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The Effect of Early Weight Bearing and Delayed Weight Bearing on Functional Recovery in Post Total Knee Replacement

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Abstract
Background: Early mobilization is a central component of rehabilitation after total knee replacement (TKR), yet the timing of loading through the operated limb varies across clinical settings. This study compared early weight bearing with delayed weight bearing for functional recovery after primary unilateral TKR. Methods: Thirty patients aged 50-75 years were included in a prospective comparative interventional study and allocated to an Early Weight Bearing (EWB) group (n=15) or Delayed Weight Bearing (DWB) group (n=15). EWB participants began supported standing and walking within 24-48 hours when medically stable; DWB participants followed protected/minimal loading for the first 14 days before progressive advancement. Outcomes included Knee Society Score (KSS), WOMAC physical function, Visual Analog Scale (VAS), active knee flexion range of motion (ROM), and Timed Up and Go (TUG). Non-parametric between- and within-group tests were used with $p<0.05$ as the significance level. Results: Baseline characteristics and clinical measures were comparable. At 6 weeks, EWB showed higher KSS (77.15±3.49 vs 69.02±7.16; p=0.002), lower WOMAC disability (29.61±3.29 vs 35.71±4.63; p<0.001), greater knee flexion ROM (106.38±5.22° vs 98.06±4.38°; p<0.001), and faster TUG (9.31±0.79 vs 11.49±1.35 s; p<0.001). VAS was also lower (2.24±0.64 vs 2.69±0.56), although the 6-week difference was not statistically significant (p=0.074). Early advantages were evident at 2 weeks and remained significant for all five outcomes at 3 months. No fall, confirmed deep vein thrombosis, or major implant-related complication occurred. Conclusion: Early, protected and supervised weight bearing was associated with faster early functional recovery after TKR without an observed increase in major short-term complications. Delayed loading may be better reserved for patient- or surgeon-specific restrictions.

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Keywords: total knee replacement; early weight bearing; delayed weight bearing; functional recovery; physiotherapy; Knee Society Score; WOMAC; Timed Up and Go

1. Introduction

Total knee replacement (TKR), or total knee arthroplasty (TKA), is an established treatment for end-stage knee osteoarthritis when pain, structural degeneration and functional loss remain substantial despite conservative management. Although modern implants and surgical technique are important determinants of outcome, the quality and timing of post-operative rehabilitation strongly influence how quickly patients regain walking ability, knee motion, confidence and independence. In the early weeks after TKR, pain, swelling, quadriceps inhibition, limited range of motion and altered gait can make basic activities such as bed-chair transfer, sit-to-stand, toileting, stair negotiation and household walking difficult. Physical therapy guidelines therefore emphasize early mobility, range-of-motion exercise, strengthening, balance, gait training and patient education after TKA.[1] Enhanced recovery pathways similarly place early mobilization within coordinated perioperative care.[2]

The timing of weight bearing is a particularly practical rehabilitation decision. Early weight bearing generally means initiating supported standing and ambulation with an assistive device within the first 24-48 hours when the patient is medically stable. Delayed weight bearing uses a more protective approach in which full loading is restricted during the initial post-operative period, often for approximately two weeks, before progressive loading is introduced. Early mobilization after hip and knee arthroplasty has been associated with improved functional readiness and reduced immobility-related risk, but actual practice remains variable across hospitals and clinical teams.[3] Gnanakumaran and colleagues reported that early mobility after TKR can influence length of stay, pain and function, reinforcing early independence as a relevant rehabilitation target.[4]

The potential benefit of early loading is biologically and functionally plausible. Closed-chain loading may provide proprioceptive input, encourage quadriceps activation, reduce avoidance of the operated limb and facilitate task-specific practice of standing and walking. The greatest rate of functional recovery after arthroplasty occurs during the early post-operative weeks, making the timing of rehabilitation exposure potentially important.[5] At the same time, functional recovery is multidimensional. Patient-reported disability and performance-based mobility do not measure exactly the same construct, so both should be assessed.[6-8] Knee function scores, WOMAC disability, pain intensity, active knee flexion and TUG together provide complementary information about recovery.[9-19]

