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Effect of group-based outpatient physiotherapy on function after total knee replacement: The ARENA randomised controlled trial

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ABSTRACT

Objective

To evaluate the long-term clinical effectiveness of a novel group-based outpatient physiotherapy following total knee replacement (TKR).

Methods

In this two centre, unblinded, superiority, randomised controlled trial, 180 patients on a waiting list for primary TKR due to osteoarthritis were randomised to a 6 session group-based outpatient physiotherapy intervention and usual care (n=89) or usual care alone (n=91).

The primary outcome was patient-reported functional ability measured by the Lower Extremity Functional Scale at 12 months post-operative. Secondary outcomes included knee symptoms, depression, anxiety and satisfaction. Questionnaires were completed pre-operatively and 3, 6 and 12 months post-operatively.

Results

The mean difference in function between groups was 4.47 (95% CI 0.20 to 8.75; p=0.04) at 12 months post-operative, favouring the intervention.. The mean difference in function between groups decreased over time; from 8.1 points at 3 months (95% CI 3.8 to 12.4; p<0.001) to 5.4 (95% CI 1.1 to 9.8; p=0.015) at 6 months post-operative. There were no

clinically relevant differences in any secondary outcomes between groups, although patients in the intervention group were more likely to be satisfied with their physiotherapy. No serious adverse events related to the intervention were reported.

Conclusion

Supplementing usual care with this group-based outpatient physiotherapy intervention led to improvements in function at 12 months after TKR, although the magnitude of the difference was below the minimal clinically important different of 9 points. However, patient satisfaction was higher in the intervention group and there was some evidence of clinically relevant improvements in function at 3 months.

Trial registration

ISRCTN32087234

Key words:

Knee replacement, physiotherapy, function, pain, satisfaction

Significance and Innovations

- This trial found that supplementing usual care with a novel group-based outpatient physiotherapy intervention lead to an improvement in patient-reported function; while there was some evidence that the short-term improvements were clinically important,

the magnitude of the benefit was not sustained in the longer-term after total knee replacement

- Patients randomised to the group-based outpatient physiotherapy intervention were more satisfied with their physiotherapy treatment than patients in the usual care group, and the group format was considered beneficial as it provided peer-support, motivation and increased confidence.

Total knee replacement (TKR) is a common operation, with approximately 100,000 TKRs performed annually in the National Health Service (NHS) [1, 2]. The surgery is performed to reduce pain and improve function for people with osteoarthritis; however, 20-30% of patients with TKR report long-term disability [3] and 20% report chronic pain [4]. These poor outcomes can have a considerable negative impact on quality of life [5, 6].

Physiotherapy is often provided to patients undergoing TKR and aims to optimise physical function. Physiotherapy can be provided before surgery, on the post-operative ward or on an outpatient basis after surgery. There is conflicting evidence of the effectiveness of pre-operative physiotherapy for improving post-operative functional outcome [7-9]. Post-operative inpatient physiotherapy is focussed on early functional recovery and independent mobilisation to ensure safe hospital discharge, rather than long-term functional improvement. Outpatient physiotherapy has been shown to improve function up to 3 months after TKR, although there is insufficient evidence to determine clinical effectiveness beyond 3 months after surgery [10].

In the UK, provision of physiotherapy after TKR is variable[11] and no definitive guidelines currently exist. Evidence is needed to guide the provision of effective physiotherapy services for patients with TKR. The primary aim of this randomised controlled trial (RCT) was to determine the clinical effectiveness of a novel group-based outpatient physiotherapy intervention for improving long-term function after primary TKR.

METHODS

Trial design

The ARENA (Activity-orientated rehabilitation following knee arthroplasty) study was a multi-centre, pragmatic, unblinded, superiority RCT. Follow-up assessments were performed at 3, 6 and 12 months post-operative, with a primary outcome of patient-reported function at 12 months post-operatively. The trial was informed by a systematic review [10], survey of current practice [12], and feasibility study [13], and the protocol has been published previously [14]. Reporting follows CONSORT guidelines (Supplementary material 1) and the TIDIeR guidance for intervention reporting [15] (Supplementary material 2). A full trial-based cost-effectiveness analysis will be reported separately.

