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Functional Outcomes of Cruciate-Retaining and Posterior-Stabilized Total Knee Arthroplasty: A Randomized Trial Using the Two-Minute Walk and Timed Up and Go Tests

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Purpose: To compare early postoperative functional recovery in patients undergoing total knee arthroplasty (TKA) using cruciate-retaining (CR) and posterior-stabilized (PS) implant designs, as measured by the Two-Minute Walk Test (2MWT) and Timed Up and Go (TUG) test.
Methods: This prospective, double-blind, randomized controlled trial included 80 patients with primary knee osteoarthritis (OA) who underwent unilateral TKA. The patients were randomized to receive either a CR or PS implant from the same manufacturer. All surgeries were performed by a single surgeon using a standardized technique. Functional outcomes were assessed preoperatively and at 2, 6, and 12 weeks postoperatively using the 2MWT and TUG tests. Statistical comparisons between the groups were performed using t-tests and repeated-measures ANOVA.
Results: Both groups showed progressive improvement over time. At 12 weeks, the mean increase in 2MWT distance was 32.75 ± 24.55 m for PS and 27.91 ± 15.45 m for CR ($p = 0.296$). TUG test times also improved, with a decrease of −7.53 ± 7.18 s in the PS group and −8.94 ± 8.45 s in the CR group ($p = 0.425$). No statistically significant differences were observed between groups at any time point. Both groups exceeded the minimal clinically important difference for the 2MWT.
Conclusions: Both the CR and PS implant designs demonstrated comparable early postoperative functional outcomes, as assessed by the 2MWT and TUG tests, without statistically significant differences. While the PS group achieved greater improvements in walking distance, the CR group exhibited superior mobility. These findings indicate that implant design does not substantially affect early functional outcomes following TKA.

Keywords: Total knee arthroplasty, cruciate retaining, posterior stabilized, Two-Minute Walk Test, Timed Up and Go, functional recovery

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Total knee arthroplasty (TKA) is one of the most frequently performed surgical procedures in patients with advanced knee osteoarthritis (OA) aimed at alleviating pain and restoring functional mobility[1,2]. Improvement in physical function is the primary reason why patients with chronic, painful, and disabling knee OA seek surgical intervention[3]. Accordingly, physical function is

considered a mandatory outcome in clinical trials of knee OA[4].

Cruciate-retaining (CR) and posterior-stabilized (PS) implant designs are among the most widely used prosthetic options for TKA[5]. Although both designs have demonstrated excellent long-term survival and clinical outcomes[6,7], their impact on short-term functional recovery—particularly walking performance remains uncertain[8].

The Two-Minute Walk Test (2MWT) is a simple, practical, and validated measure of functional mobility that is well suited for assessing early postoperative recovery[9]. Compared to the more widely used Six-Minute Walk Test (6MWT), the 2MWT is more feasible in the immediate postoperative setting while still correlating strongly with global physical function measures[10].

The 2MWT and Timed Up and Go (TUG) test are validated and complementary tools for assessing functional recovery after TKA. The 2MWT evaluates endurance and walking capacity, whereas the TUG test focuses on dynamic balance, transitional movement, and overall mobility. Although both have been individually studied for TKA recovery, few studies have combined them into a single protocol, especially randomized controlled trials. Prior research has typically relied on either the 6MWT or TUG test alone, each capturing distinct aspects of function. By integrating the 2MWT and TUG tests, this study offers a more comprehensive evaluation of early postoperative ambulation and mobility.

Despite the widespread use of CR and PS implants, there is a lack of evidence directly comparing their effects on objective measures of early mobility such as the 2 MWT. To date, no randomized controlled trial (RCT) has investigated whether implant design influences short-term walking performance after TKA using this metric. This knowledge gap provides the rationale for the present study, which aimed to compare postoperative functional recovery, as measured using the 2MWT, between patients who underwent TKA with CR and PS implants. We hypothesized that PS implants would result in superior early functional recovery compared with CR implants, particularly in terms of walking performance, as assessed using the 2 MWT.

