ORIGINAL RESEARCH PAPER
Volume - 9 | Issue - 8 | August - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

USE OF NAVIGATION IN TOTAL KNEE REPLACEMENT WITH SPECIAL EMPHASIS ON ROTATING PLATFORM KNEE

Orthopaedics

Dr. Praveen. S. Battepati* Consultant Arthroplasty & Trauma Surgeon Department of Orthopaedics HOSMAT HOSPITAL, Bangalore *Corresponding Author

Dr. Manish P Samson M.B.B.S, D-Ortho, M.S Ortho, Mch Ortho, Fellowship in Arthroplasty Consultant Orthopaedic Surgeon & Joint Replacement Surgeon HOSMAT HOSPITAL, Bangalore

Dr. Thomas Chandy M.B.B.S, F.A.A.O.S, D.A.B.O.S, F.A.C.S, F.I.C.S (U.S.A) Director and Chief of Orthopaedics HOSMAT HOSPITAL, Bangalore

ABSTRACT

Background: Malalignment during knee arthroplasty leads to Polyethylene overload, Bone overload, soft tissue imbalance and patellar maltracking. Malaligment can be Medial/Lateral, Anterior /Posterior, Proximal/Distal placement of implants or Rotational. This study was performed to determine whether Computer Assisted Navigation Surgery (C.A.N.S) significantly improves the Implant Placement. **Materials and Methods**: This is both a Retrospective and Prospective Study.
Duration of Study : 14months, Number of Patients: 21
Results: The mean preoperative FTA was – 6.7º (0º to –19.6º) in the conventional group where as in the Navigation group it was –6.71º (0º to –23.5º). The mean postoperative FTA was 4.56º (1.0º to 9.4º) in the conventional group where as in the Navigation group it was 4.86º (1º to 13.7º).
Conclusion: In this study we have found a statistically significant difference in the placement of Tibial Tray in the frontal plane between the two groups, but unable to conclude which method is more advantageous. This is because we cannot compare our study with that of others.

KEYWORDS

Total Knee Replacement, Navigation, Rotating Platform Knee.

INTRODUCTION:

Accurate placement of Knee components in Knee Arthroplasty are important for good long-term results. According to Benjamin et al (2) and others, malalignment leads to Polyethylene overload, Bone overload, soft tissue imbalance and patellar maltracking. Malaligment can be Medial /Lateral, Anterior /Posterior, Proximal /Distal placement of implants or Rotational.

Implant placement is a Surgeon specific factor which affects the biomechanics of the operated knee and thus the functional outcome. This indirectly also is responsible for the durability of the implant. The Conventional jig has limitations when the patient spectrum extends to obese patients and Revision Replacements. For the PFC Sigma implants, both Flexion and Extension gaps are of the same dimension but in PFC Sigma RP-F, Flexion gap dimensions are more than that of the Extension gap. This is due to the design of the femoral component. Computer Assisted Navigation is touted as the most useful aide with which the normal mechanical axis can be restored more accurately.

This study was performed to determine whether Computer Assisted Navigation Surgery (C.A.N.S) significantly improves the Implant Placement when compared with the conventional method of Intramedullary femoral and Extramedullary tibial jigs in Primary Knee Arthroplasty.

Aims and Objectives: To Compare the precision of Implant Placement (PFC sigma RPF) in the Knee between the Conventional Technique (Intramedullary Femoral and Extramedullary Tibial jigs) and with the use of Computer Assisted CT free Navigation system.

Materials and Methods:
Total Knee Replacement using PFC Sigma RPF from September 2005 to October 2006 were included in this study.

Inclusion Criteria: Patients with Osteoarthritis.

Exclusion Criteria: Valgus Knees, Pre-operative knee movement less than 100 degrees,

Previous surgeries done on Knee, Revision TKR.
Patients were divided into 2 groups. First group where Replacement was performed using conventional method of using femoral intramedullary and Tibial extramedullary jigs. In the Second group, surgeries were performed using the Navigation (Vector Vision Knee, Brainlab). The patients were allotted at random depending on the availability of the instrument. For the purpose of the study, the following X-Rays were taken, Pre-operative X-rays: AP of the knee. (Weight bearing) in 14*17" films. Post-operative X-rays: AP and lat of the operated knee. (Immediate Post op) in 10*12 "film.

All X-rays were digitally photographed. Using Scale 2.0 programme, the following Angles were measured with accuracy of 0.1º.

Image-1

Post-Operative X-ray: In the AP view:
FTA: Femoral Tibial Angle: The Angle between Anatomical Axes of femur and tibia.

