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The effects of preoperative balance training on balance and functional outcome after total knee replacement: a randomized controlled trial

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Abstract

Objective: To assess the effects of preoperative balance training on the early postoperative balance and functional outcomes after total knee replacement surgery and to test whether an outpatient intervention may be as effective as a domiciliary intervention.

Design: This is a three-arm randomized controlled trial.

Setting: University hospital.

Subjects: Eighty-six individuals were recruited. Seventy-seven were analysed, aged 72.1 (SD 7.6) years, of which 68% were women.

Outcome measures: Overall state of balance, as measured with the Berg Balance Scale, and patient-perceived functionality, as measured with the Knee Injury and Osteoarthritis Outcome Score Function in Activities in Daily Living (KOOS-ADL) questionnaire, were the primary outcomes. Secondary assessments targeted knee function, balance and mobility, quality of life, and self-reported outcomes. The primary end-point was six weeks after surgery.

Intervention: The hospital group implemented a four-week preoperative outpatient balance-oriented intervention. The home group implemented similar training, but this was domiciliary. The control group was instructed to keep performing their normal activities.

Results: Home and hospital groups presented a moderate effect against the control group ($d_{hospital\text{-}control}$ = 0.54; $d_{home\text{-}control}$ = 0.63), both being similarly effective in improving the overall state of balance at six weeks

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after surgery ($P = 0.013$). KOOS-ADL scores showed no between-group differences and a small effect size ($d < 0.5$; $P = 0.937$). Secondary assessments suggested non-significant between-group differences.
Conclusion: Preoperative balance training, conducted either as domiciliary or as an outpatient, is an effective approach to enhance early postoperative balance outcome but not the perceived functionality of individuals undergoing total knee replacement.

Keywords
Arthroplasty, balance, preoperative exercise

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Introduction

Total knee replacement has a high degree of satisfaction,[1] but a number of patients present with persistent deficits in sensorimotor function.[2] Approximately 60%–80% of patients report knee instability and difficulties in performing basic functional tasks.[3,4] In addition, partial restoration of knee proprioception, poor postural control, mobility, and dynamic balance are prevalent factors that can increase the risk of falls.[5–8]

Balance has been demonstrated to be a predictive factor for function after total knee replacement[9] and is important for independent and safe performance of basic daily activities. Therefore, implementing an intervention oriented to train balance could potentially have a positive impact on surgery results. Balance-oriented interventions have been broadly referred as balance, as proprioceptive or neuromuscular training, and overall as sensorimotor training.[10] Acknowledging the importance of proprioception in the rehabilitation process, this approach emphasizes postural control and progressive challenges to the sensorimotor system to restore normal motor programmes.[10]

Even when limited sensorimotor function is commonly reported, sensorimotor interventions have been scarcely appraised in patients undergoing total knee replacement. Recent research synthesized the available evidence, finding that postoperative interventions appear to be effective in enhancing early postoperative outcomes[11] and supporting the use of sensorimotor training as an adjunct[12] or as an alternative[8] to standard rehabilitation protocols in total knee replacement. However, research on preoperative interventions is still scarce,[11] with only three previous trials having assessed this possibility.[13–15] The design of such trials differed in methodological aspects, such as the amount of treatment that ranged from four to eight weeks. In addition, the resultant evidence was inconclusive, and the effectiveness of the preoperative approach remains unresolved.[11]

The purpose of this research was to determine the effects of preoperative balance-oriented intervention on patients undergoing total knee replacement. The intervention could be undertaken at home or supervised in a hospital setting. Since a domiciliary rehabilitation programme for total knee replacement is used to lower the expenses,[16] both possibilities were assessed. It was hypothesized that domiciliary and outpatient preoperative intervention would be similarly effective in enhancing balance outcomes in the early postoperative period, which in turn would have a positive impact on patient functionality.

