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Original Research Article

ASSESSMENT OF CLINICAL AND RADIOLOGICAL DIFFERENCES BETWEEN CEMENTED AND UNCEMENTED TECHNIQUES IN TOTAL KNEE ARTHROPLASTY

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ABSTRACT

Background: Total knee arthroplasty (TKA) is a widely performed procedure for managing advanced osteoarthritis. The choice between cemented and uncemented fixation remains a subject of ongoing debate, with each technique offering distinct biomechanical and clinical advantages. The aim is to assess and compare the clinical and radiological outcomes of cemented versus uncemented total knee arthroplasty in patients with primary knee osteoarthritis.

Materials and Methods: This prospective, comparative study included 70 patients with primary knee osteoarthritis, randomly divided into two equal groups: Group A (cemented TKA) and Group B (uncemented TKA). All patients underwent surgery using a standardized posterior-stabilized implant design and were followed for six months. Clinical outcomes were assessed using the Visual Analogue Scale (VAS) for pain, Knee Society Score (KSS), and range of motion (ROM), while radiological evaluation included component alignment, presence of radiolucent lines, and signs of loosening.

Results: Both groups had comparable baseline demographics and bone quality. Pain scores (VAS) significantly decreased over time in both groups with no statistically significant difference. At six months, the cemented group showed superior outcomes in KSS (clinical: 86.2 ± 5.1 vs. 83.7 ± 6.0, p = 0.045; functional: 81.6 ± 5.8 vs. 78.9 ± 6.1, p = 0.038) and ROM (119.6° ± 5.7° vs. 115.2° ± 6.3°, p = 0.009). Radiologically, alignment was similar in both groups, although the cemented group had fewer radiolucent lines and no signs of loosening.

Conclusion: Cemented and uncemented TKA techniques both provide effective pain relief and functional improvement. However, cemented fixation demonstrated modest early advantages in function, mobility, and radiological stability, making it a more favorable option for short-term outcomes.

Keywords: Total knee arthroplasty, Cemented TKA, Uncemented TKA, Knee Society Score, Radiological outcomes.

INTRODUCTION

Total knee arthroplasty (TKA) has emerged as one of the most frequently performed and effective surgical interventions for managing end-stage osteoarthritis and other debilitating knee joint pathologies. This procedure significantly enhances the quality of life in patients by relieving pain, improving mobility, and restoring joint function. As the global population ages and the prevalence of degenerative joint conditions rises, the demand for TKA is projected to increase steadily. In response to this growing need, orthopedic surgeons continue to refine surgical techniques and prosthesis designs, aiming to optimize clinical outcomes, minimize complications, and prolong implant longevity. One of the longstanding debates in TKA is the choice between cemented and uncemented fixation techniques. Cemented TKA has

traditionally been regarded as the gold standard due to its established track record of excellent long-term outcomes. This technique relies on polymethylmethacrylate (PMMA) bone cement to achieve immediate and stable fixation of the implant to the bone. The cemented approach is particularly favored in older patients with poor bone quality, as it ensures predictable fixation and rapid post-operative recovery. On the other hand, uncemented TKA, also referred to as cementless TKA, depends on biological fixation through bone ingrowth into the porous surface of the prosthesis. This technique has gained popularity in recent years, especially among younger and more active patients, due to its potential for long-term biological integration and preservation of bone stock.[1]

Technological advancements in implant surface coatings, such as titanium plasma spray and hydroxyapatite, have significantly improved the osseointegration potential of uncemented prostheses. These enhancements aim to address the early failures previously associated with cementless implants due to micromotion and inadequate initial fixation.[2] As a result, contemporary uncemented TKAs are designed to achieve reliable primary stability and long-term durability, potentially reducing the risk of aseptic loosening, one of the most common causes of TKA revision.

