



ORIGINAL RESEARCH PAPER

A COMPARATIVE STUDY OF RADIOLOGICAL OUTCOMES BETWEEN POSTERIOR STABILIZING AND CRUCIATE RETAINING IMPLANTS IN TOTAL KNEE REPLACEMENT

Orthopaedics

KEY WORDS: Total Knee Arthroplasty; Cruciate-Retaining; Posterior-Stabilized; Osteoarthritis Knee; Radiological Outcomes; Functional Outcomes.

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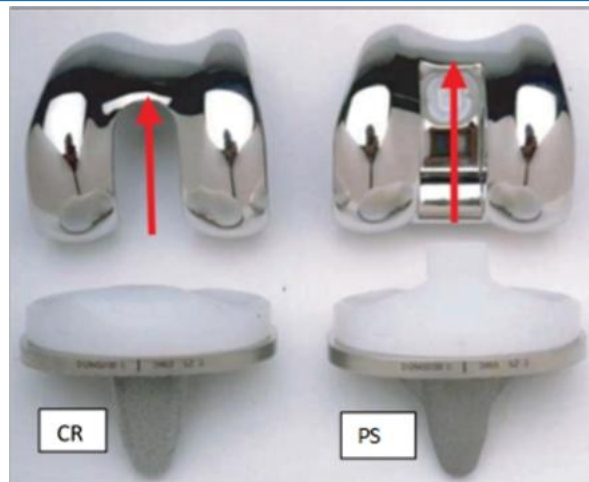
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ABSTRACT

Background: Total knee arthroplasty (TKA) is the gold-standard treatment for end-stage knee osteoarthritis. Among the commonly used implant designs, cruciate-retaining (CR) and posterior-stabilized (PS) prostheses remain widely utilized; however, the superiority of one design over the other remains controversial. This study compared the functional and radiological outcomes of CR and PS implants in primary TKA. **Methods:** A prospective comparative study was conducted in the Department of Orthopaedics, Index Medical College Hospital and Research Centre, Indore. Forty patients aged 55–80 years with primary knee osteoarthritis (Kellgren–Lawrence Grade III–IV) undergoing primary TKA were enrolled and divided equally into CR (n=20) and PS (n=20) groups. Standardized surgical techniques and rehabilitation protocols were followed. Functional outcomes were assessed using the Knee Society Knee Score (KSKS), American Knee Society Score (AKSS), and Lysholm Knee Score. Radiological evaluation included tibiofemoral alignment, tibial slope, component positioning, radiolucent lines, and implant stability. Patients were followed for one year. Statistical analysis was performed using SPSS version 21.0, with $p < 0.05$ considered significant. **Results:** The mean age was 66.4 ± 6.2 years in the CR group and 67.1 ± 5.9 years in the PS group ($p > 0.05$). Females constituted 52.5% of the study population. Both groups demonstrated significant improvement in functional scores from the preoperative period to one-year follow-up. Although the PS group showed marginally higher postoperative functional scores, the differences were not statistically significant. Radiological assessment revealed satisfactory correction of deformity and restoration of near-neutral mechanical alignment in both groups. Tibial slope was maintained according to implant-specific principles. Radiolucent lines were infrequent, non-progressive, and clinically insignificant. No cases of implant loosening, subsidence, deep infection, revision surgery, or mechanical failure were observed during follow-up. **Conclusion:** Both CR and PS total knee arthroplasty provide excellent short-term functional recovery, satisfactory radiological alignment, and stable implant fixation in patients with advanced knee osteoarthritis. No significant differences were observed between the two designs. Implant selection should therefore be individualized based on posterior cruciate ligament integrity, patient anatomy, degree of deformity, and surgeon preference.

INTRODUCTION

Total Knee arthroplasty, a surgical procedure to replace weightbearing surfaces of knee joint to relieve pain and disability; is an end-of-line treatment for patients with severe pain and functional limitations. Although being debated for many years, the superiority of Posterior Cruciate Retaining (CR) Total knee Arthroplasty (TKA) and Posterior Cruciate-Stabilizing (PS) TKA remains controversial. Proponents of Cruciate-Retaining; CR prosthesis assert that PCL retention preserves more normal knee kinematics (1), improved proprioception (2,3), superior Knee stability (PCL preventing anterior translation of the femur on the tibia), reduced shear stress at fixation interface, near normal knee kinematics (9) and is more of bone conserving Procedure whereas the proponents of PCL Stabilized; PS prosthesis assert that Posterior stabilized implants with a polyethylene post and femoral cam to replace the role of the PCL, has controlled replication of the femoral rollback mechanism, resulting in reduced sliding shear stress on the polyethylene liner and providing superior range of motion (4) in terminal knee flexion, a less technically demanding procedure, a more stable component interface, Also PCL is diseased with various form of arthritis and contracture and is difficult to balance reproducibly (5), so the significant deformity can be more reliably corrected with the use of PCL substituting designs. Multiple studies have addressed differences in knee range of motion following cruciate retaining and posterior stabilized primary knee replacements. (6–8) A number of studies have also reported on short- and medium-term functional results comparing these two implant designs. The purpose of the present study is to directly compare clinical and radiological outcomes, of two groups of patients who received cruciate-retaining or posterior-stabilized implant and provide guidance to surgeon on selecting implant for particular patient.



