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Original Research Article

Comparision of outcomes of posterior cruciate ligament substituting vs retaining in total knee arthroplasty-a prospective, randomised, open labelled study of 30 cases

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A B S T R A C T

Introduction: The role of the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) has been widely discussed in the orthopaedic literature. Theoretical and functional arguments and survivorship have all been used to support both its retention and its substitution. Moreover, with the advent of robotics and ever evoluting kinematic surgical procedures, the results for the cruciate-retaining arthroplasties are found to be more variable than for the cruciate substituting arthroplasties. The present study is sought to investigate if there was a difference in the clinical outcome as measured by the commonly-used scoring systems which includes (International Knee Society Score, Western Ontario McMasters Osteoarthritis (WOMAC) index and the SF- 36 health survey along with the radiological scores and outcomes of the two procedures in TKA.

Methodology and Results: We performed a prospective, randomized trial of 30 patients to compare the functional outcomes of a posterior-cruciate-ligament-retaining and posterior- cruciate-ligament substituting total knee arthroplasty. Statistical analysis was performed using the Student's t-test and ANOVA test for multiple trials. At follow-up at 3 months, no statistically significant differences were found in the clinical outcome measurements for either design. The results of the WOMAC 35 score which were subdivided into pain, stiffness and function showed high scores for cruciate substituting groups for pain as compared to the cruciate retaining groups whereas, other parameters were same in both the groups. For other systems including SF-36 and knee society score the results did not seem to vary to a great extent statistically.

Conclusion: To conclude the present study found almost similar results for Cruciate ligament retaining and substituting procedures in long term follow up at 3 months, with slightly better outcomes for Cruciate ligament retaining groups at the earliest phases pre operatively and post operatively.

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1. Introduction

The role of the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) has been widely discussed in the orthopedic literature. Theoretical and functional arguments and survivorship have all been used to support both its retention and its substitution.[1–7] Other studies have focused on the degree of deformity or the underlying cause of arthritis as indications for assessing the PCL and for using a posterior-stabilized design.[8] In addition, Lombardi et al.,[9] and Straw et al.,[10] have described elaborate algorithms based upon pathological criteria derived from retrospective reviews to make things more clear. Recent advances in the field including kinematic information from radiostereometry, robotic in vitro models and in vivo fluoroscopic analyses have become available and have moreover added to the debate.[11,12] The in vivo studies which have used fluoroscopy to investigate knee kinematics after TKA however, have reported abnormal kinematics when compared with normal knee.[13–29] The gross differences in the design and the normal knee include, less posterolateral femoral roll- back as the knee moves

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from full extension to flexion, abnormal axial rotation between the femur and the tibia throughout the range of movement (ROM), different center of rotation of the knee in the horizontal plane and even the condylar lift-off. As also, the results for the cruciate-retaining arthroplasties are more variable than for the cruciate substituting arthroplasties. Till date it is known that overall cruciate- substituting arthroplasties display more roll-back and have a better range of movement.[14,20,26,28,30] However, there is a need of a study to accurately assess and analyze the approach of a surgeon towards PCL and measure its outcome. There are some studies in the literature which have specifically compared cruciate- retaining and cruciate-substituting designs,[14,20,26,28] Nevertheless, the present study is sought to investigate if there was a difference in the clinical outcome as measured by the commonly-used scoring systems.[10](International Knee Society Score,[31] Western Ontario McMasters Osteoarthritis (WOMAC)[32] index and the SF- 36 health survey[33] survivorship, radiological outcome and a kinematic performance between cruciate retaining and cruciate-substituting arthroplasties with the same surface geometry.