Concern about pain, swelling, wound condition, balance, fear of loading and surgeon-specific restrictions may still lead clinicians to delay loading in some patients. In addition, prescribed weight-bearing status does not always match actual loading behaviour, indicating the importance of clear instruction and supervision.[23] The clinical question is therefore not whether patients should mobilize after TKR, but whether medically stable patients recover more quickly when functional loading begins early rather than after an initial protected period. The present study compared early and delayed weight bearing after primary unilateral

TKR, with functional recovery assessed through KSS, WOMAC physical function, VAS pain, active knee flexion ROM and TUG. The working hypothesis was that early, supervised loading would produce faster early recovery without increasing major short-term complications.

Aim & Objectives

The aim of this study is to compare the effect of early weight bearing and delayed weight bearing on functional recovery in patients after primary unilateral total knee replacement.

1. To compare functional recovery between early weight bearing and delayed weight bearing groups using the Knee Society Score.
2. To compare patient-reported physical function using the WOMAC physical function score.
3. To compare pain intensity between both groups using the Visual Analog Scale.
4. To compare active knee flexion range of motion measured with a universal goniometer.
5. To compare functional mobility using the Timed Up and Go test.
6. To observe post-operative complications and adverse events associated with both weight-bearing approaches.

2. Materials and Methods

2.1 Study design and participants

A prospective comparative interventional, two-group pre-test and post-test design was used. The total sample consisted of 30 post-TKR participants: 15 in the Early Weight Bearing group and 15 in the Delayed Weight Bearing group. Participants were recruited using non-probability purposive sampling from orthopaedic in-patient and physiotherapy rehabilitation services of a selected tertiary-care hospital. Follow-up assessments were scheduled during the early post-operative period through 3 months.

2.2 Eligibility Criteria

Eligible participants were 50-75 years of age, male or female, had undergone primary unilateral cemented TKR for advanced knee osteoarthritis, were medically stable for physiotherapy, could understand instructions and provide consent, and were willing to attend follow-up.

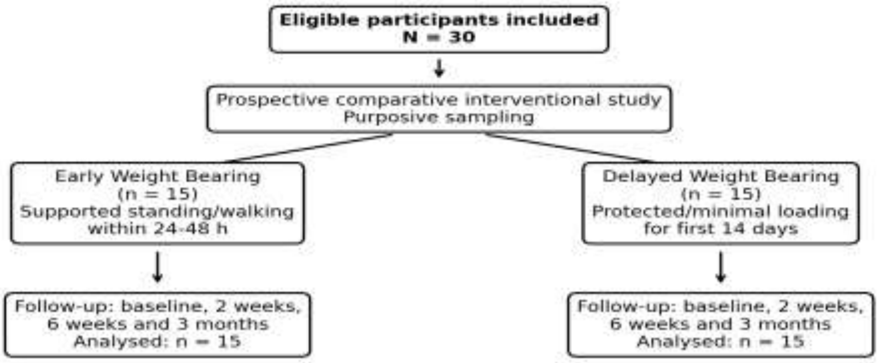

Figure 1. Participant grouping, intervention timing, and assessment schedule

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Exclusion criteria included revision or same-admission bilateral TKR, neurological disorders affecting gait or balance, unstable cardiorespiratory disease, intra-operative fracture or major surgical complication, severe uncontrolled pain, major metabolic conditions affecting healing or bone quality, active infection, DVT, or another post-operative complication requiring immobilization.

2.3 Outcome measures

Knee Society Score (KSS) was used to represent knee-related clinical and functional recovery, with higher scores indicating better function. WOMAC physical function assessed difficulty with daily activities; lower scores represented less disability.

Pain intensity was recorded using a 0-10 Visual Analog Scale (VAS), where lower scores indicated less pain. Active knee flexion was measured in degrees with a universal goniometer using consistent anatomical landmarks.