METHODS

Study Design

A prospective, double-blind, randomized controlled trial

Participants

Patients aged 55–80 years with primary knee OA, diagnosed using clinical and radiographic criteria according to the American College of Rheumatology (ACR) guidelines[11], and scheduled for unilateral TKA, were eligible for inclusion.
Exclusion criteria were:

- Communication impairment
- Revision TKA or previous TKA of the affected side
- Secondary OA
- Loss to follow-up within 3 months
- Neurological disorders affecting gait
- Varus deformity >10 °or valgus deformity >15 °.
- Bone loss or soft tissue laxity

Randomization and Blinding

Patients were randomized in blocks of four using a computer-generated sequence to ensure a balanced allocation between the groups. Allocation concealment was maintained using sealed opaque envelopes, which were opened in the operating room immediately before surgery. This was a double-blind, randomized controlled trial. Patients and outcome assessors were blinded to implant allocation, whereas the operating surgeon was not.

Surgical Technique and Intervention

All surgeries were performed by a single experienced orthopedic surgeon using a standardized medial parapatellar approach. Cemented fixation was performed in all cases. Patients were assigned to receive either a CR or a PS prosthesis, both from the same manufacturer and design family, to control implant variability.

Postoperative care was standardized across both groups, including multimodal analgesia and early mobilization, beginning on postoperative day one. During hospitalization, all patients followed the same outpatient rehabilitation protocol consisting of progressive range of motion and ambulation exercises.

Outcome Measures

Primary and secondary outcomes were assessed preoperatively and at 2 weeks, 2 months, and 6 months postoperatively.

- Primary outcome: 2MWT
- Secondary outcome: TUG test

All outcome assessments were performed by orthopedic residents blinded to implant allocation.

Sample Size Calculation

The sample size was calculated based on previously published data comparing postoperative 6MWT distances. According to Bade et al.[12], using mean values of 395 meters in the treatment group and 323 meters in the control group, with standard deviations of 111 and 104 respectively, a clinically significant difference (Δ) of 72 meters was assumed. With a two-sided α level of 0.05 and a power (1−β) of 90%, the required sample size was calculated using the standard formula for randomized controlled trials comparing continuous outcomes. The final sample size was 36 patients per group. To account for potential dropouts and losses to follow-up, 40 patients were enrolled in each group.

Statistical Analysis

Continuous variables are expressed as means with standard deviations, and categorical variables as frequencies with percentages. Between-group comparisons were performed using independent t-tests or chi-squared tests, as appropriate. Repeated-measures ANOVA was used to assess the within- and between-group changes over time. Statistical significance was set at $p < 0.05$. All analyses were performed using an intention-to-treat protocol

