ORIGINAL RESEARCH

Comparison of Outcomes of Posterior Cruciate Ligament Substituting Versus Retaining in Total Knee Arthroplasty

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ABSTRACT

Background:To compare the gait patterns between posterior cruciate retention (CR) and posterior cruciate substitution (PS) in total knee arthroplasty (TKA).

Materials and Methods: This is a prospective, randomized study of 35 patients to compare the functional outcomes of a posterior-cruciate-ligament-retaining and posterior- cruciate-ligament substituting total knee arthroplasty. 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.

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.

Conclusion: 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.

Keywords: Posterior cruciate retention (CR), Posterior cruciate substitution (PS), Total knee arthroplasty.

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INTRODUCTION

Clinically, patients with knee osteoarthritis are generally characterized by impaired knee function and disabling knee pain. In the later stage of the disease, the only remaining treatment is total knee arthroplasty, which is a common and effective surgical operation to relieve permanent pain.[1] The total knee arthroplasty is to resurface the joint articulating surfaces. The posterior cruciate ligament involved in the knee joint is commonly either retained or replaced by artificial structures during total knee arthroplasty surgery, i.e., posterior cruciate retention and posterior cruciate substitution. The knee joint is one of the largest, most complex, and most important joints in the human body. But the joint function and quality of life in people are seriously affected with the incidence of knee osteoarthritis increasing all over the world.[2]

Several randomized studies comparing two designs have been conducted from the early 90 s up to now,[3] but the debate continues today in terms of the significance of preserving the posterior cruciate ligament (PCL) in total knee arthroplasty surgery. It is generally assumed that CR design could increase range of motion and knee flexion by restoring anatomical femoral rollback and normal knee biomechanics, but some studies show a lack of posterior femorotibial translation with knee flexion in CR design.[3] Besides, several studies also show that preservation of the posterior cruciate ligament in TKA surgery does not guarantee the proper function of this ligament.[4]

The PS design has a cam post mechanism to substitute for the PCL and permits rollback of the femoral component on the tibial component during flexion.[5] And its proponents argue that the posterior translation of the femur creates more clearance on the tibia, and theoretically, more knee flexion.[6] In general, numerous studies have reported that both designs show satisfactory results, but the specific importance of posterior cruciate ligament retention has yet to be confirmed, and the particular advantages of one design over the other have not been documented.[7]

In addition, some studies have shown no difference between CR and PS designs in knee flexion and kinematic gait parameters.[8] However, others have found a marked improvement in PS design concerning knee flexion and range of motion, including one systematic review.[9] These contradictory results hinder consensus. In addition, this analysis attempted to analyse the clinical and functional results of treatment between the two designs with the Knee Society Score (KSS), extension, and walking speed, as well.

MATERIALS & METHODS

This is a prospective and single centers study was conducted in the Department of Orthopedics, Malla Reddy Institute of Medical Sciences. A total sample size of 35 patients (n=35) 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. Since, we wished to compare the outcome of two versions, cruciate-retaining and cruciate substituting designs of the same prosthesis.

Inclusion criteria

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.

Exclusion criteria

Whereas, Patients with post-traumatic arthritis, previous osteotomy, rheumatoid arthritis or sagittal instability were excluded.

After obtaining thorough medical and anesthesia 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 15th day, 1st month and 3rd month.

On follow up visits patients 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.

In each group thirty-five patient from the cruciate-retaining (CR) group and Thirty-five from the cruciate-substituting (CS) group were randomly chosen for further assessment. 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. We used a medial Para patellar 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 SF36 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.

Radiological analysis

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 15th day, 1 month, and 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.

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 (<0.05).

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 analyzed and the observations were made as follows.

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

Deformity	**CR**	**CS**
Varus	34	34
Valgus	1	1
Total	35	35

Table 2: Kellgren and Lawrence OA knee grading distribution

Grade	**CR**	**CS**
Grade 3	17	17
Grade 4	18	18

Total	35	35

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	31±4.95	29±2.95	47±5.83	49±5.46
	CS	26±3.82	26±3.02	51±6.37	51±6.20
Mental score	CR	64±7.59	63±5.32	60±6.95	56±5.42
	CS	56±6.72	56±6.72	57±6.79	59±5.52

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	10±2.49	3±0.25	3±0.84	3±0.88
	CS	12±2.69	5±1.98	4±0.97	4±0.98

Outcomes comparison (as per knee society score)

Table 5: Outcome comparison of Stiffness

Womac score		Pre-op (Mean±SD)	(2 weeks Mean±SD)	1 month (Mean±SD)	3 months (Mean±SD)
Stiffness	CR	4±0.72	4±0.73	4±0.71	1(±0.32)
	CS	4±0.70	4±0.71	3±0.	1(±0.49)