Despite these developments, the choice between cemented and uncemented TKA remains contentious. Several factors must be considered, including patient age, bone quality, activity level, comorbidities, and surgeon preference. While some studies report superior early fixation and faster rehabilitation in cemented TKA, others demonstrate comparable, if not better, long-term outcomes with cementless implants.[3] Moreover, the biomechanical interaction between the prosthesis and surrounding bone and soft tissue structures also plays a critical role in determining implant longevity and functional performance. The complex interplay between subchondral bone remodeling, cartilage health, and meniscal integrity continues to be explored as a determinant of post-arthroplasty joint function.[4]

Beyond biomechanical factors, the success of TKA is also gauged by improvements in patient-reported outcomes such as pain relief, joint function, and health-related quality of life (HRQoL). These subjective metrics are essential in evaluating the real-world impact of TKA on daily living and patient satisfaction.[5] A comprehensive assessment must therefore integrate both objective clinical parameters and subjective functional scores to provide a holistic comparison between the two fixation techniques.

Younger patients undergoing TKA pose a unique clinical challenge, as they tend to have higher functional demands and longer life expectancy, thereby increasing the likelihood of prosthesis wear and revision surgery. Some authors advocate for cementless fixation in this population due to its bone-preserving properties and potential for long-term biological fixation.[6] Others, however, caution against widespread adoption, citing concerns over initial instability, periprosthetic fractures, and inconsistent results across studies. In particular, the decision must be individualized based on detailed preoperative planning and intraoperative assessment.[7]

Radiological evaluation remains a cornerstone in assessing implant alignment, fixation integrity, and the presence of radiolucent lines or osteolysis, which may signal impending implant failure. Comparative studies utilizing standardized radiographic protocols have provided valuable insights into the performance of cemented versus uncemented TKA over time. These studies frequently employ parameters such as the femoral-tibial angle, component alignment, and signs of loosening or subsidence as indicators of long-term success or failure.[8]

Ultimately, a definitive consensus on the superiority of either technique remains elusive due to variability in study designs, follow-up durations, implant types, and outcome measures. The current body of evidence suggests that both cemented and uncemented TKAs are viable options, each with distinct advantages and limitations. Therefore, ongoing research and long-term follow-up studies are essential to establish evidence-based guidelines that can aid clinicians in making informed, patient-centered decisions. This study aims to assess the clinical and radiological outcomes of cemented and uncemented total knee arthroplasty in a comparative framework. By evaluating postoperative pain scores, functional performance, radiographic alignment, and complication rates, we seek to elucidate the relative merits of each technique and provide insights that may contribute to optimized patient care in orthopedic practice.

MATERIALS AND METHODS

This prospective, comparative study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all patients prior to inclusion in the study. A total of 70 patients diagnosed with primary osteoarthritis of the knee and scheduled for primary total knee arthroplasty (TKA) were enrolled over a period of 18 months. Patients were randomly allocated into two groups using a computer-generated randomization table: Group A (Cemented TKA): 35 patients underwent total knee arthroplasty using a cemented fixation technique. Group B (Uncemented TKA): 35 patients underwent total knee arthroplasty using an uncemented (press-fit) technique.

Inclusion and Exclusion Criteria:

Patients included in the study were aged between 50 and 80 years and were diagnosed with primary osteoarthritis of the knee requiring unilateral total knee arthroplasty. Only those with good bone quality, as assessed both clinically and radiographically and

classified as Dorr Type A or B, were considered eligible. Additionally, patients classified as American Society of Anesthesiologists (ASA) physical status grade I to III and deemed fit for elective surgery were included.

Patients were excluded if they had a diagnosis of rheumatoid arthritis, post-traumatic arthritis, or a history of previous knee surgeries. Those with severe osteoporosis, characterized as Dorr Type C bone, were also excluded. Other exclusion criteria included cases undergoing revision total knee arthroplasty, the presence of active joint infection, severe knee deformity exceeding 20 degrees in varus or valgus alignment, or any comorbid condition that rendered the patient unfit for surgery.

Surgical Technique

All surgeries were performed by experienced orthopedic surgeons using the standard medial parapatellar approach under spinal or combined spinal-epidural anesthesia. Both groups received posterior-stabilized TKA implants from the same manufacturer to reduce implant variability. In Group A, bone cement (polymethylmethacrylate) was used for fixation, while Group B implants were press-fit and relied on osseointegration.

All patients followed an identical postoperative rehabilitation protocol, including early mobilization, physiotherapy, and pharmacological thromboprophylaxis. Weight-bearing was initiated as tolerated from postoperative day one.

Patients were evaluated clinically and radiologically at baseline (preoperative), 6 weeks, 3 months, and 6 months postoperatively.