Methods

This study was a three-arm randomized controlled trial approved by the research ethics committee ensuring compliance with the ethical and legal provisions of the research carried out in the Hospital Universitario y Politécnico La Fe from Valencia (no. 2016/499). The study was prospectively registered on ClinicalTrials.gov under identifier number NCT-03100890. A detailed protocol was made publicly available online.[17] The study was conducted in Hospital La Fe, and the University of Valencia was responsible for the integrity and conduct of the study. Assessment of participants started in April 2017 and finished in June 2018.

Potential participants were eligible if they were aged 60–80 years and were on the waiting list for undergoing total knee replacement surgery. Potential participants were referred by the orthopaedic surgeon and had to score >21 in the Berg Balance Scale[18] and 20 in the Mini-Mental State Examination[19] to meet the inclusion criteria. The thresholds were established for ensuring that participants were cognitively able to understand the physiotherapist's instructions and physically capable to perform the interventions with safety. Individuals with central or vestibular limitation affecting balance or presenting with postoperative complications of knee surgery, such as deep venous thrombosis, were excluded. Potential participants meeting criteria and signing a consent form took part in the study. Participants were allocated using the output of a random number generator (Matlab ®, The MathWorks, Inc, Natick, Massachusetts) provided by an external assessor. Following randomization, the principal investigator notified patients by phone regarding their treatment allocation. Data collection was blinded; one member of the team was designated with the only task of conducting all assessments. The two experienced physiotherapists (experience of >15 years) supervising interventions were not blinded. Group allocation was not revealed to participants, but the concealment was not ensured, since they were informed about the groups before signing consent.

Outcomes were assessed at the hospital facilities in a space enabled for this purpose. Baseline characteristics and clinical outcomes were assessed from five to eight weeks before surgery. Clinical outcomes were reassessed one week before surgery, before initiating in-hospital early postoperative rehabilitation (10–14 days after surgery), and after discharge (six weeks after surgery: early postoperative period hereinafter). The latter is the primary end-point. We set two primary outcomes. The overall state of balance was assessed with the Berg Balance Scale[18] (minimal detectable change = 2.3–6.2),[20,21] and the self-reported functionality was assessed with the Knee Injury and Osteoarthritis Outcome Score Function in Activities in Daily Living (KOOS-ADL) subscale. In this test, the total score was normalized between 0 and 100 (minimal detectable change = 8–15.4).[22] Secondary outcomes included clinician-based measures to assess knee function in terms of knee range of motion, measured using a telescopic goniometer, and isometric quadriceps strength, measured with a Lafayette Hand-Held Dynamometer model 01165 (Lafayette Instruments ®) as the mean in three attempts of 6 seconds. Performance-based measures were used to assess balance and mobility. Specifically, the Timed Up and Go test[23] assessed dynamic balance and mobility (minimal detectable change = 2.3),[21] the one-leg standing test[24] assessed the static balance, and the Functional Reach test[25] was used as a reasonable approximation of the margin of stability. Finally, the KOOS questionnaire assessed patient perception in symptoms and stiffness, pain, and quality of life.[22] Considering the target population, we did not assess the sport and recreation KOOS subscale. The three-level version of the Euro Quality of Life 5-Dimension questionnaire assessed the quality of life, and the scores were interpreted using the visual analogue scale validation technique for the Spanish population.[26] This outcome was assessed at baseline and primary end-point alone.

Participants were allocated into three groups. One group (hospital group hereinafter) performed a preoperative outpatient intervention consisting of 12 training sessions spread out on alternate weekdays for four weeks; this intervention was supervised by physiotherapists in the hospital setting. The volume was based on previous research on the topic,[27,28] our clinical experience,[29] and available resources. The intervention included lower limb strengthening exercises and balance-oriented training. Specifically, the latter consisting of the side walk, treadmill walk, crosswalk, and tandem walk exercises were performed during the first two weeks. Multiple changes of direction, foam activities, and proprioceptive work with proprioception plate were included on week 3. During the last four sessions, 5 minutes of weight-bearing exercises and limits of stability testing were performed. A second group (home group) performed a preoperative domiciliary intervention that had similar training volumes and types of exercises. However, the programme was adapted to be implemented at home. For instance, since there are no parallel bars at home, the participants were instructed to exercise either in a corridor or in front of a table or chair for safety. First, an education session was held in the hospital facilities, so that a physiotherapist could instruct the training procedure and resolve doubts face to face. The participants were trained at home and were appointed to review and correct possible deviations from the programme two weeks after starting the training. Participants were called on a weekly basis to check compliance. The control group did not perform preoperative intervention, and participants were instructed to keep their normal activities. Details on the interventions are reported in Blasco et al.[17]