Functional mobility was measured with the Timed Up and Go (TUG) test using a standard chair, a 3-metre walking distance and a stopwatch; lower completion time indicated better mobility.

Complications and adverse events, including swelling, wound problems, dizziness, falls and suspected DVT, were recorded during follow-up.

Assessments were performed at baseline and scheduled follow-up intervals: WOMAC, VAS, ROM and TUG at 2 weeks; all principal outcomes at 6 weeks and 3 months; and KSS at its planned score intervals in the source chart.

2.4 Interventions

Both groups received the same basic post-TKR physiotherapy programme, including breathing exercises, ankle pumps, knee-extension positioning, quadriceps and gluteal activation, heel slides, active-assisted progressing to active knee movement, transfer education, progressive strengthening and gait re-education. Progression was individualized according to pain, swelling, wound status, quadriceps control, balance and medical instructions. The planned group difference was the timing and progression of loading through the operated limb.

In the EWB group, supported standing and walking with a walker were initiated within 24-48 hours once medical stability and permission to mobilize were confirmed. Weight bearing was progressed as tolerated while the physiotherapist monitored pain, swelling, knee control, balance, gait quality and confidence. Walking began over short, level distances and was advanced with practice of sit-to-stand, turning, step symmetry and functional transfers. From approximately week 2 onward, supported closed-chain loading, balance and step or stair practice were added as tolerated.

In the DWB group, full loading of the operated limb was restricted during the first 14 post-operative days. Bed mobility, range-of-motion exercise, muscle activation and transfer training continued, while standing or short-distance mobility used protected or minimal loading with a walker as clinically advised. From day 15 onward, loading was advanced progressively toward partial loading and then weight bearing as tolerated after review of pain,

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swelling, wound status, quadriceps control, balance and gait safety. From week 6 to 3 months, both groups emphasized strength, balance, endurance, stair climbing and independence in activities of daily living.

2.4 Statistical analysis

Data were organized in a master chart and summarized using mean, standard deviation, frequency and percentage, with median and interquartile range available where appropriate. Because each group contained 15 participants, the analysis plan specified assessment of distribution with the Shapiro-Wilk test and use of non-parametric inferential methods when normality could not be assumed. Mann-Whitney U tests were used for between-group comparisons, Wilcoxon signed-rank tests for within-group pre-post comparisons, and Fisher's exact or chi-square tests for categorical data according to expected cell counts. Statistical significance was set at $p<0.05$. To mirror the reporting style of the sample article, standardized mean differences (Cohen's d) at 6 weeks were additionally calculated from the reported group means and pooled standard deviations; these effect-size calculations are descriptive complements to the source non-parametric p-values.