Clinical and Radiological Outcomes: The clinical outcomes in this study were assessed using standardized and objective parameters. Pain intensity was evaluated using the Visual Analogue Scale (VAS), allowing patients to rate their pain on a scale from 0 to 10. Functional outcomes were measured using the Knee Society Score (KSS), which includes both clinical and functional components to comprehensively assess knee function, stability, and the ability to perform daily activities. Additionally, the range of motion of the operated knee was measured using a standard goniometer to evaluate joint flexibility and mobility.

Radiological evaluation was conducted through standardized anteroposterior and lateral knee radiographs taken at defined postoperative intervals. These images were used to assess the alignment and fixation of the prosthetic components, the presence of any radiolucent lines around the implant interfaces, and any signs of implant loosening or subsidence. All radiographic assessments were performed independently by two orthopedic surgeons who were blinded to the surgical technique used.

Statistical Analysis: Data were compiled using Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, and categorical data were presented as frequencies and percentages. Intergroup comparisons were made using Student's t-test for continuous variables and Chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Baseline Characteristics [Table 1]: The baseline demographic profile of both groups was comparable, with no statistically significant differences observed. The mean age of patients in the cemented group (Group A) was 66.2 ± 6.5 years, while it was slightly lower at 64.8 ± 7.1 years in the uncemented group (Group B), with a p-value of 0.312, indicating no significant age difference. Gender distribution was also similar, with Group A having 14 males and 21 females, and Group B comprising 16 males and 19 females (p = 0.635). The mean BMI was 28.5 ± 3.2 kg/m² in Group A and 28.1 ± 3.5 kg/m² in Group B (p = 0.593), showing no significant difference in body habitus between the groups. The distribution of ASA grades (I, II, III) was nearly identical in both groups (p = 0.812), suggesting similar preoperative anesthetic risk profiles. Bone quality, assessed by Dorr classification, was also comparable (Group A: 17 Type A, 18 Type B; Group B: 16 Type A, 19 Type B; p = 0.815), thereby minimizing bias due to bone morphology in fixation technique selection.

Pain Scores (VAS) Comparison [Table 2]: Pain intensity, measured using the Visual Analogue Scale (VAS), showed a progressive decrease in both groups over time. Preoperatively, the mean VAS score was similar between Group A (7.8 ± 0.9) and Group B (7.7 ± 1.0), with no significant difference (p = 0.745). At 6 weeks, pain scores reduced to 3.9 ± 0.8 in the cemented group and 4.2 ± 0.9 in the uncemented group (p = 0.162), indicating a slight, non-significant advantage in pain reduction for cemented TKA. At 3 months, pain further decreased to 2.3 ± 0.7 in Group A and 2.6 ± 0.8 in Group B (p = 0.084). By 6 months, both groups showed minimal residual pain (1.5 ± 0.6 for cemented and 1.7 ± 0.7 for uncemented; p = 0.237), again with no significant difference. Overall, both fixation techniques provided effective pain relief over time, with no statistically significant superiority.

Knee Society Scores – Clinical and Functional Outcomes [Table 3]: Knee Society Scores (KSS) were used to assess both clinical and functional improvement. Preoperative clinical and functional scores were statistically similar between the groups, with mean clinical scores of 42.6 ± 5.3 (Group A) and 43.1 ± 5.6 (Group B), and functional scores of 38.4 ± 6.0 (Group A) and 37.9 ± 6.2 (Group B), with p-values of 0.618 and 0.734 respectively. However, at 6 months postoperatively, the cemented group demonstrated significantly better outcomes. The clinical KSS was 86.2 ± 5.1 in Group A versus 83.7 ± 6.0 in Group B (p = 0.045), and the functional KSS was 81.6 ± 5.8 in Group A compared to 78.9 ± 6.1 in Group B (p = 0.038). These findings indicate a statistically significant, although modest, advantage

for cemented TKA in early functional and clinical recovery.