After surgery, all groups received the same standard in-hospital care (average 3.56 days). Before discharge from the hospital, participants were scheduled to be reassessed and initiate a standard outpatient rehabilitation two weeks after surgery. The programme was based on the following aspects: muscular strengthening with isometric, isotonic, and resistance exercises, functional exercises, and, to a lesser extent, proprioception and balance work. The protocol consisted of three phases: a warm-up phase with passive, active-assisted, and active mobilizations, a work phase with functional and strengthening exercises, and a cool-down phase. A total of 12 sessions of 45–60 minutes were prescribed on alternate days, three times per week, starting on week 2 and ending on week 6 after surgery.

A descriptive analysis of demographical data including sex, age, operated knee, and body mass index was conducted. Data were presented as mean and standard deviation, frequencies, and percentages. Participants' flow, drop-outs, and adverse events were described. Between-group baseline comparison assessed normality in sample distribution with one-way analysis of variance and chi-square tests. Inferential methods conducted with SPSS version 22.0 primarily intended to resolve whether preoperative balance training could enhance early postoperative recovery at six weeks. An analysis of covariance looking for time, group, and time $\times$ group interactions was implemented to assess if the mean score for each outcome measured for each group (three groups), at each time point (three time points: one week before surgery and two and six weeks after surgery) and adjusted for baseline scores (covariate), differed between the groups. Age and weight were confounding factors. Post hoc analysis was conducted in case of significant differences. Confidence intervals were set at 95%, and F values were extracted. In addition, Cohen's d effect size was estimated by using the two-by-two between-group magnitude of change from baseline to primary time end-point, divided by the pooled standard deviation, and interpreting values of <0.2 as small, 0.5 as moderate, and >0.8 as large effect size.[30] Based on the results of a previous study,[29] a priori sample size was estimated by considering that an interventional group would reach a score of 53 (4.5) in the primary outcome measure, the Berg Balance Scale, this score being five points above of that achieved in the control group. An estimated 63 participants, plus a predicted 20% sample loss, resulted in a rounded number of at least 75 participants to be allocated into three equal groups to achieve $d > 0.8$ with $\alpha = 0.05$.

Deviations from the protocol were minor. One-leg balance test was not assessed at week 2 after surgery for safety reasons. This test and the Functional Reach test were not originally described in the prospective register, but they were in the published protocol.

Results

Overall, 119 potential participants were assessed for eligibility. Eighty-six agreed to participate and were randomized, of which 83 (95%) received the programmed preoperative intervention and 77 (88%) were analysed. The flow of participants throughout the study is shown in Figure 1. There were no between-group baseline differences in demographical and clinical characteristics, but a significant difference was found in the Functional Reach test (see Table 1). To the best of our knowledge, there were no adverse events potentially derived from the interventions.

Assessment at one week before surgery suggested that implementing 12 sessions of preoperative balance