3. Results

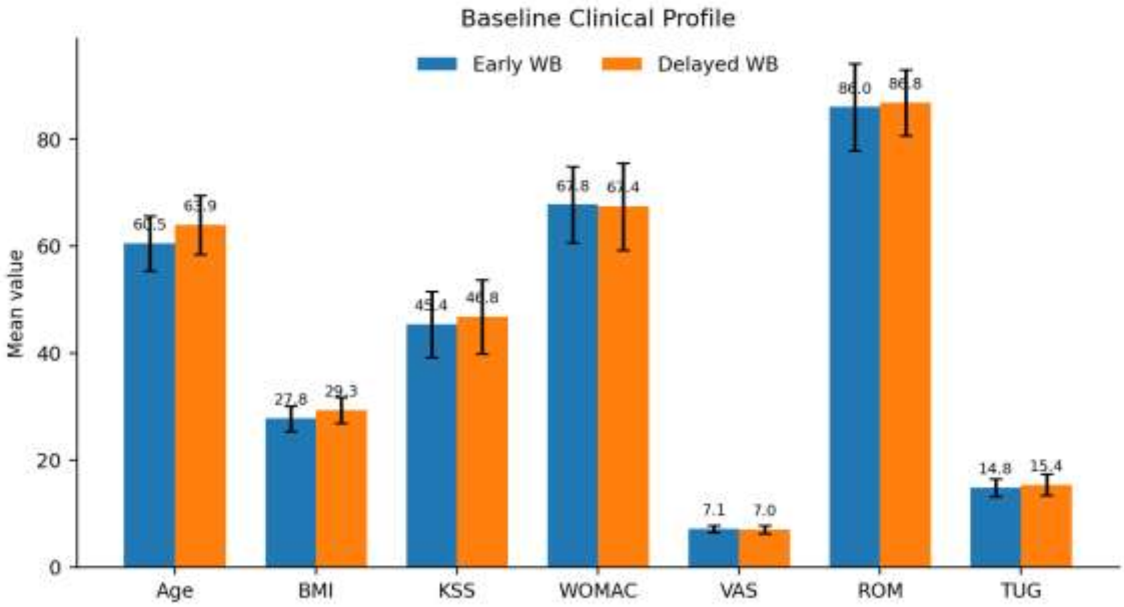
3.1 Baseline characteristics

All 30 participants were represented in the study master chart, with 15 in each group. Baseline demographic and clinical characteristics were comparable. Mean age was 60.53±5.14 years in EWB and 63.93±5.50 years in DWB (p=0.067). The male/female distribution was 6/9 and 7/8, respectively (p=1.000), and mean BMI was 27.77±2.37 versus 29.33±2.47 kg/m² (p=0.115). Baseline KSS, WOMAC, VAS, knee flexion ROM and TUG also showed no statistically significant between-group differences, supporting reasonable comparability before the intervention.

Table 1. Baseline demographic and clinical characteristics

Characteristic	Early WB (n=15)	Delayed WB (n=15)	p-value
Age, years	60.53 ± 5.14	63.93 ± 5.50	0.067
Male/Female, n	6/9	7/8	1.000
BMI, kg/m²	27.77 ± 2.37	29.33 ± 2.47	0.115
KSS	45.39 ± 6.13	46.75 ± 6.93	0.740
WOMAC	67.75 ± 7.18	67.41 ± 8.16	0.852
VAS	7.13 ± 0.66	6.99 ± 0.81	0.618
Knee flexion ROM, °	85.97 ± 8.09	86.81 ± 6.11	0.693
TUG, seconds	14.83 ± 1.64	15.37 ± 1.97	0.520

Values are mean ± SD unless otherwise indicated.



Graph 1. Comparison of baseline clinical scores between Early and Delayed Weight Bearing groups