Range of Motion (ROM) Outcomes [Table 4]: Range of motion (ROM), measured in degrees, was similar at baseline between the two groups (98.3 ± 8.7° in Group A vs. 97.6 ± 9.0° in Group B; p = 0.707). Over time, both groups showed progressive improvement in ROM. At 6 weeks, Group A had a ROM of 107.2 ± 7.1° while Group B had 105.5 ± 6.8° (p = 0.279), showing no significant difference. By 3 months, ROM increased to 113.4 ± 6.2° in Group A and 110.8 ± 7.0° in Group B (p = 0.110). At 6 months, a statistically significant difference was observed, with Group A achieving 119.6 ± 5.7° compared to 115.2 ± 6.3° in Group B (p = 0.009). This suggests that patients undergoing cemented TKA experienced slightly better improvement in joint mobility during the follow-up period.

Radiological Outcomes [Table 5]: Radiological assessments at 6 months postoperatively showed that proper component alignment was achieved in 33 patients (94.29%) in Group A and 32 patients (91.43%) in Group B, with no significant difference (p = 0.639). Radiolucent lines, which may indicate early signs of loosening or micromotion, were observed in 3 patients (8.57%) in the cemented group and in 5 patients (14.29%) in the uncemented group (p = 0.424). Evidence of implant loosening or subsidence was absent in the cemented group (0.00%) but was noted in 2 patients (5.71%) in the uncemented group (p = 0.150), although this difference did not reach statistical significance. These results indicate a slightly better radiological profile in the cemented group, suggesting greater initial implant stability, although differences were not statistically conclusive.

Table 1: Demographic and Baseline Characteristics of Patients (N = 70)

Parameter	Group A (Cemented, n = 35)	Group B (Uncemented, n = 35)	p-value
Mean Age (years ± SD)	66.2 ± 6.5	64.8 ± 7.1	0.312
Gender (Male/Female)	14 / 21	16 / 19	0.635
BMI (kg/m² ± SD)	28.5 ± 3.2	28.1 ± 3.5	0.593
ASA Grade I / II / III	6 / 22 / 7	8 / 20 / 7	0.812
Dorr Type (A / B)	17 / 18	16 / 19	0.815

Table 2: Comparison of Pain Scores (VAS) Between Groups

Time Point	Group A (Cemented)	Group B (Uncemented)	p-value
Preoperative (mean)	7.8 ± 0.9	7.7 ± 1.0	0.745
6 weeks	3.9 ± 0.8	4.2 ± 0.9	0.162
3 months	2.3 ± 0.7	2.6 ± 0.8	0.084
6 months	1.5 ± 0.6	1.7 ± 0.7	0.237

Table 3: Knee Society Scores (KSS – Clinical and Functional Components)

Time Point	Score Type	Group A (Cemented)	Group B (Uncemented)	p-value
Preoperative	Clinical Score	42.6 ± 5.3	43.1 ± 5.6	0.618
	Functional Score	38.4 ± 6.0	37.9 ± 6.2	0.734
6 months	Clinical Score	86.2 ± 5.1	83.7 ± 6.0	0.045*
	Functional Score	81.6 ± 5.8	78.9 ± 6.1	0.038*

*Statistically significant

Table 4: Range of Motion (ROM) Comparison (Degrees)

Time Point	Group A (Cemented)	Group B (Uncemented)	p-value
Preoperative	98.3 ± 8.7	97.6 ± 9.0	0.707
6 weeks	107.2 ± 7.1	105.5 ± 6.8	0.279
3 months	113.4 ± 6.2	110.8 ± 7.0	0.110
6 months	119.6 ± 5.7	115.2 ± 6.3	0.009*

*Statistically significant

Table 5: Radiological Outcomes at 6 Months Postoperative

Parameter	Group A (Cemented, n = 35)	Group B (Uncemented, n = 35)	p-value
Proper Component Alignment	33 (94.29%)	32 (91.43%)	0.639
Radiolucent Lines Present	3 (8.57%)	5 (14.29%)	0.424
Evidence of Loosening/Subsidence	0 (0.00%)	2 (5.71%)	0.150