Patient and Public Involvement (PPI)

The trial was developed and managed in collaboration with a PPI group [16], comprising nine patients with musculoskeletal conditions. Further details of how PPI informed the trial are reported in Supplementary material 3, following guidance from GRIPP-2 short form [17].

Participants

NHS patients were recruited from pre-operative assessment clinics at two orthopaedic centres in Bristol, UK: Southmead Hospital and Emersons Green Independent Treatment Centre. All patients provided informed written consent prior to participation. Inclusion criteria were adults on the waiting list for primary TKR due to osteoarthritis. Exclusion criteria were inability to participate in exercise for medical reasons; unable/ unwilling to attend physiotherapy classes post-operatively; unable/unwilling to provide informed consent; inability to understand English; and post-operative complications within the first two weeks of surgery which precluded participation in physiotherapy.

Randomisation

Participants were randomised with 1:1 treatment allocation to the intervention group or usual care group two weeks after TKR. Randomisation with allocation concealment was conducted by the Trial Manager or Trial Administrator through the Bristol Clinical Trials and Evaluation Unit, using a computer-generated code which was administered centrally and communicated via the internet. Randomisation was stratified by pre-operative function measured by the Lower Extremity Functional Scale [18](categorised as high or low function based on mean scores from a previous study [19]) and recruitment centre. Blinding of participants and trial personnel was not possible due to the nature of the intervention.

Usual care

At hospital discharge following TKR, patients at both centres were assessed on an individual basis by the inpatient physiotherapy team. All patients received advice on knee-specific and

functional exercises. Referral for outpatient physiotherapy was on a needs-only basis, with patients with poor range of motion or muscular weakness being further referred for outpatient physiotherapy. Criteria for referral differed between the centres and are described in Supplementary material 4. General Practitioners could also refer patients for outpatient physiotherapy as appropriate.

Intervention

Participants allocated to the intervention group received the intervention in addition to usual care. The intervention was a novel one-hour group-based physiotherapy class, starting at six weeks after surgery and delivered on a weekly basis over six consecutive weeks (Supplementary material 2). The classes were in an NHS outpatient gymnasium and included individualised exercises within a group-based task-orientated exercise circuit. Classes were run on a rolling system with a maximum of 12 patients and supervised by two physiotherapists or a physiotherapist and physiotherapy technician. Delivery was in a group-based setting, which is common in the NHS [12] and has been shown to be a cost-effective way to deliver rehabilitation without compromising effectiveness [20].

Classes began with a short warm up, after which patients followed an exercise circuit consisting of 12 exercise stations. Ten stations were designed to increase lower limb strength, balance, function and confidence using task-related activities. Two stations were dedicated to individualised exercises, which were developed in the first class to help participants achieve their functional goals. Individualised exercises aimed to improve patients' ability to participate in valued activities [21], empower people to take an active role in rehabilitation, and increase self-efficacy [22, 23].

Graded exercises were provided at each station to enable the patients to exercise at an intensity level suitable to their ability. Exercises were progressed on an individual basis through discussion with the physiotherapists (Supplementary material 5). Participants were given an exercise booklet in which they recorded details about their weekly progress in the class. At the end of the intervention, participants were provided with an individualised home exercise plan. Attendance at sessions was recorded and adherence with the intervention was predefined as attendance at ≥4 sessions.

Outcomes

Postal questionnaires were administered pre-operatively and at 3, 6 and 12 months after TKR. Participants completed additional pre-operative questions on demographics, socioeconomic status, and medical co-morbidities [24].

Primary outcome

The primary outcome was functional ability measured by the Lower Extremity Functional Scale (LEFS) [18] at 12 months post-operative. Twelve months was the primary end point as functional outcomes after TKR start to plateau around this time [25]. The LEFS is a validated 20-item questionnaire assessing lower limb function and difficulty in performing everyday tasks, with scores ranging from 0-80 (worst to best).

Secondary outcomes

The LEFS was collected at 3 and 6 months to assess lower limb function. Knee pain, symptoms, function in daily living, function in sports and recreation and knee-related quality

of life were assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS) [26], with each subscale score ranging from 0-100 (worst to best). Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale (HADS) [27], with subscale scores ranging from 0-21 (best to worst). Patient satisfaction was assessed using the Patient Satisfaction Scale [28], with scores ranging from 25-100 (worst to best). Satisfaction with physiotherapy was assessed using a 5-point Likert-type scale (ranging from very satisfied to very dissatisfied). Self-reported use of physiotherapy services was also captured. Health care resource use data, including the EQ-5D [29], was collected for the cost-effectiveness analysis and will be reported separately.