Table 6: Outcome comparison of Function score

Womac score		Pre-op (Mean±SD)	2 weeks (Mean±SD)	1 month (Mean±SD)	3 months (Mean±SD)
Function score	CR	39±3.14	13±3.46	9±1.29	8±0.91
	CS	37±3.13	36±4.18	12±2.48	14±3.84

Table 7: Patient satisfaction

Patient satisfaction	CR	CS
Very satisfied	9(25.7%)	10 (28.5%)
Satisfied	11(31.4%)	11(31.4%)
Neutral	8(22.8%)	7(20%)
Dissatisfied	7(20%)	7(20%)
Very dissatisfied	0(0%)	0(0%)

Table 8: Functional activities

Functional activities	CR	CS
Walking and standing without aid	18(51.4%)	19(54.2%)
Walking and standing with aid	17(48.5%)	16(45.7%)

DISCUSSION

The role of the PCL has been a controversial issue since the early days of TKA. Numerous authors have shown good clinical outcomes for both cruciate-retaining and cruciate-substituting designs.[10] Straw et al,[11] showed similar results for patients with cruciate-retaining and cruciate-substituting arthroplasties. Significantly worse results were reported for patients with a cruciate-retaining arthroplasty when a tight PCL had been released. Since our surgical technique aimed to restore the joint line and the flexion gap correctly with the use of posterior referencing instrumentation for sizing the femoral component, no further releases of the PCL were required at the end of the operation in the cruciate-retaining group.

Our results showed a similar post-operative outcome for the classical outcome measurement tools of WOMAC, SF-36, and the Knee Society scores. No significant differences were detected at three months and at one, two and five years although this may have been because these scoring systems were too crude to identify important differences. This effect can be caused by the non-parametric character and ceiling effect of these scores.[12] Survivorship at five years and the appearance of radiolucency's were identical for both groups, except for one radiolucency in zone 7 on the tibia in a cruciate-substituting knee. Since all knees were well aligned and balanced, this finding is not surprising.[13]

The aim to reproduce normal knee kinematics after implantation of a TKA has been questioned.[14] However, other authors share our view that the reproduction of normal kinematic patterns is the best option for preserving stability and movement. Since most modern knee arthroplasties are surface replacements which mimic the anatomical form of the human knee, this is a logical assumption. Normal knee kinematics under loaded conditions (deep knee bend) have recently been studied by dynamic MRI, bi-planar image-matching of radiographs and fluoroscopy.[14]

It was shown that the posterior part of the medial femoral condyle had a single radius of curvature, acting like a ball in a socket from between 20° and 110° of flexion, and allowing the lateral condyle to pivot around it.[15] This positions the lateral tibiofemoral contact point in deep flexion well posterior on the tibia. Asano et al,[16] used a bi-planar image-matching technique to describe the kinematic behaviour of the normal human knee.

Despite differences in the arthroplasties which were used, a clear trend appears from these studies. In the replaced knee, axial rotation is less pronounced than in the human knee, and forward sliding of the medial femoral condyle during flexion on the medial side is present for all cruciate-retaining types of knee while lateral femoral rollback is better for cruciate-substituting than for the cruciate- retaining devices. Maximum flexion tends to be better in the cruciate-substituting than in the cruciate-retaining groups.

In our study, the difference in maximum flexion during lunge between cruciate-retaining and cruciate-substituting patients was not significant although the gain in flexion compared with the pre-operative situation was greater in the cruciate-substituting than in the cruciate-retaining group. The better flexion in the cruciate-substituting group correlated with earlier findings.[17] The explanation probably lies in the greater posterior translation of the femur on the tibia. The cruciate-substituting group displayed a greater posterior contact area in flexion than the cruciate-retaining group. Also, within the cruciate substituting group, a clear linear relationship strongly suggested that the anteroposterior position of the femur relative to the tibia was a key factor in maximum knee flexion. This can be explained anatomically since a posterior position of the femur relative to the tibia clears the back of the knee and prevents impingement of soft-tissues or polyethylene. This phenomenon works synergistically with the posterior condylar offset as described by Bellemans et al.[18]

No difference was found between the clinically measured maximum passive flexion (unloaded) and the image intensifier measured maximum flexion during lunge (loaded). In two studies, the maximum weight-bearing flexion was reported to be reduced when compared with passive maximum flexion. This phenomenon was most pronounced in cruciate-retaining devices. The difference from our findings may be because of the difference in activity (squat vs lunge) or the different surface geometry of the prosthesis (LCS vs Genesis II).[19]

CONCLUSION

Our randomized controlled study was not able to demonstrate clinical differences between cruciate-retaining and cruciate-substituting TKAs, nor was there a difference in survivorship or prevalence of radiolucent lines at one year. In kinematic analysis however, it was shown that the cruciate-substituting group had more consistent and more natural function than the cruciate-retaining group, without replicating the kinematics of the normal knee.

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