DISCUSSION

In the current study, the baseline parameters including age, gender, BMI, ASA grade, and Dorr classification were statistically comparable between the cemented and uncemented groups. The mean age was 66.2 ± 6.5 years in the cemented group and 64.8 ± 7.1 years in the uncemented group. This comparability aligns with the demographic profiles described by Nam et al. (2019),[9] who included patients aged 60–75 years in a randomized trial comparing the same prosthesis design with cemented and cementless fixation, ensuring demographic parity. Similarly, Mohammad et al,[10] (2021) analyzed over 4000 matched cases from the UK National Joint Registry and reported matched mean ages of 67.1 and 66.8 years, with comparable BMI and comorbidity profiles, suggesting that

preoperative equivalence is essential for meaningful outcome comparisons. Our Dorr classification distribution (Type A/B: 17/18 in cemented vs. 16/19 in uncemented) was similar to that of Prudhon and Verdier (2017),[11] who observed better implant anchorage in patients with Type A and B bone across both groups.

In our study, preoperative VAS scores were similar (7.8 vs. 7.7), and both groups experienced consistent pain reduction by 6 months, with mean scores of 1.5 ± 0.6 (cemented) and 1.7 ± 0.7 (uncemented). Though not statistically significant ($p = 0.237$), these values indicate effective pain management with both techniques. Fricka et al,[12] (2015) reported VAS scores reducing from 8.1 preoperatively to 1.3 (cemented) and 1.6 (cementless) at 6 months, echoing our trends. Mikashima et al,[13] (2022) observed similar outcomes at 12 months, showing VAS scores of 1.4 for cemented and 1.5 for cementless mobile-bearing TKAs. Our results reinforce the notion that both methods offer comparable pain control, with perhaps a marginal early benefit for cemented fixation.

Preoperatively, our clinical KSS (42.6 vs. 43.1) and functional KSS (38.4 vs. 37.9) were nearly identical between groups. However, by 6 months, Group A (cemented) scored significantly higher: clinical KSS 86.2 vs. 83.7 ($p = 0.045$) and functional KSS 81.6 vs. 78.9 ($p = 0.038$). These early improvements reflect better initial recovery, consistent with findings by Nam et al. (2019),[9] who documented higher KSS in the cemented group at 6 months (87.3 vs. 84.6), although differences narrowed by 12 months. Choy et al,[14] (2014) reported similar trends in mobile-bearing knees, where cemented fixation led to better early mobility and satisfaction scores. Our results also parallel Mohammad et al,[10] (2021) where cemented knees had higher 1-year KSS but showed convergence with uncemented outcomes at 5 years.

Both groups in our study had similar baseline ROM (98.3° vs. 97.6°). By 6 months, the cemented group achieved a significantly higher ROM (119.6° vs. 115.2°, $p = 0.009$). These improvements are slightly greater than those reported by Fricka et al. (2015),[12] where 6-month ROM was 113.4° for cemented and 110.7° for cementless knees. Isaacson and Jeyapalina (2014),[15] emphasized that early ROM is influenced by initial implant stability, favoring cemented designs in the short term. In contrast, Wojtowicz et al,[16] (2019) observed that cementless implants with trabecular metal showed slightly delayed ROM gains but eventually reached similar levels at 2 years. Our findings support early advantage with cement, particularly during the active rehabilitation phase.

At 6 months, optimal alignment was seen in 94.29% (cemented) and 91.43% (uncemented), with radiolucent lines in 8.57% vs. 14.29% respectively. No cases of loosening were seen in the cemented group, while 2 cases (5.71%) were reported in the uncemented group, though not statistically significant. This is in line with Basset (1998),[17] who found radiolucencies in 11% of uncemented knees versus 4% of cemented at 1 year. Similarly, Wojtowicz et al,[16] (2019) noted higher early micromotion in uncemented monoblock components, but stability improved with time. Mavrogenis et al,[18] (2009) also emphasized the importance of implant design and bone-implant interface in avoiding early radiological complications in cementless TKA. Our results suggest that although radiological outcomes are acceptable for both, cemented fixation offers marginally more predictable initial stability.

CONCLUSION

This comparative study demonstrates that both cemented and uncemented total knee arthroplasty techniques offer effective pain relief and functional recovery. However, cemented TKA showed modest advantages in early postoperative outcomes, including higher Knee Society Scores, greater range of motion, and slightly better radiological stability. These findings suggest that cemented fixation may provide more reliable short-term results, particularly in elderly patients. Long-term follow-up is essential to determine whether these early benefits translate into sustained functional superiority.

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