Safety data

Participants self-reported adverse events and these were verified through medical records review. Serious adverse events (SAEs) were defined as any untoward medical occurrence that resulted in death, was life-threatening, required inpatient hospitalisation/ prolongation of existing hospitalisation or resulted in persistent or significant disability/incapacity.

Process evaluation

Intervention

Participants who attended the classes were telephoned by a researcher one month after the classes and asked about their experiences of the intervention. Questions focussed on satisfaction with the classes, which aspects were helpful or unhelpful, adherence to the home

exercise plan and any barriers to performing the exercises. Responses were recorded on a standardised proforma and free-text data was analysed using a descriptive content analysis.

Trial participation

After completion of the final questionnaire, all participants were telephoned and asked about reasons and experiences of participation, and any perceived benefits or negative aspects to participation.

Sample size

The minimal clinically important difference (MCID) for the LEFS is 9 scale points [18]. In our feasibility study [13], the pooled standard deviation (SD) on the LEFS score at 6 months post-operative was 18.4 points. For the purposes of the sample size calculation, a similar SD for the LEFS at 12 months after TKR was assumed. To account for the uncertainty induced by estimating parameters from a small feasibility study, the assessed sample was adjusted by an inflation factor of 1.12^2, a value derived from the 80% upper confidence limit of the SD estimate [30]. A sample of 166 (83 participants per arm) would allow the detection of a MCID in the LEFS between trial arms at 12 months post-operatively, assuming a power of 80%, a two-sided 5% significance level and accounting for an inflation factor of 1.12^2. In our feasibility study, the rate of missing LEFS scores at 6 months post-operative was 9% in the intervention group and 35% in the usual care group. Assuming a 35% loss to follow-up, 256 patients would need to be recruited to include data from 166 participants in the primary analysis.

Statistical analysis

Analyses were performed according to the Statistical Analysis Plan [31]. Baseline characteristics were reported by trial arm using percentages, means and SDs or medians and interquartile ranges (IQR) as appropriate. The repeated measures of primary and secondary outcomes were plotted by trial arm.

The analyses were conducted on an intention-to-treat basis. The main analysis consisted of a linear mixed regression (with random intercept for patient to control for the repeated follow-up measures) with an interaction between the intervention effect and the assessment time adjusted for stratification variables, pre-operative function and centre (with fixed effects). The use of these interaction terms allowed the estimation of time-specific effect of the intervention on the LEFS at 3, 6, and 12 months post-operative (primary outcome). Four separate sensitivity analyses were conducted. First, the effect of clustering at surgeon level was investigated by adding an additional level to the previous linear mixed regression. Then the analysis was adjusted for imbalanced individual characteristics between arms at baseline, followed by adjustment for whether additional physiotherapy was received. Finally, the primary outcome treatment effect was estimated using a per-protocol approach. Given the gender differences in TKR outcomes [32], exploratory analysis was undertaken to investigate and compare the intervention effect by gender using interaction terms. An additional analysis was conducted to investigate the effect of class size on 12 month LEFS using linear regression.

The analyses were conducted with and without imputation of missing primary outcome data. Missing data was imputed using multiple imputation by chained equations under a missing at

random assumption, stratified by randomisation [33]. In a sensitivity analysis to the imputation method, missing data were also imputed using the value 10% greater than the mean and 10% smaller than the mean value of the observations for each outcome. The same modelling strategy was used to investigate the intervention effect on secondary outcomes. A similar strategy was used to impute the secondary outcomes.

RESULTS

Participants

Between March 2015 and March 2017, 225 patients were recruited. Of these, 45 patients withdrew prior to randomisation and 180 were randomised: 89 to the intervention and 91 to usual care (Figure 1). Questionnaires were completed by 163 participants (91%) at 3 months, 158 (88%) at 6 months and 169 (94%) at 12 months post-operatively. The primary analysis included 173 participants who completed at least one post-operative LEFS. Participants' baseline characteristics are displayed in Table 1. Some differences in anxiety levels, education level, and working status between groups were observed and adjusted for in sensitivity analyses. Demographics of participants was similar to the national profile of patients undergoing TKR [1].