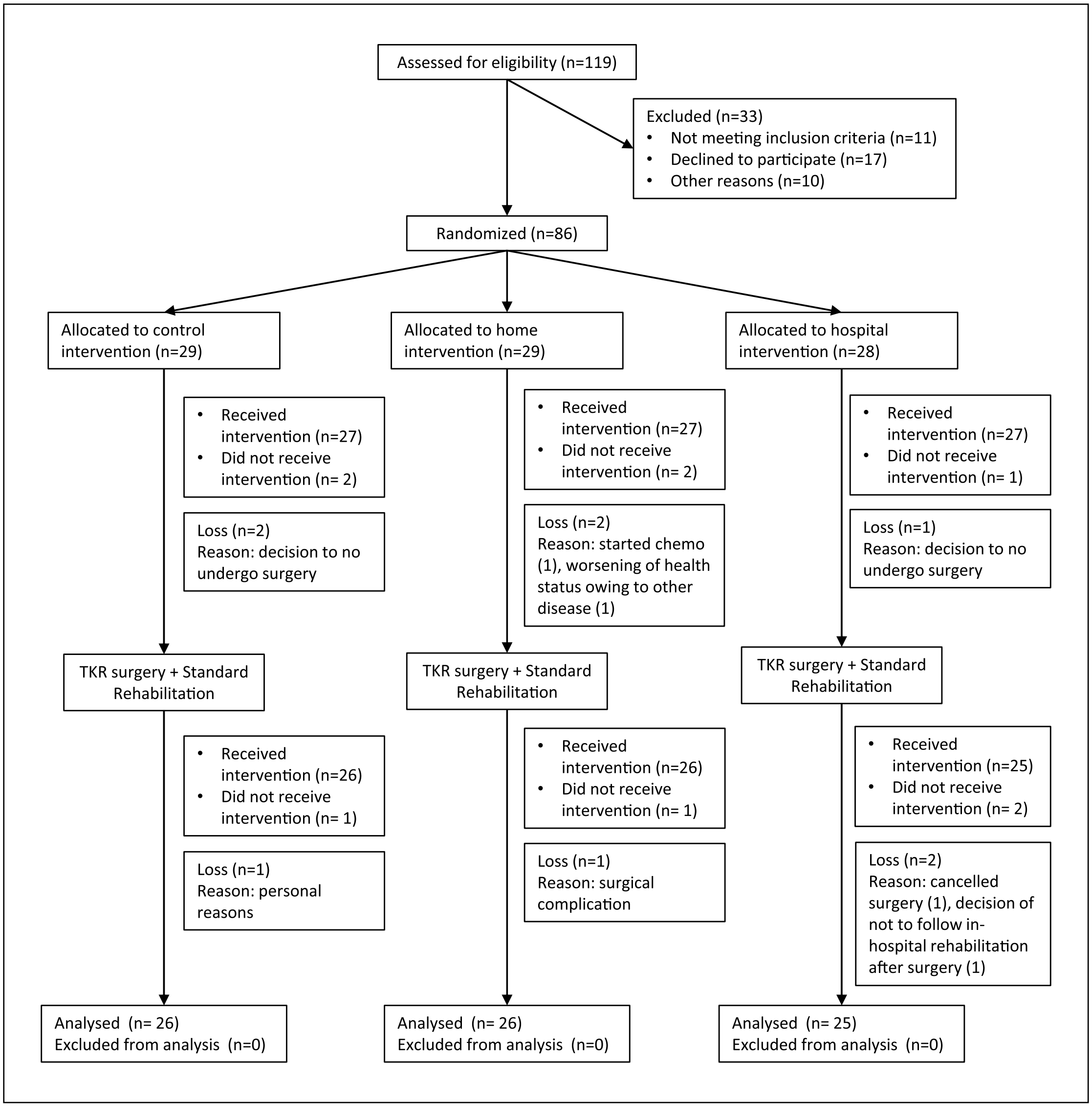

Figure 1. CONSORT diagram of participants flow.

training, either supervised at hospital or implemented at home, enhances balance and self-perceived functionality over controls (Berg Balance Scale home vs. control, $P < 0.001$; hospital vs. control, $P < 0.001$; hospital vs. home, $P = 0.236$ and KOOS-ADL home vs. control, $P < 0.001$; hospital vs. control, $P < 0.001$; hospital vs. home, $P = 0.495$). Assessment at two weeks after surgery, that is, before commencing the outpatient rehabilitation, showed that participants presented similar characteristics in primary and secondary outcomes ($P > 0.05$). After 12 sessions of postsurgical rehabilitation, the results showed that preoperative home and hospital interventions were similarly effective in enhancing balance – as measured with the Berg Balance Scale – at six weeks after surgery, the effect being moderate ($d > 0.5$) compared to the control group (home vs. control, $P = 0.010$; hospital vs. control, $P = 0.012$; hospital

Table 1. Baseline characteristics of the sample.