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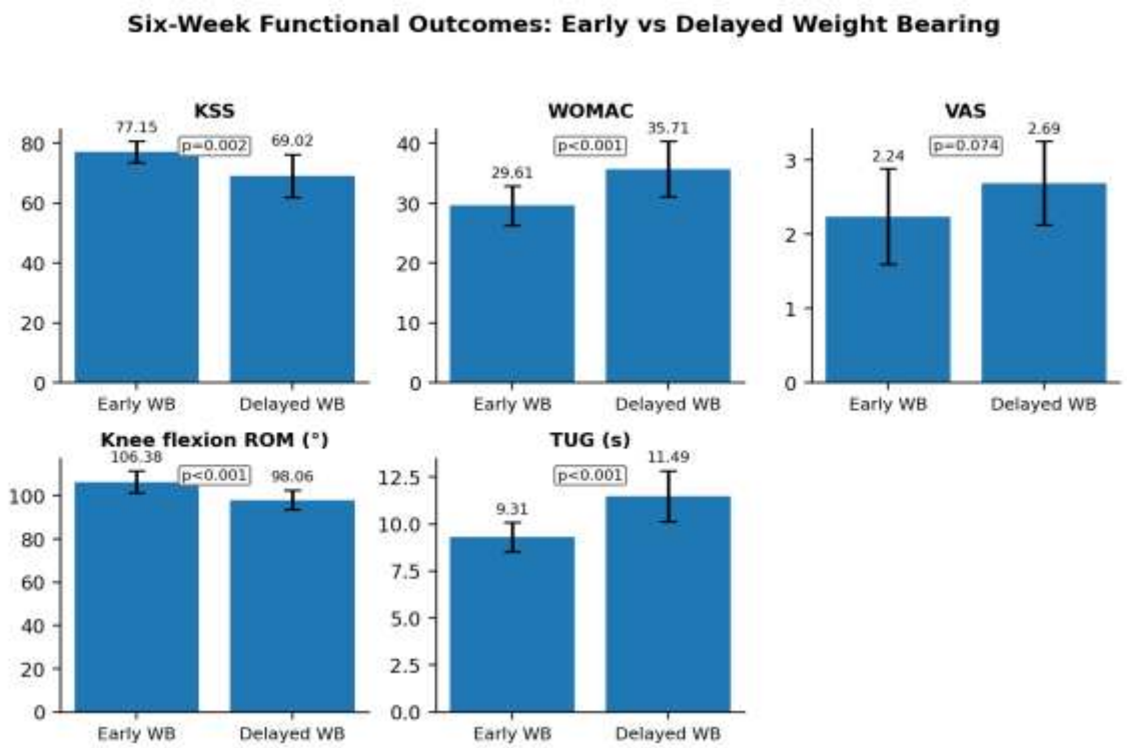
3.2 Six-week functional outcomes

Both groups improved substantially from baseline to 6 weeks, and every within-group change across KSS, WOMAC, VAS, ROM and TUG was significant on Wilcoxon testing (all p<0.001). The magnitude and speed of improvement were greater in the EWB group for most outcomes. At 6 weeks, KSS was 8.13 points higher with EWB, WOMAC disability was 6.10 points lower, knee flexion was 8.32° greater, and TUG was 2.18 seconds faster. These between-group differences were statistically significant for KSS (p=0.002), WOMAC (p<0.001), ROM (p<0.001) and TUG (p<0.001). VAS was 0.45 points lower with EWB, but the 6-week between-group p-value was 0.074.

Table 2. Between-group functional outcomes at 6 weeks

Outcome	Early WB	Delayed WB	Mean difference*	p-value	Cohen's d*
KSS	77.15 ± 3.49	69.02 ± 7.16	+8.13	0.002	+1.44
WOMAC	29.61 ± 3.29	35.71 ± 4.63	-6.10	<0.001	-1.52
VAS	2.24 ± 0.64	2.69 ± 0.56	-0.45	0.074	-0.75
Knee flexion ROM (°)	106.38 ± 5.22	98.06 ± 4.38	+8.32	<0.001	+1.73
TUG (s)	9.31 ± 0.79	11.49 ± 1.35	-2.18	<0.001	-1.97

**Mean difference = Early WB minus Delayed WB. Cohen's d calculated from reported means/SDs; direction depends on whether higher or lower scores are favorable.*