Intervention

Of the 89 participants randomised to the intervention, 42 (47%) attended all six sessions and 69 (78%) met the criteria for adherence. Participants attended a median of five classes (IQR 4 to 6). Reasons for non-attendance included post-operative complications, holidays,

unwilling/unable to travel to the hospital, and other commitments. Classes were attended by a median of four participants (IQR 2 to 6). No effect of class size on LEFS at 12 months was observed (Supplementary material 6). During the trial period, usual care or private (self-funded) physiotherapy (excluding the trial intervention) was received by 52% of participants in the intervention group and 58% in the usual care group (Table 2).

Primary analyses

A summary of all outcomes by arm and timepoint is provided in Supplementary material 7. The mean LEFS score from randomisation to 12 months post-operative by group is displayed in Figure 2. At 12 months after TKR, the mean LEFS score was 55.8 (95% CI 51.7 to 59.9) for the intervention group and 53.3 (95% CI 49.5 to 57.1) for the usual care group (score distribution provided in Supplementary material 8). The primary analyses are presented in Table 3. The primary intention-to-treat analysis adjusted for stratification variables suggested a difference in the mean LEFS at 12 months after surgery in favour of the intervention group(difference in means 4.47; 95% CI 0.20 to 8.75; p=0.04). Analyses further adjusted for clustering at surgeon level, baseline imbalances, and physiotherapy received produced similar results to the primary analysis. Similar results were also found when imputing missing data (Table 3, Supplementary material 9). The per protocol analysis adjusting for stratification variables found a slighter higher difference in mean treatment effect (difference in means 6.12; 95% CI 1.60 to 10.64; p=0.008). Similar results were found in the adjusted per-protocol analysis.

Exploratory analysis of the impact of gender on the LEFS at 12 months (Supplementary material 10) showed some evidence of treatment effect within males (difference in means

6.88; 95% CI 0.97 to 12.79; p=0.023), but not females (2.33; 95% CI -3.19 to 7.84; p=0.408). However, no evidence of a difference in the treatment effect between males and females was found (-4.55 95% CI -12.17 to 3.07; p=0.242).

Secondary analyses

The mean LEFS score was better in the intervention group compared to the usual care group at 3 months (difference in means 8.07; 95% CI 3.75 to 12.40; p<0.001) and 6 months post-operatively (difference in means 5.41; 95% CI 1.06 to 9.77; p=0.015) (Table 3). The difference in LEFS between groups was statistically evident at each follow-up time point but decreased over time (difference between 3 months and 12 months in treatment effects 3.60; 95% CI 0.06 to 7.15; p-value 0.05), with the highest treatment effect observed at 3 months post-operatively. Similar results were observed in the sensitivity analyses and per-protocol analysis (Supplementary materials 11.1 and 11.2).

There was no evidence of differences in the mean total KOOS score, KOOS subscales, HADS anxiety, HADS depression or Patient Satisfaction Scale between groups at 3, 6 or 12 (Table 4; Supplementary materials 11.3-11.11). However, patients in the intervention group were more likely to have high satisfaction with their physiotherapy than patients in the usual care group throughout the post-operative period (Table 4; Supplementary material 11.12).

Safety

A total of 21 SAEs occurred during the trial (8 in the intervention group and 13 in the usual care group). All SAEs were deemed expected and unrelated to the intervention. Events

included 14 hospital readmissions, five prolongations of hospital stay, one Accident & Emergency outpatient visit, and one death. Further details are provided in Supplementary material 12.

Process evaluation

Descriptive statistics and summaries of the free-text data are provided in Supplementary material 13.

Intervention evaluation

Sixty-eight participants completed a structured telephone survey. Participants were generally satisfied with both the task-orientated and individualised exercises. Most thought that the class length was appropriate, although 50% of participants would have liked more classes. Participants found it helpful to have 1:1 time with a physiotherapist during the classes for individualised advice and support. The group format was considered beneficial as it provided peer-support, motivation and increased confidence. While some task-related exercises were particularly helpful to some participants, they were too easy for other patients, highlighting the difficulty in delivering an intervention catering for people with different levels of functional ability.

Participants found the home exercise plan useful, and most reported that they were performing their home exercises a month after their final class. Reasons given for discontinuation were that people were participating in other exercises or they felt they had

good functional ability. The most common challenges with adhering to the home exercises were a lack of access to gym equipment and difficulty fitting the exercises into daily routines.