	Control (*n* = 26)	Home (*n* = 26)	Hospital (*n* = 25)	*P*-value
Characteristics				
Women (%)	15 (58%)	19 (73%)	19 (76%)	0.193
Operated knee – right (%)	12 (46%)	14 (54%)	11 (44%)	0.913
Age (years)	70.9 (9.5)	72.3 (4.5)	70.2 (7.2)	0.082
Weight (kg)	84.2 (11.2)	78.5 (14.9)	83.3 (12.8)	0.171
BMI (kg/m^2)	31.2 (4.6)	30.8 (5.7)	32.5 (4.9)	0.483
Compliance (no. sessions)	–	11.6 (1.1)	11.1 (0.9)	
Primary outcome				
Berg Balance Scale (score)	47.5 (11.6)	44.2 (7.0)	44.3 (9.1)	0.497
KOOS-ADL (%)	40.4 (20.6)	35.0 (18.3)	30.5 (17.9)	0.210
Secondary outcome				
Function				
Knee flexion (°)	103.5 (16.0)	105.6 (13.2)	105.2 (12.2)	0.988
Knee extension (°)	−4.4 (4.7)	−4.8 (6.6)	−5.8 (9.5)	0.741
Quadriceps strength (kg)	15.9 (8.0)	12.2 (5.8)	12.4 (5.3)	0.247
Balance/mobility				
Timed Up and Go (seconds)	18.0 (11.1)	22.1 (11.3)	20.5 (8.2)	0.612
Functional Reach (cm)	24.1 (6.9)	16.5 (5.8)	20.9 (6.1)	0.034
One-leg stand (seconds)	4.6 (9.3)	4.6 (5.0)	6.7 (10.5)	0.086
Quality of life				
EQ-5D (VAS score)	0.43 (0.18)	0.36 (0.18)	0.38 (0.14)	0.214
SR-outcome				
KOOS-Symptoms (%)	39.7 (18.4)	39.6 (22.2)	35.0 (19.0)	0.817
KOOS-Pain (%)	45.8 (23.4)	34.7 (23.3)	31.2 (20.3)	0.115
KOOS-QoL (%)	24.4 (16.2)	20.5 (17.7)	16.3 (16.2)	0.431

BMI: body mass index; KOOS: Knee Injury and Osteoarthritis Outcome Score; KOOS-ADL: function in daily living subscale of KOOS; EQ-5D: Euro Quality of Life 5-Dimension health-related score with results of VAS (visual analogue scale) validation techniques according to Spanish value sets; SR: Self-reported; KOOS-QoL: Quality of life subscale of KOOS questionnaire. Values are given as *n* (%) and mean (standard deviation).

vs. home, $P = 0.953$). However, an enhanced patient-perceived functionality measured with the KOOS-ADL scale was not observed at the primary end-point. The details are shown in Table 2.

Regarding the secondary outcomes, the evolution from baseline to one week before surgery showed that regardless of where the preoperative training was implemented, this produced significant time improvements over control in terms of knee function (extension and strength), stability and mobility, quality of life, and self-reported scores (symptoms and pain). However, there were no group or time per group differences throughout the trial in these outcomes – see Table 2.

Discussion

The main finding of this study was that participants implementing 12 sessions of a balance-oriented intervention before undergoing total knee replacement surgery demonstrated superior improvements in the overall state of balance at six weeks after surgery compared to those who did not perform such training. This effect was observed, regardless of whether the intervention was supervised by physical therapists in the hospital setting or implemented at home, deducing that both approaches were similarly effective. However, the positive effect on balance did not translate into a participant-perceived functional

Table 2. Effects of intervention.