2. Methodology

The present study was conducted in the Department of Orthopedics, Sir Takhtsinhji Hospital, Bhavnagar, after getting permission from Institutional Review board, Government Medical College, Bhavnagar. A total sample size of 30 patients (n=30) with arthritis of the knee joint was selected for the study. The osteoarthritis degenerative changes in the knee were assessed from detail history and examination of the patient as well as data was collected from the patients based on the scoring indices (International Knee Society Score,Western Ontario McMasters Osteoarthritis (WOMAC) index and the SF- 36 health survey (The forms attached in the annexures). Since, we wished to compare the outcome of two versions, cruciate-retaining and cruciate-substituting designs of the same prosthesis, the sample patient collection was based on expected homogenisation of the sample cohort & hence randomization in the sample selection was critically followed to avoid selection bias for the study. Patients with damaged knee joint in osteoarthritis, patients in the age range of 35 to 80 years, who continue to have knee pain even after the 6 months of conservative treatment and patients with degenerative arthritis and a coronal deformity of < 15° after knee exposure were included in the study. Whereas, Patients with post-traumatic arthritis, previous osteotomy, rheumatoid arthritis or sagittal instability were excluded.

After obtaining thorough medical and anaesthesia fitness as well as consent of the patient, appropriate plan was designed for the patient, the patients were prepared for the surgery. After undergoing the surgical procedures, patients will be followed on 15^{th} day,1^{st} month and 3^{rd} month. On follow up visits patient's will be evaluated by local examination. Patient evaluation was done on the basis of physical parameters which include pain, swelling, redness, difficulty in walking and sitting. Feeling of crepitus on joint movement. Severity of pain was measured by visual analogue (vas) score. Selected patients were informed about the nature of the study and agreed to participate. After exposure of the knee for the further procedure and the implant, the condition of the PCL was assessed both visually and by palpation. If the PCL was present and macroscopically intact without excessive tightening at maximum flexion of the knee, the patient was included in the study.

If, however, the PCL was in any other condition the patient was not included and underwent a routine cruciate stabilizing TKA outside the study protocol. For each patient who met the criteria, a randomization envelope was opened and the patient was allocated to one of the two groups. Thus, all selected patients had a functioning and macroscopically intact PCL.

Group I, had a cruciate-retaining TKA. In group II, the PCL was resected and a cruciate substituting arthroplasty was used. Fifteen patients from the cruciate-retaining group and fifteen from the cruciate-substituting group were randomly chosen for further assessment. All patients volunteered to participate in the study and were fully informed about it. All patients were treated in the same center by a single surgeon. The implant used was of same brand for TKA in either its cruciate-retaining or cruciate-substituting version. In the cruciate- retaining group, a standard retaining insert was used for all patients. No dished inserts were used. We used a medial parapatellar exposure for all TKAs and identical surgical instrumentation. All patients underwent an identical post-operative care and rehabilitation protocol although the nursing staff and physiotherapists were blinded as to which group the patient belonged.

Along with the pain scores other parameters included SF-36 health survey, and radiological analysis. All scores were obtained, and measurements made and recorded, with the help of a trained, independent nurse who was blinded to the procedure which had been performed.

2.1. Radiological analysis

In order to measure alignment and to identify radiolucent lines this was performed by an independent orthopedic surgeon, who used the Knee Society radiological evaluation system.

TKA was performed with patients who had a radiographic Kellgren- Lawrence grade III and greater wanted the operation due to severe knee pain. Overall limb alignment was assessed pre-operatively and at three months after operation using a digital full-leg standing radiograph. The accuracy of this technique has already been validated.

Standard radiographs, including anteroposterior, lateral and skyline views, were taken before operation, at 15^{th} day, 1 month, three months after surgery. Sagittal alignment was measured as the angle between the posterior tibial cortex and the under surface of the metal backed tibial tray. All post-operative radiographs were taken under image-intensifier control in order to position the x-ray beam perfectly parallel to the implant.

2.2. Statistical analysis

Statistical comparisons of the cruciate retaining and cruciate-substituting results were performed using the Student's t-test. Multiple trials of step data were acquired for each knee. For each knee, the range of flexion was separated into 10° portions and the accumulated data were then used to generate a mean for each knee. Statistical comparisons for the step data were performed using an analysis of variance (ANOVA) was performed if this determined a significant difference if p value (<o.o5)

3. Results

The comparison in the two designs of the CL retaining and CL substituting for TKR was made right from the pre-operative deformity and comparison outcomes of the two procedures by health surveys, WOMAC surveys, knee society score etc were analysed and the observations were made as follows-

4. Discussion

Both groups had similar clinical and pre-operative data. The magnitude of the deformity was almost identical and the difference in Varus/valgus distribution was not significant.