Graph 2. Primary functional outcomes at 6 weeks

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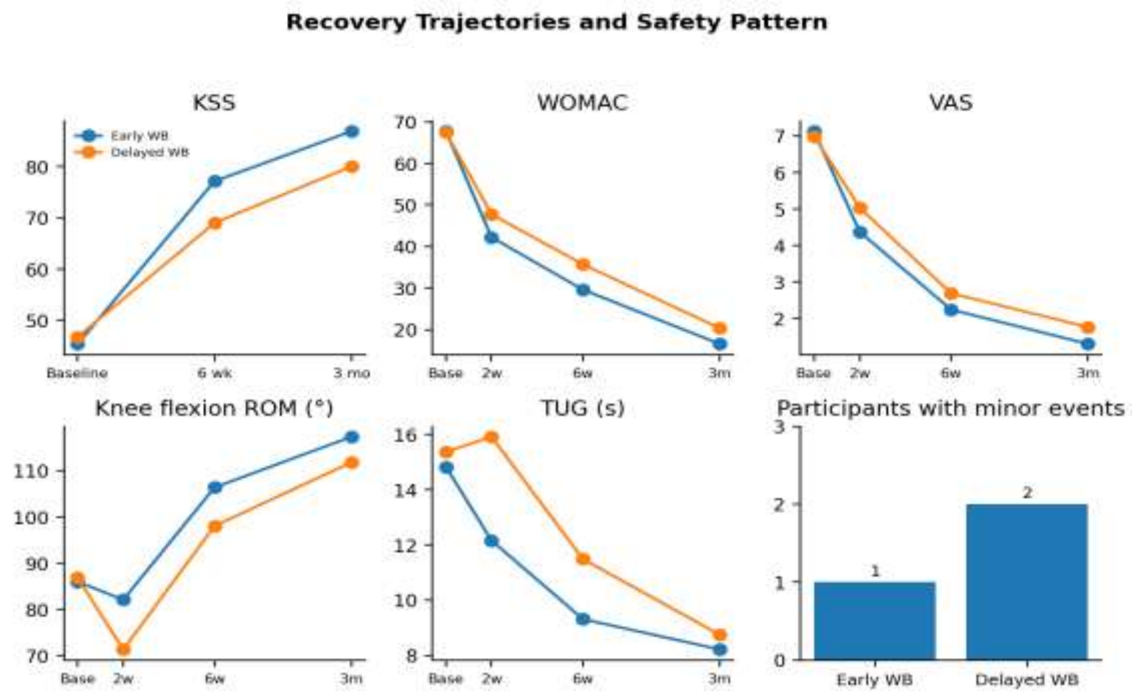
3.3 Early trajectory, three-month status and safety

Early divergence between groups was already evident at 2 weeks. EWB participants had lower WOMAC disability (42.24±3.89 vs 47.75±4.39; p<0.001), lower VAS pain (4.37±0.71 vs 5.03±0.58; p=0.021), greater knee flexion (82.07±3.86° vs 71.33±5.43°; p<0.001), and faster TUG performance (12.16±0.94 vs 15.92±2.19 s; p<0.001). The early ROM pattern is clinically notable because the DWB group showed a larger short-term decline in flexion during the protected loading phase, whereas EWB maintained more functional movement.

Table 3. Three-month outcomes and post-operative safety

Parameter	Early WB (n=15)	Delayed WB (n=15)	Statistical result
KSS	86.89 ± 3.35	80.03 ± 3.87	p<0.001
WOMAC	16.56 ± 2.75	20.35 ± 4.04	p=0.014
VAS	1.30 ± 0.35	1.76 ± 0.45	p=0.006
Knee flexion ROM, °	117.34 ± 2.70	111.80 ± 5.14	p=0.003
TUG, seconds	8.21 ± 0.48	8.74 ± 0.93	p=0.025
No complication, n (%)	14 (93.3%)	13 (86.7%)	Descriptive
Minor events	1 mild effusion	1 delayed wound healing; 1 transient dizziness	Descriptive
Fall / confirmed DVT / major implant complication	0	0	None observed



Graph 3. Recovery trajectories and safety pattern across follow-up

At 3 months, both groups had made substantial gains, but statistically significant between-group differences remained across all five principal outcomes. KSS was higher in EWB (86.89±3.35 vs 80.03±3.87; $p<0.001$), WOMAC was lower (16.56±2.75 vs 20.35±4.04; $p=0.014$), VAS was lower (1.30±0.35 vs 1.76±0.45; $p=0.006$), knee flexion ROM was greater (117.34±2.70° vs 111.80±5.14°; $p=0.003$), and TUG remained faster (8.21±0.48 vs 8.74±0.93 s; $p=0.025$). The between-group gap was smaller for some measures than during the early weeks, indicating partial catch-up in the delayed group while preserving an EWB advantage at 3 months.