AIMS AND OBJECTIVES

Aim

A comparative study of radiological outcomes between posterior stabilizing and cruciate retaining implants in total knee replacement

Objectives

1. To compare functional outcome in patients who underwent primary total knee arthroplasty surgery using posterior stabilized and cruciate retaining implants.
2. To evaluate radiological outcomes.
3. To review the available literature.
4. Evaluation of treatment related complications, if any.

MATERIALS AND METHODS

This prospective comparative study evaluated the radiological and functional outcomes of Posterior-Stabilized

(PS) versus Cruciate-Retaining (CR) implants in primary Total Knee Arthroplasty (TKA).

Study Design and Setting

- Prospective comparative study.
- Conducted in the Department of Orthopaedics, Index Medical College Hospital and Research Centre (IMCHRC),Indore.
- Study period:June 2024 to October 2026 (18 months).

Study Population

- 40 patients aged 55–80 years with primary osteoarthritis knee (Kellgren–Lawrence Grade 3 or 4).
- Patients were recruited after obtaining informed written consent and Institutional Ethics Committee approval.

Inclusion Criteria

- Age 55–80 years.
- Either gender.
- Primary knee osteoarthritis (KL Grade 3 or 4).
- Willingness to participate and provide consent.

Exclusion Criteria

- Age <55 years.
- Medically unfit for surgery.
- Active knee infection.
- Previous revision TKA.
- Prior femoral/tibial osteotomy.
- Need for augmentation during TKA.
- Malignancy, patellectomy, extra-articular deformity, or refusal of consent.

Group Allocation

Patients were equally divided into:

- CR Group (n=20):Posterior cruciate ligament preserved.
- PS Group (n=20): PCL sacrificed with cam-post mechanism; tibial slope maintained at 5° ± 1°.

Preoperative Assessment

- Clinical examination and demographic data collection.
- Radiological evaluation:
 - Weight-bearing AP and lateral knee radiographs.
 - MRI scanogram of bilateral knees.
- Laboratory investigations:
 - Hb, blood sugar, renal function tests, ESR, CRP, rheumatoid factor, blood grouping, ECG.

Surgical Procedure

- All surgeries performed under spinal anesthesia using a standard medial parapatellar approach.
- Femoral and tibial cuts made using standard jigs.
- CR group:physiological tibial slope preserved.
- PS group: tibial slope targeted at 5° ± 1°.
- Cemented implantation technique used in all cases.

Postoperative Protocol

- Drain removal after 24 hours.
- Physiotherapy from postoperative day 1.
- Full weight-bearing from day 2.
- Stair climbing from day 7.
- Discharge on postoperative day 5–6.
- Follow-up at 3 months, 6 months, 1 year, and every 6 months thereafter.

Outcome Measures

Functional Assessment

- Knee Society Knee Score (KSKS)
- American Knee Society Score (AKSS)
- Lysholm Knee Score
- Assessment included pain, range of motion, deformity, stability, walking ability, stair climbing, and functional independence.

Radiological Assessment

- Tibiofemoral angle.
- Femoral and tibial component alignment.

- Component positioning.
- Tibial slope.
- Radiolucent lines.
- Signs of implant loosening and osteolysis.

Data Collection and Statistical Analysis

- Data recorded in a standardized proforma.
 - Analysis performed using SPSS version 21.0.
 - Continuous variables expressed as mean ± SD.
 - Independent t-test and Chi-square test used for comparisons.
 - Correlation analysis assessed relationships between radiological and functional outcomes.
- p < 0.05 considered statistically significant.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 21.0.

- Continuous variables were expressed as mean ± standard deviation
- Categorical variables as frequencies and percentages
- Independent t-test was used to compare continuous variables
- Chi-square test was applied to categorical variables
- Correlation tests were used to study associations between functional and radiological outcomes

A p-value < 0.05 was considered statistically significant

RESULTS

The present prospective study included 40 patients diagnosed with primary knee osteoarthritis who fulfilled the inclusion and exclusion criteria. All patients underwent primary total knee arthroplasty and completed the scheduled follow-up assessments. Based on the type of prosthesis implanted, patients were divided equally into two groups: Cruciate-Retaining (CR) Total Knee Arthroplasty group (n = 20) and Posterior-Stabilized (PS) Total Knee Arthroplasty group (n = 20).