FFC: Frontal Femoral Component: The Angle between the anatomical axis of femur and tangential line to femoral component on the medial side as shown.

Image-2

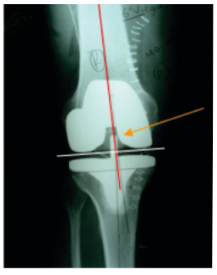


Image-3

FTC: Frontal Tibial Component: The Angle between the anatomical axis tibia and line parallel to the tibial tray medially as shown.

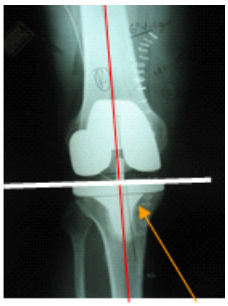


Image-4

In the lateral view:
LFC: Lateral Femoral Component: The angle between the anterior cortex of distal femur and the shield of the femoral component.

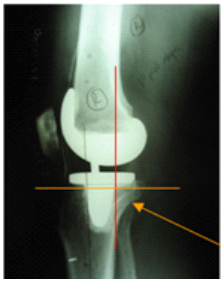
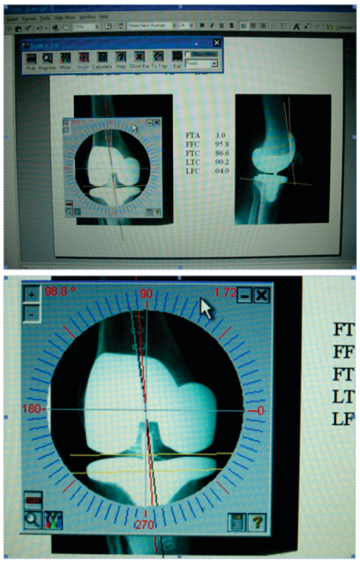


Image-6

Photographs showing Usage of Scale V 2.0 program for measurement of angles



RESULTS:
This is both a Retrospective and Prospective Study.

Duration of Study	14 months
Number of Patients	21
Number of Knees that were operated	33
Male: Female ratio (Patients)	07:14
Male: Female ratio (Knees)	12:21
Unilateral/Bilateral ratio	06:15
Left: Right ratio	15:18
Conventional Vs C.A.N.S ratio	17:16

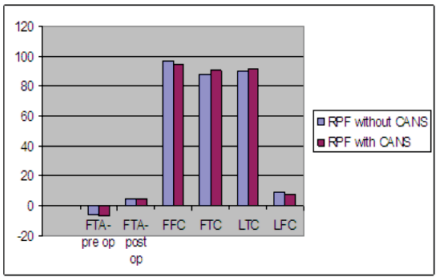
The mean preoperative FTA was –6.7º (0º to –19.6º) in the conventional group where as in the Navigation group it was –6.71º (0º to –23.5º).

The mean postoperative FTA was 4.56º (1.0º to 9.4º) in the conventional group where as in the Navigation group it was 4.86º (1º to 13.7º).

The other variables are depicted in the tables below.

Table 1: Comparison

Measurements	RPF without CANS	RPF with CANS
FTA - Pre-op	-6.18	-6.71
FTA - Post-op	4.56	4.86
FFC	96.63	94.49
FTC	88.25	90.61
LTC	89.78	91.19
LFC	9.66	7.59



Statistical analysis: For comparing post-operative alignment of the leg between the two groups, box-and-whisker plots were used and deviations compared using the Mann-Whitney U-test. The box limits represent the lower quartile (25th percentile) and upper quartile (75th percentile) and the box height is the interquartile range (IQR). The upper and the lower whiskers are 2.8 x IQR distance from the box limits and the median is displayed as a horizontal line across each box. For continuous variables and differences between two means, 95% confidence intervals (CI) were calculated. Two-tailed values of p (0.05).

Table 1: Testing Pre-operative leg malfunction for the similarity check.
The Independent-Samples T Test procedure compares means for two groups of cases:

T-test: (Independent Samples Test)		Levene's Test for Equality of Variances		t-test for Equality of Means			95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Lower	Upper
Pre op FTA	Equal variances assumed	0.012	0.915	0.31	31	0.758	-3.28354	4.46148

Interpretation: If the significance value is high (p>0.05) and the confidence interval for the mean difference contains zero, then we may conclude that there is a no significant difference between the two group means in Pre-Operative leg malformation.

Table 2: Testing Total Knee Replacement for all the Components.