	Group	Presurgery, M (SD)	Two weeks postsurgery, M (SD)	Six weeks postsurgery, M (SD)	*d*	*P*-value (time)	*F* (time)	*P*-value (group)	*F* (group)	*P*-value (time × group)	*F* (time × group)
Primary outcome											
Berg Balance Scale (score)						<0.001	47.6	0.013	4.6	0.027	3.3
	G1: control	46.0 (11.2)	42.2 (10.0)	51.2 (4.6)	0.54 (1–2)						
	G2: home	48.6 (6.0)	40.2 (11.9)	51.7 (5.1)	0.63 (1–3)						
	G3: hospital	50.0 (5.6)	43.1 (8.3)	53.5 (2.8)	−0.13 (2–3)						
KOOS-ADL (%)						<0.001	11.7	0.937	0.1	0.443	0.9
	G1: control	39.8 (20.2)	44.3 (17.3)	65.8 (22.8)	0.22 (1–2)						
	G2: home	41.9 (16.0)	40.8 (24.4)	66.0 (21.1)	0.11 (1–3)						
	G3: hospital	36.9 (19.0)	39.1 (20.6)	58.5 (19.8)	0.13 (2–3)						
Secondary outcome											
Function											
Knee flexion (°)						0.351	1.9	0.418	0.9	0.391	1.2
	G1: control	104.6 (16.0)	89.4 (13.7)	102.5 (12.4)	0.09 (1–2)						
	G2: home	110.2 (9.1)	80.7 (14.2)	103.3 (13.0)	0.15 (1–3)						
	G3: hospital	110.8 (14.5)	85.9 (15.6)	101.8 (13.6)	0.07 (2–3)						
Knee extension (°)						<0.001	20.9	0.426	0.8	0.351	1.1
	G1: control	−4.2 (4.7)	−8.6 (6.0)	−2.5 (3.9)	−0.03 (1–2)						
	G2: home	−3.0 (4.0)	−6.5 (7.9)	−3.1 (6.0)	0.09 (1–3)						
	G3: hospital	−2.7 (5.1)	−8.5 (6.8)	−3.2 (5.0)	−0.10 (2–3)						
Strength (kg)						<0.001	9.5	0.620	0.5	0.179	1.5
	G1: control	15.2 (8.1)	8.1 (3.5)	14.9 (5.4)	0.49 (1–2)						
	G2: home	14.6 (5.7)	8.0 (5,6)	14.8 (5.9)	0.24 (1–3)						
	G3: hospital	16.1 (6.7)	7.4 (3.4)	13.3 (5.3)	0.26 (2–3)						
Balance/mobility											
Timed Up and Go (seconds)						<0.001	5.8	0.429	0.8	0.071	2.2
	G1: control	18.9 (11.2)	24.8 (10.1)	16.5 (6.0)	0.42 (1–2)						
	G2: home	18.8 (7.0)	25.2 (18.4)	16.8 (5.4)	0.35 (1–3)						
	G3: hospital	17.7 (6.0)	26.9 (10.7)	16.2 (5.0)	0.12 (2–3)						
Functional Reach (cm)						<0.001	10.2	0.760	0.3	0.054	2.5

(Continued)

Table 2. (Continued)