4. Discussion

The principal finding was that supervised early weight bearing after primary unilateral TKR accelerated functional recovery during the period when patients are regaining basic independence. Both rehabilitation approaches produced substantial improvement, but EWB generated a steeper early trajectory for knee function, self-reported disability, range of motion and mobility. The strongest between-group differences were present at 2 and 6 weeks, which is clinically important because this period determines whether patients can transfer safely, walk to essential destinations, negotiate steps and reduce caregiver dependence. The source thesis therefore supports the alternative hypothesis that the timing of loading contributes meaningfully to early recovery.

The findings align with the broader literature on early mobility and enhanced recovery after arthroplasty. Jette et al. emphasize early mobility, strengthening, functional training and education in physical therapist management after TKA.[1] ERAS recommendations similarly integrate early mobilization into multimodal perioperative care.[2] Chua et al. reported that early mobilization is recommended after hip or knee arthroplasty but implementation varies across hospitals.[3] Gnanakumaran et al., the mother article identified in the thesis, linked early mobility after TKR with hospital stay, pain and function.[4] The present comparison isolates the weight-bearing component more directly: initiating supervised loading within 24-48 hours was associated with faster recovery than maintaining protected loading for the first 14 days.

The KSS pattern is particularly consistent with a functional loading mechanism. At 6 weeks, the EWB group had a mean KSS of 77.15 compared with 69.02 in DWB, with a large standardized difference calculated from the reported summary values. By 3 months, scores had increased to 86.89 and 80.03, respectively. The improvement probably reflects more than pain reduction alone. Weight bearing places the lower limb in a closed-chain context that requires quadriceps recruitment, postural control and coordinated transfer of body mass. Quadriceps weakness is a major determinant of functional limitation after TKA, and earlier functional use may help patients restore effective muscle activation and confidence.[7] Studies of movement symmetry and weight-bearing feedback also support the importance of how patients load the operated limb rather than simply whether they complete exercises.[14,15]

Patient-reported physical function showed the same directional advantage. WOMAC disability was already lower in EWB at 2 weeks and remained lower at 6 weeks and 3 months. This supports the use of both questionnaire-based and performance-based outcomes because a patient may report difficulty differently from what is observed during a standardized mobility task.[6,8] In the present study, the concordance between WOMAC and TUG strengthens the clinical interpretation: patients who loaded earlier not only perceived less disability but also completed a timed transfer-and-walking task more rapidly. At 6 weeks, the TUG difference was 2.18 seconds, and the standardized mean difference based on source means and SDs was large.

The range-of-motion findings provide another clinically relevant signal. During the initial two weeks, mean knee flexion was 82.07° in EWB but 71.33° in DWB, followed by 106.38° versus 98.06° at 6 weeks. The delayed group therefore demonstrated a more pronounced short-term restriction during the protected loading phase. Early supervised standing and gait practice may reduce avoidance, promote repeated movement through functional arcs and reinforce confidence in the operated limb. However, weight bearing should not be interpreted as a substitute for dedicated ROM exercises; both groups received heel slides, active-assisted movement and progressive exercise, so the observed difference reflects weight-bearing timing within a broader rehabilitation programme.

Pain decreased markedly in both groups. EWB had significantly lower VAS at 2 weeks and again at 3 months, while the 6-week difference did not meet the $p<0.05$ criterion despite a lower mean pain score. This is important clinically because it argues against the assumption that early protected loading necessarily aggravates pain. Instead, carefully supervised loading may coexist with pain reduction when progression is guided by symptoms, wound status, balance and quadriceps control. The non-significant 6-week comparison also cautions against overstating uniform superiority across every time point; the main strength of the intervention was the overall functional trajectory rather than a significant pain difference at every assessment.