Trial participation

A structured telephone survey was completed by 142 participants. Altruism was the most common reason for participation, with many eager to help future patients and be involved in generating evidence to inform improvements to healthcare. The potential for personal benefit was also a key motivation, with people perceiving that allocation to the classes would be beneficial. The majority of participants had a positive experience of the trial, finding it enjoyable and easy to take part. The main suggestions for improvements included shorter questionnaires that avoided questions that were perceived to be irrelevant and repetitive.

DISCUSSION

This is the first trial to evaluate whether group-based outpatient physiotherapy can improve patient-reported function up to 12 months after TKR in an NHS setting. Supplementing usual care with a novel group-based outpatient physiotherapy intervention resulted in better patient-reported function at 3, 6 and 12 months after TKR. However, the difference in function at 12 months was below the MCID, suggesting the intervention may not result in a clinically important improvement in function. However, the intervention was safe, associated with higher patient satisfaction and there was some evidence of a clinically important short-term benefit at 3 months post-operatively.

This project was informed by a robust series of projects, including a feasibility study [13], in line with Medical Research Council guidance on complex interventions [34]. PPI activities guided the design and management of the trial to ensure the research was relevant and acceptable to patients. Patients were recruited from an NHS independent treatment centre and an elective orthopaedic centre, thereby increasing the generalisability of the results. This was a pragmatic trial with patient eligibility criteria, intervention delivery and non-standardised usual care designed to reflect how the intervention would be delivered if implemented within usual NHS care. However, limitations of the trial should also be acknowledged when interpreting the results. As with many physiotherapy trials [35], blinding of the intervention was not possible, which could have led to an overestimation of the treatment effect [36]. While this risk of bias may have influenced the positive short-term effects, the decrease in treatment effect over time would have rendered this bias less meaningful. Another potential limitation is our use of the LEFs MCID threshold. Using the MCID allows a more meaningful evaluation of the clinical relevance of the results, rather than simply interpreting the results based on statistical significance. However, the MCID for the LEFs was derived in patients with a variety of lower extremity musculoskeletal conditions [18], which may limit the applicability to patients with TKR. It should also be acknowledged that findings from our trial only relate to the specific physiotherapy intervention that we evaluated. However, other trials have reported similar findings. Since the publication of a systematic review which found insufficient evidence to evaluate the long-term effectiveness of post-discharge physiotherapy [10], relevant trials have been published. An Australian trial found that an outpatient exercise programme did not improve patient-reported outcomes at one year after TKR compared to usual care [37]. Another Australian trial found that 10 days of post-discharge inpatient physiotherapy and a monitored home exercise programme did not

improve walking ability at 6 months after TKR compared with a home exercise programme only [38].

There are a number of potential reasons why our intervention was only associated with a small improvement in function at 12 months after TKR. First, we limited the dose to six classes to optimise the feasibility of the intervention being implemented into usual NHS practice if found to be effective. It is possible that a more intensive intervention may have had a beneficial effect, however previous studies which have evaluated more intensive interventions have found similar results [37-39]. Also, no follow-up support was provided to participants for their home exercise programme, which may have resulted in participants not continuing an adequate amount of home exercises and contributed to the short-term benefits not being sustained in the longer-term. Second, both groups had access to usual care and private physiotherapy because we wanted to assess the effectiveness of the intervention as implemented within the NHS setting. Very few trials compare a physiotherapy intervention to no care [10, 40], and the purpose of our trial was to evaluate if the addition of group-based physiotherapy to usual care could improve patient outcomes. This resulted in approximately half of participants in both arms using usual care or private physiotherapy during the follow-up, although physiotherapy usage was balanced between trial arms and adjustment in sensitivity analyses produced similar results. Third, adherence to rehabilitation interventions is a common issue [41]. Similar to a previous study [37], only half of participants randomised to the intervention group attended all the classes. Per protocol analysis of the 78% of participants who met the pre-specified adherence criteria found a larger treatment effect and the 95% CIs suggest that the true difference at 12 months could reach a clinically meaningful level. This suggests a possible dosage effect, which has been found previously [42], and that attending less than six sessions may not provide patients with an adequate intervention level

to change outcomes. Higher dosage physiotherapy is unlikely to be pragmatic in the NHS, however supplementing weekly classes with guidance on home exercises could be beneficial and warrants further research. Fourth, we used a patient-reported outcome measure to capture patients' experiences of their function, rather than objective measures or performance tests to evaluate their actual functional ability because performance tests may not capture limitations experienced during important daily activities [43]. However, self-reported function is strongly influenced by pain [44, 45], and the small difference in outcomes between groups may be because the intervention was not designed to reduce pain. The intervention may have shown a larger effect on objective outcomes or performance measures, which are less influenced by pain and more sensitive to changes in function changes in function [44, 45], further research is warranted.