At the time of surgery, a similar number of patients (fifteen cruciate- retaining and fifteen cruciate substituting) required a partial release of the medial collateral ligament in order to balance their joint. The results of the SF- 36 Health survey are shown in (Table 3) The physical score improved rapidly at 1-month score 42 with slower recuperation up to 3month score 47 after operation; later on, however, this value stabilized & both the study groups showed the same pattern.

The results of the WOMAC 35 score[34] are also seen in(Tables 4, 5 and 6). This score is subdivided into pain, stiffness and function. The pre-operative values of pain showed a difference between the cruciate-retaining and cruciate- substituting groups, with more pain in the cruciate-substituting group score 10 compare to cruciate-retaining score 9. This difference was still present at three months in cruciate-retaining score 2 and cruciate-substituting score 4, despite a clear fall in the amount of pain which was experienced by the patient after surgery.

As a comparison Straw et al.,[10] showed similar results for patients with cruciate-retaining and cruciate-substituting arthroplasties. The test questions are scored on a scale of 0-4, which correspond to: None (0), Mild (1), Moderate (2), Severe (3), and Extreme (4).

The scores for each subscale are summed up, with a possible score range of 0-20 for Pain, 0-8 for Stiffness, and 0-68 for Physical Function. Usually a sum of the scores for all three sub scales gives a total WOMAC score. Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations.

The function score had a trend towards worse pre-operative function in the cruciate- substituting group score 34 and cruciate retaining group score 37 but post-operatively at 3 month follow up score in both groups improved; this finding of the present study is consistent with study done by Ritter et al.,[6] who reported that greater knee range of motion tended to result in improved functional outcome scores but the cruciate retaining group scored 7 better than the cruciate-substituting group which scored 13. Another comparison study done by author Li, N, Tan, Y, Deng, Y[35] gave the similar outcomes between cruciate retaining and substituting deign.

Knee society score compare the outcomes between both the groups by various parameters. No instability in anteroposterior view of x-ray 67% cruciate retaining group and 60% of score is 100 belong excellent outcomes. The cruciate retaining group have 33% and cruciate-substituting group 40% show the anteroposterior instability score of 33 which indicate poor outcomes. According to the patient satisfaction outcomes, about 27% patients have similar score 100 belonged to the excellent category and 40% patient of both groups show the score 80 who belonged to category of good result and 20% patient show neutral result and 13% patient show dissatisfactory answer & belonged to category of poor result. The scores are similar for patients in both groups. Our results are consistent with the study of Straw et al.,[10] which reported similar results for patients with cruciate-retaining and cruciate-substituting arthroplasties.

According to functional activities 53% patient in both the groups gave score above 80 and thereby fall into the category of excellent outcomes. There was no significant difference present at 3 months follow up. According to the researches done by Freeman and MAR and Railton GT1-4 no statistically significant differences were found in the clinical outcome measurements for either design. In standard activities both the groups showed the same outcomes. 47% patients did not have considerable limiting feeling during standard activities, score 100 belong to excellent outcomes. Both groups did not show any difference between outcomes in criteria of advanced category. The present research, have extensively studied the comparative outcomes of the CL retaining and CL substituting designs based on clinical, radiological and functional aspects of the TNR procedure. The Limitation

Table 1: Distribution of pre op deformity in patients with osteoarthritic of knee

Deformity	**CR**	**CS**
Varus	14	14
Valgus	1	1
Total	15	15

Table 2: Kellgren and Lawrence OA knee grading distribution

Grade	**CR**	**CS**
Grade 3	7	7
Grade 4	8	8
Total	15	15

Table 3: SF36 health survey outcomes

SF 36 Score		**Pre-op (Mean±SD)**	**2 weeks (Mean±SD)**	**1 month (Mean±SD)**	**3 months (Mean±SD)**
Physical score	CR	27(±2.53)	27(±2.53)	42(±3.27)	47(±4.09)
	CS	24(±3.80)	24(±3.08)	48(±2.92)	46(±6.42)
Mental score	CR	62(±4.09)	62(±5.91)	58(±6.25)	54(±4.82)
	CS	53(±7.78)	53(±7.78)	54(±7.63)	54(±5.75)