Safety findings were reassuring within the limits of the small sample. One participant in EWB had mild effusion; DWB recorded one delayed wound-healing event and one episode of transient dizziness. No fall, confirmed DVT or major implant-related complication occurred in either group. This observation is consistent with the thesis conclusion that early loading, when protected and supervised, did not produce an evident increase in short-term major complications. Nevertheless, the study was not powered to establish safety equivalence for uncommon adverse events. Larger cohorts would be needed before making definitive claims regarding DVT, wound complications, implant migration or other rare outcomes.

The recovery pattern also fits work showing that the greatest improvement after arthroplasty occurs early, particularly over the first several weeks.[5] Fast-track rehabilitation studies have reported improved early clinical and functional outcomes when mobilization and other recovery components are standardized.[11,13,20,21] Continued home exercise remains important beyond the initial hospital phase.[12] Thus, early weight bearing should be viewed as one component of an integrated rehabilitation pathway that includes pain and swelling management, restoration of extension and flexion, quadriceps strengthening, balance, gait retraining and progressive return to daily activity.

The findings have practical implications for physiotherapists. In medically stable patients without a surgical contraindication, supported standing and short-distance ambulation can be initiated within 24-48 hours using a walker and symptom-guided progression. Progression should be based on pain, swelling, wound status, quadriceps control, balance and surgeon instructions rather than on a rigid expectation of unrestricted walking. Education on walker sequence, safe turning, transfer technique, pacing and warning symptoms is essential. Delayed weight bearing may remain appropriate when patient-specific risk factors or surgeon-directed restrictions make early loading unsafe, but the present findings do not support routine delay for otherwise stable primary unilateral TKR patients.

4.1 Strengths and limitations

Several features strengthen the study: both groups received comparable basic physiotherapy, the weight-bearing contrast was clearly defined, repeated functional assessments were used, and the outcome battery combined clinician-rated, patient-reported and performance-based measures. Results were directionally coherent across KSS, WOMAC, ROM and TUG, and within-group improvement was significant in both groups. However, the sample included only 30 participants from a selected hospital setting, reducing generalizability and limiting precision. Non-probability purposive sampling and the absence of participant or therapist blinding introduce potential selection and performance bias. Medication use, motivation and home-exercise compliance could have influenced recovery but were not fully controlled. Muscle strength was not quantified with an isokinetic dynamometer, radiological implant migration was not assessed, and broader endurance or stair-climb outcomes were not included. The analysis focused on short-term recovery through 3 months, so conclusions about long-term function and implant safety cannot be made.

4.2 Clinical implications

For routine physiotherapy practice, the findings support early, protected and supervised loading rather than unnecessary postponement in medically stable patients. Walking should begin with an appropriate assistive device and progress according to pain, swelling, wound condition, quadriceps control, balance and surgeon instructions. KSS, WOMAC, VAS, goniometric ROM and TUG can be used together to monitor whether early gains are occurring across impairment, disability and mobility domains. Delayed loading remains a reasonable individualized option when surgical or medical restrictions are present, but it should not be applied automatically to all patients.

4.3 Future Scope

Future studies should use larger multicentre samples, concealed or randomized allocation where feasible, standardized analgesic and home-exercise documentation, blinded outcome assessment, and longer follow-up. Objective strength testing, six-minute walk distance, stair-climb performance and radiographic or implant-safety outcomes would broaden the assessment. Research should also identify which patients benefit most from immediate weight bearing and which clinical factors justify a slower progression. Such work would help translate the current early-recovery signal into a more precise, risk-stratified post-TKR rehabilitation protocol.

5. Conclusion

In this 30-participant prospective comparative study, early weight bearing initiated within 24-48 hours after primary unilateral total knee replacement was associated with faster improvement in knee function, self-reported physical function, knee flexion and mobility than delaying full loading for approximately 14 days. Advantages were most evident during the first 2-6 weeks and remained statistically significant for all principal outcomes at 3 months. No major fall, confirmed DVT or implant-related complication was observed. Early weight bearing should therefore be considered as a protected, supervised and symptom-guided component of post-TKR rehabilitation in medically stable patients, while delayed loading should be reserved for specific clinical restrictions.

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