In conclusion, addition of group-based outpatient physiotherapy to usual NHS care led to improvements in function at 12 months after TKR, although the magnitude of the difference did not reach a clinically meaningful level. However, patient satisfaction was higher in the intervention group and there were clinically relevant improvements in function at 3 months. This suggests there is early benefit from physiotherapy with the potential for longer-term benefit. Recommendations for future research include evaluating the optimal mode of physiotherapy delivery to maximise patient benefit, including intensity, duration, progression and support with home exercises. Our findings add to the evidence on the effectiveness of group-based outpatient physiotherapy to guide decisions by clinicians and patients, and inform commissioning of services to ensure patients receive optimal physiotherapy after TKR.

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Authors' contributions

VW, EL, NA, EM, JM, TP, ADB, RGH and AWB were responsible for study conception and planning. All authors contributed to study conduct. ES, EL and VW performed the data analyses. VW drafted the manuscript and all authors revised it critically for important intellectual content. All authors gave final approval of the version to be published.

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funders and all authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of interest

The authors declare that they have no competing interests relating to the submitted work. VW and AWB have received institutional funding from Stryker for a study outside of the submitted work. JM has received institutional funding from Smith/Nephew, DePuy, Biocomposites, Aquliant, Zimmer Biomet and Newsplint for research outside of the submitted work, and personal educational consultancy from Smith and Nephew for teaching and speaking.

Ethics approval and consent to participate

The trial was approved by National Research Ethics Committee South West – Central Bristol (reference 14/SW/1144). All participants provided informed, written consent.

Availability of data and material

The datasets generated during the current study will be available in the University of Bristol Research Data Repository (https://data.bris.ac.uk/data/). Data will be available 6 months following publication. Access to the data will be restricted to ensure that data is only made available to bona fide researchers for ethically approved research projects, on the understanding that confidentiality will be maintained and after a Data Access Agreement has been signed by an institutional signatory.

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FIGURE LEGENDS

Figure 1: CONSORT flow diagram

Figure 2: Mean LEFS score (with 95% CI) from randomisation to 12 months post-operative for the intervention and usual care group

Table 1: Participant baseline characteristics

	Intervention N=89	Usual care N=91	Overall N=180
Recruitment centre: Southmead, n (%)	62 (70%)	64 (70%)	126 (70%)
Age, mean (SD)	69 (9)	69 (9)	69 (9)
Female, n (%)	50 (56%)	49 (54%)	99 (55%)
Married, n (%)	55 (63%)	60 (67%)	115 (65%)
Living with someone, n (%)	60 (68%)	65 (73%)	125 (71%)
White ethnicity, n (%)	84 (95%)	88 (99%)	172 (97%)
Education above normal school leaving age, n (%)	31 (35%)	22 (25%)	53 (30%)
Working, n (%)	25 (28%)	17 (19%)	42 (24%)
Deprivation quintile 5 (IMD) n (%)	24 (28%)	29 (33%)	53 (30%)
Comorbidities[1], median (IQR)	2 (0.5, 3)	1 (0, 2)	1 (0, 3)
Medial parapatellar approach[2], n (%)	81 (91%)	81 (89%)	162 (90%)
Cruciate retaining surgery[3], n (%)	53 (60%)	50 (56%)	103 (58%)
LEFS, mean (SD)	25 (15)	29 (15)	27 (15)
KOOS Total, mean (SD)	29 (15)	33 (16)	31 (16)
KOOS Pain, mean (SD)	37 (21)	41 (19)	39 (20)
KOOS Symptoms, mean (SD)	39 (19)	41 (20)	40 (19)
KOOS ADL, mean (SD)	41 (20)	44 (19)	42 (20)
KOOS Sport/Rec, median (IQR)	5 (0, 20)	10 (0, 20)	5 (0, 20)
KOOS QOL, median (IQR)	25 (13, 38)	25 (13, 38)	25 (13, 38)
HADS Anxiety, median (IQR)	7 (4, 11)	5 (3, 9)	6 (3, 10)
HADS Depression, median (IQR)	7 (3, 10)	6 (4, 9)	6 (4, 9)
EQ5D-5L, median (IQR)	0.6 (0.3, 0.8)	0.7 (0.4, 0.8)	0.6 (0.3, 0.8)