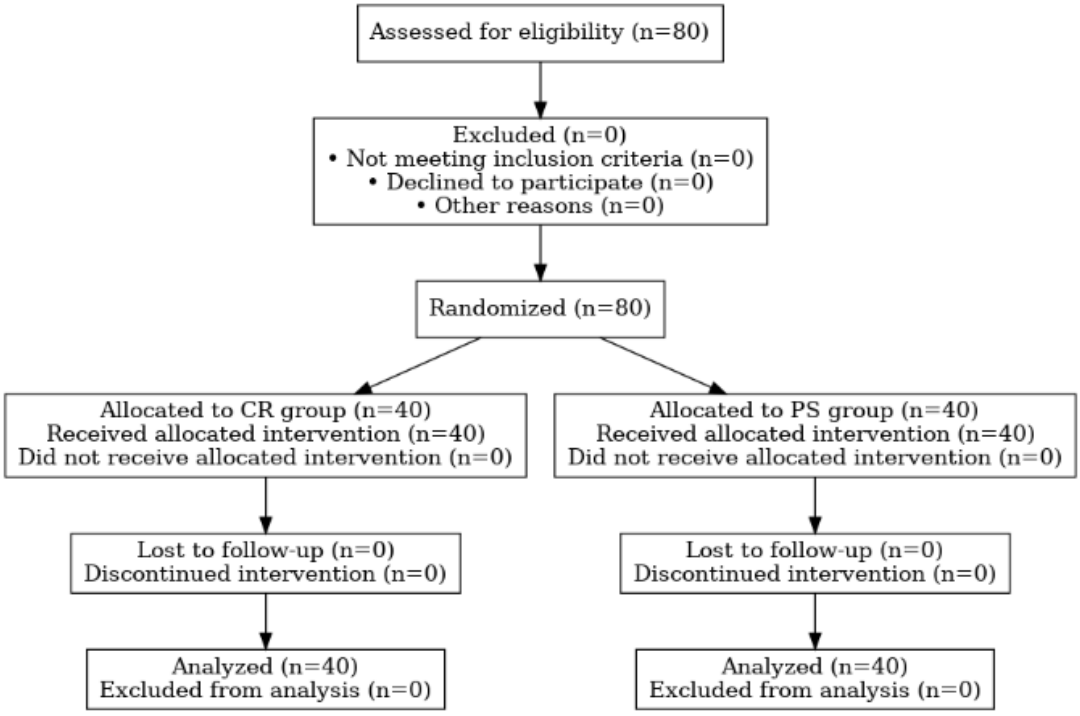

Fig. 1 Consort flow diagram illustrates the progress of participants through the phases of the randomized controlled trial comparing cruciate-retaining (CR) and posterior-stabilized (PS) implant designs in total knee arthroplasty (TKA).

RESULTS

Patient Characteristics

Eighty patients were enrolled and randomized equally into two groups: (CR; n = 40) and (PS; n = 40). The mean age of participants was 66.95 ± 6.38 years, and the baseline characteristics including sex, BMI, comorbidities (HT, DM, DLP, CKD), and ASA class were comparable between the two groups (Table 1).

Table 1 Baseline demographic and clinical characteristics of patients undergoing TKA in the PS and CR groups.

Variable	PS group	CR group	P-value
Age (years)	67.3 ± 6.5	67.1 ± 6.9	0.88
Sex (Male: Female)	12:28	10:30	0.79
BMI (kg/m²)	26.5 ± 2.7	27.2 ± 3.1	0.42
DM (%)	30%	35%	0.65
HT (%)	42.5%	45%	0.75
ASA I/II/III	1/28/11	2/27/11	0.82
Pre-op 2MWT (m.)	53.96 ± 23.9	63.99 ± 24.8	0.267
Pre-op TUG (sec.)	22.56 ± 7.91	24.36 ± 11.08	0.270

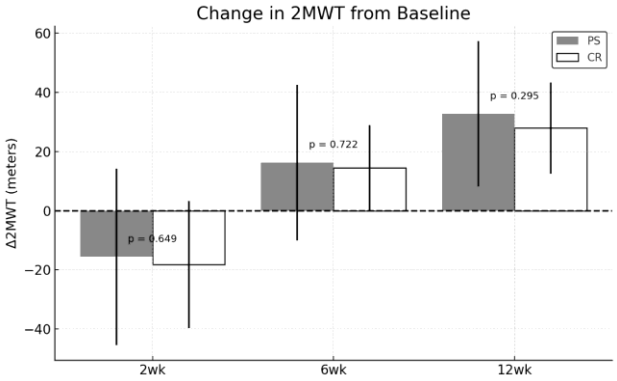

Fig. 2 Change in Two-Minute Walk Test (2MWT) distance from baseline at 2, 6, and 12 weeks postoperatively. Bars represent mean values with standard deviation (SD). Gray bars indicate the PS group, and white bars indicate the CR group. No statistically significant differences were observed between groups at any time point ($p > 0.05$ for all).

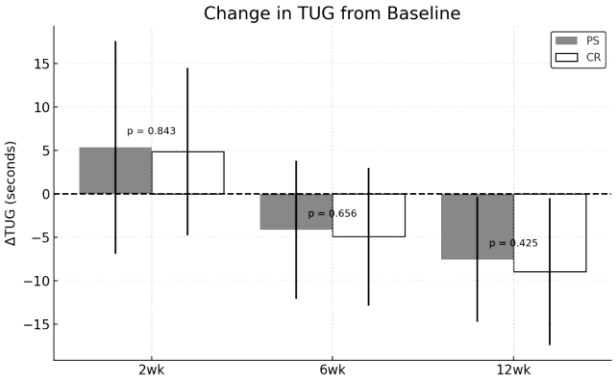

Fig. 3 Change in Timed Up and Go (TUG) test time from baseline at 2, 6, and 12 weeks postoperatively. Bars represent mean values with standard deviation (SD). Gray bars represent the PS group, and white bars represent the CR group. Lower values indicate improved performance. No significant intergroup differences were detected at any time point.