Demographic Profile

Table 1: Age-wise Distribution of Study Population

Age Group (Years)	CR Group	PS Group	Total
55–59	3 (15%)	2 (10%)	5 (12.5%)
60–64	5 (25%)	4 (20%)	9 (22.5%)
65–69	6 (30%)	7 (35%)	13 (32.5%)
70–74	4 (20%)	5 (25%)	9 (22.5%)
75–80	2 (10%)	2 (10%)	4 (10%)
Total	20 (100%)	20 (100%)	40 (100%)

The age-wise distribution of patients showed that the largest proportion of cases belonged to the 65–69 years age group, comprising 30% (n = 6) in the CR group and 35% (n = 7) in the PS group, accounting for 32.5% (n = 13) of the total study population. Patients aged 60–64 years constituted 25% (n = 5) of the CR group and 20% (n = 4) of the PS group, while those aged 70–74 years accounted for 20% (n = 4) and 25% (n = 5) of the CR and PS groups, respectively. The youngest age group (55–59 years) and the oldest age group (75–80 years) together represented smaller proportions of the study population.

Table 2: Comparison of Mean Age

Group	Mean Age (Years) ± SD	p value
CR Group	66.4 ± 6.2	>0.05
PS Group	67.1 ± 5.9	

The mean age of patients in the cruciate-retaining (CR) group was 66.4 ± 6.2 years, while that of the posterior-stabilized (PS) group was 67.1 ± 5.9 years. Statistical comparison between the two groups revealed no significant difference in mean age (p > 0.05). This indicates that both groups were age matched at baseline, ensuring that age was unlikely to influence the comparative functional and radiological outcomes observed in the study.

Table 3: Gender Distribution

Gender	CR Group	PS Group	Total
Male	9 (45%)	10 (50%)	19 (47.5%)
Female	11 (55%)	10 (50%)	21 (52.5%)

There was a slight female preponderance of the study population in terms of gender distribution. Females made up 55% (n = 11) of the CR group, with males comprising 45% (n = 9). Both sexes were present in the PS group, half of which (n = 10) was represented by males and half (n = 10) was represented by females. Overall, females formed 52.5% (n = 21) of the total study population, while males accounted for 47.5% (n = 19). The gender distribution was comparable between the two groups, indicating adequate gender matching and minimizing gender-related bias in outcome comparison.

Table 4: Side of Surgery

Side	CR Group	PS Group	Total
Right	11	10	21
Left	9	10	19

With respect to the side of surgery, right-sided total knee arthroplasty was performed in 11 patients in the cruciate-retaining (CR) group and 10 patients in the posterior-stabilized (PS) group, accounting for a total of 21 cases. Left-sided procedures were performed in 9 patients in the CR group and 10 patients in the PS group, totaling 19 cases. The distribution of operated sides was comparable between the two groups, indicating no side-related selection bias in the study population.

Overall Summary of Outcomes in CR and PS Total Knee Arthroplasty

Parameter	CR Group (n = 20)	PS Group (n = 20)
Mean age (years)	66.4 ± 6.2	67.1 ± 5.9
Gender (M/F)	9 / 11	10 / 10
Right/Left knee	11 / 9	10 / 10
KSKS – Mean (Pre-op → 1 year)	42.6 → 86.2	43.1 → 88.4
AKSS – Mean (Pre-op → 1 year)	46.3 → 84.5	47.1 → 86.9
Lysholm – Mean (Pre-op → 1 year)	38.4 → 88.1	39.2 → 90.3
KSKS improvement (mean)	+43.6	+45.3
AKSS improvement (mean)	+38.2	+39.8
Lysholm improvement (mean)	+49.7	+51.1
Post-op tibiofemoral angle (°)	178.9 ± 2.1	179.2 ± 1.9
Mean tibial slope (°)	7.6 ± 1.2	5.1 ± 0.6
Neutral alignment achieved	18 (90%)	19 (95%)
Radiolucent lines	2 (10%)	1 (5%)
Implant stability	Stable in all	Stable in all
Major complications	None	None

Both cruciate-retaining and posterior-stabilized total knee arthroplasty resulted in significant functional improvement and satisfactory radiological alignment. Improvements were progressive across all follow-up intervals. Although posterior-stabilized knees demonstrated marginally higher functional scores, the differences were not statistically significant, indicating comparable outcomes between the two implant designs.