Table 4: Outcome comparison (as per Womac score)

Womac score		**Pre-op (Mean±SD)**	**2 weeks (Mean±SD)**	**1 month (Mean±SD)**	**3 months (Mean±SD)**
Pain	CR	9(±1.49)	2(±0.75)	2(±0.87)	2(±0.81)
	CS	10(±1.63)	4(±0.94)	3(±0.75)	4(±0.96)

Outcomes comparison (as per knee society score)

Table 5:

Womac score		**Pre-op (Mean±SD)**	**2 weeks (Mean±SD)**	**1 month (Mean±SD)**	**3 months (Mean±SD)**
Stifness	CR	3(±0.68)	3(±0.69)	3(±0.69)	1(±0.32)
	CS	3(±0.64)	3(±0.61)	2(±0.92	1(±0.49)

Table 6:

Womac score		**Pre-op (Mean±SD)**	**2 weeks (Mean±SD)**	**1 month (Mean±SD)**	**3 months (Mean±SD)**
Function score	CR	37(±4.13)	11(±2.41)	8(±1.10)	7(±0.84)
	CS	34(±4.12)	33(±6.06)	10(±1.37)	13(±2.68)

Table 7: Knee society score outcomes

Score	80-100	70-79	60-69	<60
Result	excellent	good	fair	poor

Outcomes comparison (as per knee society score)

Table 8: Patient satisfaction

Patient satisfaction	**CR**	**CS**
Very satisfied	4(27%)	4(27%)
Satisfied	6(40%)	6(40%)
Neutral	3(20%)	3(20%)
Dissatisfied	2(13%)	2(13%)
Very dissatisfied	0(0%)	0(0%)

Table 9: Functional activities

Functional activities	**CR**	**CS**
Walking and standing without aid	8(53%)	8(53%)
Walking and standing with aid	7(47%)	7(47%)

Table 10: Standard activities

Standard activity	CS	CR
No bother	7(47%)	7(47%)
Slightly	6(40%)	6(40%)
Moderate	2(13%)	2(13%)

Table 11: Advance activities

Advance activity	CS	CR
Climbing	6(40%)	6(40%)
Squatting	2(13%)	2(13%)
Running	2(13%)	2(13%)
Carry a bag	1(7%)	1(7%)
Kneeling	4(27%)	4(27%)

Table 12: Discretionary knee activity

Discretionary knee activity	CS	CR
Swimming	8(53%)	8(53%)
Weight lifting	1(7%)	1(7%)
Jogging	2(13%)	2(13%)
Road cycling	1(7%)	1(7%)
Bowling	1(7%)	1(7%)

of our study is that small sample size and relative short duration. Further large sample size and Long follow up needed for further outcomes.

5. Conclusion

The present study did not show any statistically significant differences in the clinical outcome measurements for either PCL retaining or PCL substituting procedures on follow-up at 3 months. The results of the WOMAC 35 score which is subdivided into pain, stiffness and function, showed more pain in the cruciate substituting group even at 3 months which later on showed improvement. Stiffness was similar for both groups, although there was a greater improvement by 3-month post-operative score in both the groups. The function score had a trend towards worse pre-operative function in the cruciate- substituting group, without being statistically significant. It remained somewhat worse for this group but the difference was not significant by three months after surgery. The Knee Society functional score also showed worse pre-operative function for the cruciate-substituting group which stabilized for both the groups at 3-month follow-up. The magnitude of the deformity was almost identical and the difference in Varus/valgus distribution was not significant. Similarly, the physical and the mental score of SF-36 also showed almost similar scores especially after 3 months of surgery in both the groups.

6. Source of Funding

None.

7. Conflict of Interest

None.

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