	Group	Presurgery, M (SD)	Two weeks postsurgery, M (SD)	Six weeks postsurgery, M (SD)	*d*	*P*-value (time)	*F* (time)	*P*-value (group)	*F* (group)	*P*-value (time × group)	*F* (time × group)
	G1: control	22.7 (6.9)	23.8 (6.0)	31.3 (5.6)	−0.1 (1–2)						
	G2: home	20.3 (5.7)	20.7 (6.6)	22.9 (5.1)	−0.19 (1–3)						
	G3: hospital	24.4 (6.5)	22.6 (6.4)	26.3 (5.4)	0.14 (2–3)						
One-leg stand (seconds)						0.032	4.9	0.999	0.0	0.111	2.3
	G1: control	10.5 (10.8)	–	9.2 (10.9)	0.14 (1–2)						
	G2: home	7.5 (7.6)	–	10.6 (12.2)	0.04 (1–3)						
	G3: hospital	11.9 (22.2)	–	11.6 (9.5)	0.11 (2–3)						
Quality of life											
EQ-5D (VAS score)								0.617	1.3		
	G1: control	–	–	0.65 (0.24)	1.05 (1–2)						
	G2: home	–	–	0.69 (0.23)	0.07 (1–3)						
	G3: hospital	–	–	0.61 (0.20)	1.16 (2–3)						
Self-reported scores											
KOOS-Symptoms (%)						<0.001	18.5	0.234	1.5	0.912	0.2
	G1: control	41.6 (19.2)	50.7 (15.6)	64.0 (22.1)	0.19 (1–2)						
	G2: home	48.6 (17.9)	53.9 (15.9)	68.7 (20.8)	0.23 (1–3)						
	G3: hospital	43.1 (20.5)	55.1 (14.8)	64.7 (21.6)	0.03 (2–3)						
KOOS-Pain (%)						<0.001	18.5	0.836	0.2	0.962	0.1
	G1: control	44.3 (23.4)	43.7 (16.5)	65.6 (21.0)	0.44 (1–2)						
	G2: home	41.8 (15.3)	39.5 (22.9)	67.1 (24.9)	0.41 (1–3)						
	G3: hospital	37.4 (19.2)	37.4 (16.9)	61.6 (19.2)	−0.07 (2–3)						
KOOS-QoL (%)						<0.001	16.0	0.824	0.2	0.452	1.6
	G1: control	28.5 (15.6)	28.9 (14.2)	48.6 (26.4)	0.41 (1–2)						
	G2: home	28.6 (18.1)	23.5 (22.7)	54.6 (22.6)	0.08 (1–3)						
	G3: hospital	17.7 (16.1)	31.2 (18.3)	38.6 (18.7)	0.53 (2–3)						

KOOS: Knee Injury and Osteoarthritis Outcome Score; KOOS-ADL: function in daily living subscale of KOOS; EQ-5D: Euro Quality of Life 5-Dimension health-related score with results of VAS (visual analogue scale) validation techniques according to Spanish value sets; KOOS-QoL: Quality of life subscale of KOOS questionnaire.
Sample size of group: Control, $n = 26$; Home, $n = 26$; Hospital, $n = 25$. *P*-value of analysis of covariance (three times, three groups, one covariate) looking for time, group, and time per group differences; *F* analysis of covariance. Cohen's *d* effect size is estimated as the between-group magnitude of change from baseline to primary time end-point, the comparison being from top to bottom between groups 1–2, 1–3, and 2–3.

improvement. Similarly, the participants' knee function, static balance, stability and mobility, and other self-perceived outcomes were not improved with the proposed intervention in the early postoperative period.

This research largely clarified the clinical effects of the proposal. Those participants implementing preoperative training experienced significant changes over controls from baseline to one week before surgery assessment in every measured outcome – except knee flexion. The gains may be considered clinically important in terms of the overall balance and mobility, since these exceeded the minimal detectable change of 2.3 points in the Berg Balance Scale (home = 4.4; hospital = 5.7; control = −1.1),[20,21] and 2.3 seconds in the Timed Up and Go test in hospital and home groups, but not in controls. It is well established that muscle strengthening along with exercises challenging balance and proprioception is effective to improve balance and reduce falls in older adults.[31] Hence, the registered effects met the initial expectations. The knee symptoms, function, pain, and quality of life of participants also showed significant gains, although these did not overcome such threshold. In view of these results, future studies could be oriented to resolve whether sensorimotor training may be also used as a conservative treatment to delay total knee replacement surgery.[32,33]

As was introduced, balance limitations are common in the targeted population and may persist even one year after surgery.[34] This research intended that the effects of preoperative training were maintained at six weeks after surgery and enhanced participant outcome over controls, helping to relieve common complications arising from balance limitations.[5] However, the preoperative clinical impact did not translate into an early postsurgery recovery, at least in the way that might have been expected: of all the outcomes evaluated, only those participants measured with the Berg Balance Scale showed improvements superior to the controls.