Mann-Whitney U test	Knee Replacement Methods	Counts	Mean Rank	Sig. testing
Pre op FTA	Conventional	16	17.31	0.857
	CANS	17	16.71	
	Total	33		
Post op FTA	Conventional	16	17.34	0.843
	CANS	17	16.68	
	Total	33		
FFC	Conventional	16	19.34	0.176
	CANS	17	14.79	
	Total	33		
FTC	Conventional	16	13.06	0.023
	CANS	17	20.71	
	Total	33		
LTC	Conventional	16	16	0.564
	CANS	17	17.94	
	Total	33		
LFC	Conventional	16	18.69	0.331
	CANS	17	15.41	
	Total	33		

Interpretation: Results are based on Mann-Whitney U tests with significance level (p=0.05). Here, the FTC has significant difference between the two types of replacement methods (i.e., p<0.05). And

when we look at the rest they don't have the significant difference between the two types of replacement methods (i.e., p>0.05). So we may conclude apart from FTC the rest are doesn't have much difference in the knee replacement methods like Conventional and CANS.

Table 3: Testing the comparison of Means between the Conventional Vs CANS methods.

Comparisons of Means		Knee Replacement Methods	
		Conventional (A)	CANS (B)
Pre op FTA	Mean	-6.2	-6.8
	Sig. test		
Post op FTA	Mean	4.6	4.9
	Sig. test		
FFC	Mean	96.6	94.5
	Sig. test		
FTC	Mean	88.3	90.6
	Sig. test		A
LTC	Mean	89.8	91.2
	Sig. test		
LFC	Mean	9.7	7.6
	Sig. test		

Interpretation: Results are based on two-sided tests assuming equal variances with significance level 0.05. Here, the FTC has significant difference and we may also conclude that the FTC CANS method has significantly higher than the FTC Conventional methods.

Chart 2: Box- plots for checking Inter quartile range and also the Outliers

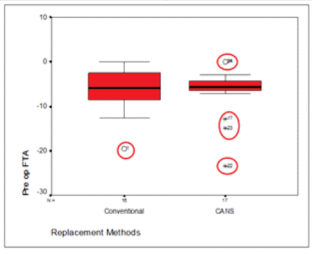
A. Pre-Operative:

Statistics: Pre op FTA - Conventional

N = 16		
Percentiles	25	-8.70
	50	-5.95
	75	-2.15

Statistics: Pre op FTA - CANS

N = 17		
Percentiles	25	-6.85
	50	-5.70
	75	-4.00



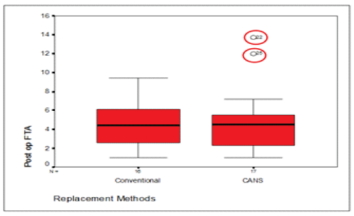
B. Post-Operative:

Statistics: Pre op FTA - Conventional

N = 16		
Percentiles	25	2.53
	50	4.40
	75	6.43

Statistics: Pre op FTA - CANS

N = 17		
Percentiles	25	1.95
	50	4.50
	75	5.60



Note:* Red color circle remarked the Outliers

On the basis of Mann-Whitney U test with significance level (p=0.05), we have found that there is a stastically significant difference of the FTC values between the two method. The other variables are not significant. On comparison of means, the T test for equality, the FTC of CANS (90.6º) is significantly higher than FTC of the conventional group (88.25º). The other variables are not significant.

DISCUSSION:

Post - Operative Mechanical axis has been stated by many authorities including Bathis et al to affect the longevity of the Total knee implants.1 Loosening rate was 24% when post - operative mechanical alignment was beyond 3º of varus or valgus but only 3 % when the alignment was within 3º of varus or valgus. It has been found that implants should be placed within 3 degree of Mechanical Axis for optimal results.1 According to Sparman et al Coronal Malalignment of more than 3 degrees causes premature failure of implants.9 AP malpositioning of Femoral Component by as little as 2.5 mm can reduce the range of movement by 20 degrees.[9]

Survivorship decreased from 96% to 73% when Mechanical Axis was deviated by more than 4 degrees.9 Overall rate of revision surgeries are at 15% at the end of 10 years . Benjamin Hewitt et al have found that Aseptic loosening and instability are the most common indication for revision Total Knee Arthroplasty.[2]

The Success of Joint replacement depends on various factors like Patient Selection, Prosthesis design, Soft tissue balancing, Alignment of leg, and Restoration of joint line.

The last 3 factors can be controlled by CANS. The greatest advantage of CANS is that Mechanical axis of limb can be accurately assessed and restored which is not possible with any Extramedullary or Intramedullary jigs.