Functional Outcomes

Two-Minute Walk Test (2MWT):

Both groups demonstrated progressive improvement in the 2MWT over time after surgery (Fig. 2). At 2 weeks postoperatively, the mean change in 2MWT was −15.56 ± 29.84 meters in the PS group and −18.22 ± 21.53 meters in the CR group ($p = 0.6493$). By 6 weeks, improvement was observed in both groups, with a mean increase of 16.23 ± 26.3 meters in the PS group and 14.54 ± 14.32 meters in the CR group ($p = 0.722$). At 12 weeks, the PS group showed a mean gain of 32.75 ± 24.55

meters compared to 27.91 ± 15.45 meters in the CR group, with no statistically significant difference (p = 0.2955).

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Timed Up and Go (TUG) Test:

The TUG test also improved across the time points in both groups (Fig. 3). At 2 weeks, the PS group showed a mean increase in time of 5.34 ± 12.23 seconds, while the CR group increased by 4.85 ± 9.62 seconds (p = 0.8431). At 6 weeks, both groups demonstrated recovery with a decrease in TUG time (−4.12 ± 7.95 seconds in PS vs. −4.92 ± 7.93 seconds in CR, p = 0.656). By 12 weeks, further improvements were observed: −7.53 ± 7.18 seconds in the PS group and −8.94 ± 8.45 seconds in the CR group (p = 0.4247).

No between-group comparisons were statistically significant at any point. However, both groups showed consistent within-group improvements over the postoperative course, particularly between weeks 6 and 12. The CR group showed a consistent trend toward greater improvement in the TUG test results at 6 and 12 weeks postoperatively.

No adverse events or postoperative complications such as infection, wound dehiscence, or joint stiffness were observed in either group throughout the follow-up period.

DISCUSSION

This randomized controlled trial investigated the effect of CR and PS implant designs on early functional recovery after TKA, as measured using the 2MWT and Timed-Up-and-Go (TUG) test. Although no statistically significant differences were found between the two groups at any postoperative time point, trends toward improvement were observed in both implant designs. These findings are consistent with those of previous meta-analyses that compared the CR and PS designs[7,8].

The PS group demonstrated slightly greater gains in 2MWT distance at 6 and 12 weeks, whereas the CR group consistently showed numerically better TUG performance outcomes across all follow-up periods. At 12 weeks, for instance, the TUG test time decreased by −8.94 ± 8.45 seconds in the CR group compared to −7.53 ± 7.18 seconds in the PS group (p = 0.4247), although the difference was not statistically significant.

The 2MWT is widely used to evaluate early functional capacity after TKA and provides a simple and validated measure of ambulatory function. Previous studies have proposed a minimal clinically important difference (MCID) of 12.7 meters at 12 months postoperatively in the 2 MWT[9]. Both groups exceeded the MCID at 12 weeks, suggesting a clinically meaningful improvement in ambulation irrespective of the implant type.

Importantly, no adverse events or complications such as postoperative infection, stiffness, or implant-related issues were observed in either group throughout the follow-up period. These findings reinforce the safety and effectiveness of both the implant designs in routine clinical practice.

This study has several limitations. First, although the sample size was sufficient to detect large differences, smaller but clinically relevant differences may have remained undetected. Second, the follow-up period was limited to 3 months, which may not fully capture the long-term differences in implant performance. Future studies with larger cohorts and long-term follow-ups are required.

Despite the observed trend favoring the PS design for early walking distance, the CR implant remains a widely accepted standard choice, offering predictable and satisfactory results, especially in patients with an intact posterior cruciate ligament and suitable anatomical alignment. Therefore, the selection of the implant type should be individualized based on the surgeon's experience, intraoperative findings, and patient-specific factors.

CONCLUSION

This randomized controlled trial demonstrated that both CR and PS TKA designs showed similar early postoperative outcomes in the 2MWT and Timed-Up-and-Go (TUG) test. While the PS group showed a trend toward greater improvement in walking distance and the CR group exhibited numerically better outcomes in functional mobility, as assessed by the TUG test, both exceeded the minimal clinically important difference in the 2MWT. These results suggest that implant design does not significantly influence short-term recovery after TKA, although further studies with larger sample sizes and longer follow-up periods are required to confirm these findings.

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