It becomes necessary to consider a factor that may be a limitation to interpret the results from a global perspective: the state of the participants one year after surgery. We know that the overall state of balance was the only outcome that presented superior effects on participants of home and hospital interventions compared to controls at six weeks. But it might be possible that the effect of the balance training on function may not be measurable at this early stage after surgery.[35] In addition, the effects of challenging the sensorimotor system do not necessarily occur immediately; the approach is known to induce structural plasticity with a cortical and integrative effect that induces neuromuscular adaptations.[36–38] Given that proprioception may take time to recover after knee replacement[34] and given that proprioceptive work could bear fruit over longer periods than the one studied and be maintained for longer,[36] assessments beyond six weeks could have provided relevant information. And yet, it has to be also emphasized that there are additional factors – such as lifestyle and continued physical exercise – that will most likely have an even greater influence on the one-year outcomes,[39] when the plateau capacities are usually reached.[40]

Focusing on the study period and contextualizing with the current literature, few previous trials assessed the effects of preoperative sensorimotor training on patients undergoing total knee replacement.[8,11] Previous studies assessed outcomes at six weeks after surgery, and their results are comparable to ours. The intervention provided by Gstoettner et al.[15] enhanced standing balance but no other outcomes. The programme proposed by Villadsen et al.[13] produced an earlier onset of postoperative recovery in perceived functionality, pain, and quality of life, whereas the intervention provided by Huber et al.[14] produced benefits that could not be sustained postoperatively. Our results appear to be in the same line as those of Huber et al.,[14] but literature still remains inconclusive about the early postoperative effects of the proposal. However, considering the conclusion drawn in a previous meta-analysis[11] and our own results from an overall perspective (not only Berg), we may speculate that the clinical benefits produced by a preoperative sensorimotor training will be likely small at six weeks post surgery.

An important factor that should be considered in clinical practice is the pragmatism of the proposal. One of the main controversies regarding preoperative training is that it needs to be justified not only in clinical but also in economic terms. For this reason, domiciliary programmes that provide clinical benefits are of great interest in practice and are used to lower the expenses.[16] In this line, findings suggest that an adequately instructed intervention, which is monitored periodically by physiotherapists, can be as effective as an outpatient-supervised intervention to enhance balance outcomes. A cost-effectiveness analysis is warranted to resolve the actual viability of the proposal.

As for the strengths, inclusion criteria were broad and not restricted to many comorbidities, which increase applicability. The interventions were designed to be pragmatic and applicable. The adherence and non-existence of adverse effects directly derived from interventions supports the methodology. Publishing the trial protocol reduced reporting bias. Furthermore, the trial presents a low risk of selection, detection, and attrition bias. However, there are also additional limitations to be acknowledged. All participants followed standard rehabilitation after surgery, and therefore, future research should consider whether the combination of preoperative and postoperative balance training could provide greater early postoperative benefits. The trial presents performance bias since participants had been informed about the groups before agreeing to participate, and physiotherapists were non-blinded. Full recovery of sensorimotor function is unlikely to occur before the one-year period elapses, as discussed.[34] This research would need to be replicated to support generalizability.

In summary, the results conclude that preoperative balance training is an effective approach to enhance early postoperative balance outcome, but it is not effective to enhance functionality in individuals undergoing total knee replacement.

Clinical messages

- Preoperative balance training is effective to enhance early postoperative balance outcomes after total knee replacement surgery, but it is not effective to enhance functional outcomes.
- Sensorimotor training conducted at home has similar effects to supervised outpatient hospital training.

Author contributions

All authors meet the criteria for authorship stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. Concept and design was by J.-M.B., C.I.-C., S.R.-C. (75%), Y.A.-B., I.M.-G., and P.G.-M. (25%); drafting the work was by J.-M.B., Y.A.-B., and S.R.-C.; data acquisition was by Y.A.-B. (75%), I.M.-G., and P.G.-M. (25%); and data analyses were by J.-M.B., C.I.-C., and S.R.-C. All authors participated in the interpretation of data, critically revised the work for important intellectual content, and gave final approval to the version to be published.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

The Hospital La Fe Ethics Committee approved this study (no. 2016/499). All participants gave written informed consent before data collection began.

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