DISCUSSION

Total knee arthroplasty (TKA) is an effective treatment for advanced knee osteoarthritis, providing pain relief, deformity correction, and functional recovery. Among available implant designs, Cruciate-Retaining (CR) and Posterior-Stabilized (PS) prosthesis are most commonly used; however, the superiority of one design over the other remains controversial.

The present prospective study compared the functional and radiological outcomes of CR and PS TKA in 40 patients with primary knee osteoarthritis. Functional outcomes were assessed using the Knee Society Knee Score (KSKS),

American Knee Society Score (AKSS), and Lysholm Knee Score, while radiological evaluation included tibiofemoral alignment, tibial slope, component positioning, radiolucent lines, and implant stability.

Both groups were demographically comparable, ensuring a homogeneous study population. Significant improvement in functional scores was observed in both CR and PS groups throughout follow-up. Although the PS group showed slightly higher mean functional scores, the differences were not statistically significant. These findings are consistent with previous studies and meta-analyses that reported comparable functional outcomes between the two implant designs.

A marked shift from poor and fair preoperative scores to predominantly good and excellent postoperative scores was observed in both groups, highlighting the effectiveness of TKA in restoring knee function and relieving pain.

Radiologically, both implant designs achieved excellent correction of coronal deformity and restoration of near-neutral mechanical alignment. A slightly higher proportion of neutral alignment was observed in the PS group, although without significant clinical impact. Differences in tibial slope reflected implant-specific surgical principles, with CR knees maintaining a more physiological slope and PS knees having a standardized lower slope.

Radiolucent lines were infrequent, non-progressive, and clinically insignificant. No cases of implant loosening, migration, subsidence, or mechanical failure were observed during follow-up, indicating excellent early implant stability and survivorship for both designs.

Recent literature similarly supports the non-inferiority of CR and PS implants, with most studies demonstrating comparable functional and radiological outcomes. While some reports suggest minor advantages of PS implants in specific functional domains, these findings have been inconsistent and do not establish clear superiority.

Overall, the present study demonstrates that both CR and PS TKA provide significant functional improvement, satisfactory radiological alignment, and excellent early implant stability. Since no clinically meaningful differences were identified between the two designs, implant selection should be individualized based on patient anatomy, posterior cruciate ligament status, degree of deformity, and surgeon preference rather than expectations of superior outcomes with either implant design.

CONCLUSION

This prospective comparative study evaluated the functional and radiological outcomes of cruciate-retaining (CR) and posterior-stabilized (PS) total knee arthroplasty in patients with advanced primary knee osteoarthritis. Both implant designs produced significant improvements in pain relief, knee stability, range of motion, and functional scores (KSKS, AKSS, and Lysholm) at one-year follow-up. Although the PS group showed slightly higher functional scores, the differences were not statistically significant.

Radiologically, both groups achieved satisfactory correction of deformity, near-neutral mechanical alignment, appropriate tibial slope, and excellent implant stability. Radiolucent lines were rare, non-progressive, and clinically insignificant, with no evidence of loosening or subsidence. No major complications such as infection, deep vein thrombosis, implant failure, or revision surgery were observed.

Overall, CR and PS TKA demonstrated comparable functional recovery, satisfactory radiological outcomes, and excellent short-term implant stability. Implant selection should therefore be individualized according to patient anatomy,

posterior cruciate ligament status, degree of deformity, and surgeon expertise.

Limitations

1. Small sample size (40 patients) limited the ability to detect subtle differences between groups.
2. Follow-up duration of one year assessed only short-term outcomes.
3. Single-center study, limiting generalizability of results.
4. Advanced assessments such as gait analysis, quality-of-life measures, and high-demand functional testing were not performed.
5. Minor variations in soft-tissue balancing and intra-operative decisions may have influenced outcomes.

Recommendations

1. Both CR and PS implants are safe and effective for primary TKA in end-stage knee osteoarthritis.
2. Implant choice should be individualized based on PCL integrity, deformity, bone quality, patient anatomy, and surgeon experience.
3. CR implants are suitable for patients with an intact PCL and preserved knee kinematics.
4. PS implants may be preferred in severe deformity, PCL deficiency, or difficult ligament balancing situations.
5. Accurate alignment, soft-tissue balancing, and standardized rehabilitation are essential regardless of implant design.

Future Scope

1. Long-term studies are needed to evaluate implant survivorship, polyethylene wear, and late complications.
2. Large multicenter studies should be conducted to identify subgroup-specific advantages of CR and PS designs.
3. Future research should incorporate advanced imaging and gait analysis to assess in-vivo knee kinematics.
4. Studies evaluating quality of life, patient-reported outcomes, and return to activity are required.
5. The influence of patient-specific alignment strategies and customized surgical techniques on outcomes warrants further investigation.

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