean difference the both groups was not significant and further investigation is needed to confirm these results. However, at 6 month post-operatively the functional outcome between the computer-navigated and conventional groups appeared to be no different despite the better alignment achieved using the computer navigation technique. Total knee replacement is a very successful operation with a high level of patient satisfaction and functional improvement. It may, therefore, be difficult for computer navigation to show a significant improvement in these variables in the short term. It is possible that improved alignment may decrease wear of the implant and improve the functional outcome in the long term, at least five to ten years after implantation. Therefore to
know if the navigation system has a role in improving the functional outcome and patient satisfaction a long term study would be needed.

Conclusion
Navigation TKR significantly improves the alignment of both femoral and tibial components when compared with the conventional TKR. However there was no significant difference in functional outcome between the two methods. Probably a long term study might highlight on if navigation has a role in improving the longevity of the implant.

References
1. Bejek Z, Solyom L, Szendro M. Experiences with computer navigated total knee arthroplasty. Int Orthop 2007; 31(5):617-22. Epub 2006 Nov 4.
2. Dev Krishan Sharma, Murtuza Rassiwala et al. Navigation assisted total knee arthroplasty - Evaluation of correction of clinico - Radiological parameters in substantial varus deformity. International Journal of Orthopaedics Sciences. 2017; 3(1):747-754.
3. Spencer JM et al. Computer navigation versus conventional total knee replacement. J Bone Joint Surg [Br] 2007; 89-B:477-80
4. Rajesh Malhotra. Newdelhi: Jaypee brother’s medical publishers; Mastering Orthopaedic Techniques Total knee arthroplasty 2010; 17(1).
5. Clement ND et al. Articular surface mounted navigated total knee arthroplasty improves the reliability of component alignment. Knee Surg Sports Traumatol Arthosc. 2018; 26:1471-1477.
6. Fehring TK. Rotational malalignment of the femoral component in total knee arthroplasty. Clin Orthop Relat Res. 2000; 380:72-9.
7. Lotke PA, Ecker ML. Influence of positioning of prosthesis in total knee replacement. J Bone Joint Surg Am. 1977; 59(1):77-9
8. Hoffart HE et al. A prospective study comparing the functional outcome of computer-assisted and conventional total knee replacement. J Bone Joint Surg Br 2012; 94-B:194-9.
9. Clemens Baier et al. Clinical, radiological and survivorship results after ten years comparing navigated and conventional total knee arthroplasty: a matched-pair analysis. International Orthopaedics (SICOT) DOI 10.1007/s00264-017-3509-z.
10. Yonghui Fu et al. Alignment outcomes in navigated total knee arthroplasty: a meta-analysis. Knee Surg Sports Traumatol Arthosc, 2012; 20:1075-1082.
11. Dnyanesh G Lad et al. Component alignment and functional outcome following computer assisted and jig based total knee arthroplasty. Indian Journal of Orthopaedics 2013, 47.
12. Jawhar A et al. Joint line changes after primary total knee arthroplasty: navigated versus non-navigated. Knee Surg Sports Traumatol Arthosc DOI 10.1007/s00167-013-2580-2.
13. Yogeesh D et al. Does computer navigation in total knee arthroplasty improve patient outcome at midterm follow-up. International Orthopaedics (SICOT). 2009; 33:1567-1570.
14. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical ratingsystem. Clin Orthop. 1989; (248):13-14.
15. Eth EK et al. Comparison of functional and radiological outcomes after computer-assisted versus conventional total knee arthroplasty: a matched-control retrospective study. Journal of Orthopaedic Surgery. 2008; 16(2):192-6
16. Jaap J et al. Computer Navigated Versus Conventional Total Knee Arthroplasty. J Knee Surg. 2012; 25:347-352.
17. Wei Ting Lee et al. Short-term outcome after computer-assisted versus conventional total knee arthroplasty: a randomised controlled trial. Journal of Orthopaedic Surgery 2015; 23(1):71-5.
18. Ritter MA, Davis KE, Meding JB, Pierson JL, Berend ME, Malinzak RA. The effect of alignment and BMI on failure of total knee replacement. J Bone Joint Surg Am 2011; 93:1588-96.
19. Huang NF, Dowsey MM, Ee E, Stoney JD, Babazadeh S, Choong PF. Coronal alignment correlates with outcome after total knee arthroplasty: five-year follow-up of a randomized controlled trial. J Arthroplasty 2012; 27:1737-41.
20. Zhang GQ, Chen JY, Chai W, Liu M, Wang Y. Comparison between computer-assisted-navigation and conventional total knee arthroplasties in patients undergoing simultaneous bilateral procedures: a randomized clinical trial. J Bone Joint Surg Am 2011; 93:1190-6.
21. Harvie P, Sloan K, Beaver RJ. Computer navigation vs conventional total knee arthroplasty: five-year functional results of a prospective randomized trial. J Arthroplasty 2012; 27:667-72.
22. Choi WC, Lee S, An JH, Kim D, Seong SC, Lee MC. Plain radiograph fails to reflect the alignment and advantages of navigation in total knee arthroplasty. J Arthroplasty 2011; 26:756-64.
23. Blakeney WG, Khan RJ, Wall SJ. Computer-assisted techniques versus conventional guides for component alignment in total knee arthroplasty: a randomized controlled trial. J Bone Joint Surg Am 2011; 93:1377-84.