Advantages of C.A.N.S: [3,4,5,6,7,8,10]

1. Useful in Multiplanar deformities like bowing, Intorsion, Recurvatum, Femoral Condyle Hypoplasia.
2. In Revision cases where bony landmarks are not visible.
3. Medullary canal of femur is not breached, hence the associated complications like embolism, and excessive blood loss is avoided.
4. Minimises the chances of Notching.
5. Oversizing or under sizing of the implant can be avoided.
6. Better ligament balancing: this can be objectively assessed.
7. Real time kinematic Analysis: Gives better idea about soft tissue balancing throughout the range of motion.
8. Better control over flexion , Extension Gap
9. Minimal Soft tissue handling.

Disadvantages of C.A.N.S: [3,4,5,6,7,8,10]

1. 2-4 cms longer incision
2. Extra Stab incisions in the leg over tibia to insert the shanz pins
3. The jigs are controlled by navigation, not the saw blades which are flexible and can alter the cuts.
4. Longer learning curve for the surgeon.
5. Longer Operating time
6. Expensive Instrumentation.

The Highlight of our Study: All surgeries were performed by the same surgical team. We used scale 2.0 , a computer programme that measures angle upto to the accuracy of 0.1 degrees. This gives the advantage of being able to do multiple measurements and thus minimizes bias.

Limitations of our Study: Long leg films were not taken as we did not have the facility. We did not wish to expose the patient to multiple radiations; hence we did not do the stack/grid method. We have compared the weight bearing preoperative X- Rays with Non Weight bearing X- Ray due to the Retrospective and Prospective nature of the study. Since these variables are same in both group, we felt that it does not give rise to bias.

Due to the small size of X-ray films, we could not calculate Mechanical Axis, but instead have calculated Anatomical Axis. Hence we cannot compare our study to any other study as all the others have calculated Mechanical Axis. We were unable to measure the rotational alignment of the implants. We have not compared the difference in Improvement in Range of Movement, the difference in blood loss, Incidence of complications, overall functional outcome and longevity of the

Implants between the two groups our study indicated that there is no statistical difference between Implant placement between the two groups which is in accordance with the study by Kevin et al 6

CONCLUSIONS:

In this study we have found a statistically significant difference in the placement of Tibial Tray in the frontal plane between the two groups, but unable to conclude which method is more advantageous. This is because we cannot compare our study with that of others. Only because of this inference we cannot completely rule out the importance of Navigation as we have not compared the difference in Improvement in Range of Movement, the difference in blood loss, Incidence of complications, overall functional outcome and longevity of the Implants between the two groups and these last two variables are the ultimate deciding factors for the success of the surgery.

REFERENCES:

1. Bathis H et al : Alignment in Total knee Arthroplasty ; A comparison of computer – Assisted surgery with the conventional technique. J Bone Joint Surg. Vol 86-B. No 5, 2004, 682-687
2. Benjamin Hewitt et al : A Straightforward method of assessing the accuracy of implantation of knee prostheses : The Knee 8 , 2001, 139-144.
3. Bernd Stockl et al : Navigation Improves Accuracy of Rotational Alignment in Total Knee Arthroplasty. Clin Orthop. Vol 426. 180-186.
4. Chauhan S.K et al : Computer –assisted knee Arthroplasty versus a conventional jig-based technique. J Bone Joint Surg. Vol 86-B, No 3, 372-77.
5. Jean-Yves Jenny et al : Consistency of Implantation of Total Knee Arthroplasty with Non-Image-Based Navigation System. J Arthroplasty. Vol 20. No. 7. 2005.832-838.
6. Kevin C. Anderson et al : Computer Assisted Navigation in Total Knee Arthroplasty, Comparsion with conventional methods . J Arthroplasty . Vol 20.No 7,suppl 3, 2005.
7. Pak Lin Chin et al : Randomized Control Trial Comparing Radiographic Total Knee Arthroplasty Implant Placement using Computer Navigation Versus Conventional Technique. J Arthroplasty. Vol 20. No. 5. 2005. 618-626.
8. Rolf G Haaker et al : Computer-Assisted Navigation Increases Precision of Component Placement in Total Knee Arthroplasty. Clin Orthop. Vol 433 . 152-159.
9. Sparman.M et al : Positioning of total knee Arthroplasty with and without navigation support .J Bone Joint Surg. Vol 85-B, No 6, 830-835.
10. Steve J. Kim et al : Computer Assisted Navigation in Total Knee Arthroplasty .Improved Coronal Alignment . J . Arthroplasty . Vol 20. 7 Suppl 3. 2005 .123-131

.