[1] Excluding arthritis (rheumatoid or osteoarthritis) in number of comorbidities
[2] All other surgical approaches were "Medial subvastus"
[3] All other knee replacements were "posterior cruciate sacrificing" designs

Table 2: Use of additional physiotherapy services during the trial period, n (%[1])

	Timepoint	Intervention N=89	Usual care N=91	Overall N=180
Any type of additional physiotherapy	**3**	43 (48%)	47 (52%)	90 (50%)
	6	17 (19%)	15 (16%)	32 (18%)
	12	8 (9%)	8 (9%)	16 (9%)
	Any	46 (52%)	53 (58%)	99 (55%)
1:1 hospital physiotherapy	3	33 (37%)	29 (32%)	62 (34%)
	6	9 (10%)	8 (9%)	17 (9%)
	12	5 (6%)	4 (4%)	9 (5%)
	Any	36 (40%)	35 (38%)	71 (39%)
Physiotherapy at GP surgery	3	9 (10%)	12 (13%)	21 (12%)
	6	3 (3%)	2 (2%)	5 (3%)
	12	3 (3%)	1 (1%)	4 (2%)
	Any	11 (12%)	12 (13%)	23 (13%)
Home-based physiotherapy	3	3 (3%)	4 (4%)	7 (4%)
	6	1 (1%)	2 (2%)	3 (2%)
	12	0 (%)	1 (1%)	1 (1%)
	Any	3 (3%)	7 (8%)	10 (6%)
Hydrotherapy	3	4 (4%)	3 (3%)	7 (4%)
	6	6 (7%)	3 (3%)	9 (5%)
	12	3 (3%)	3 (3%)	6 (3%)
	Any	6 (7%)	5 (5%)	11 (6%)
Other[2]	3	1 (1%)	5 (5%)	6 (3%)
	6	3 (3%)	4 (4%)	7 (4%)
	12	1 (1%)	1 (1%)	2 (1%)
	Any	3 (3%)	7 (8%)	10 (6%)

[1]Percentage out of N in each arm (intervention N=89; usual care N=91 and overall N=180)
[2]Other includes: inpatient, local community hospital, private physiotherapy, local health centre, local gym and soft tissue massage

Table 3: Intervention effect on LEFS

Adjustments	N participants[3] Intervention	N participants[3] Usual Care	Difference in means	95% CI	p-value
Primary analysis (intention-to-treat, no imputation) of LEFS at 12 months					
Model 1	87	86	4.47	(0.20, 8.74)	0.040
Sensitivity analyses (intention-to-treat, no imputation)					
Model 2[1]	87	86	4.44	(0.18, 8.70)	0.041
Model 3[2]			4.27	(0.10, 8.44)	0.045
Model 4			3.95	(-0.26, 8.17)	0.066
Analysis using MICE to account for missing data (intention-to-treat)					
Model 1	89	91	4.31	(-0.18, 8.80)	0.060
Model 2[1]			4.29	(-0.19, 8.77)	0.060
Model 3[2]			3.93	(-0.45, 8.32)	0.079
Model 4			3.80	(-0.49, 8.10)	0.082
Per protocol analyses					
Model 1	69	86	6.12	(1.60, 10.64)	0.008
Model 2[1]			6.12	(1.60, 10.65)	0.008
Model 3[2]			6.34	(1.87, 10.82)	0.005
Model 4			5.54	(1.10, 9.97)	0.014
Primary analysis (intention-to-treat, no imputation) of LEFS at 3 months					
Model 1	87	86	8.07	(3.75, 12.40)	<0.001
Primary analysis (intention-to-treat, no imputation) of LEFS at 6 months					
Model 1	87	86	5.41	(1.06, 9.77)	0.015

[1] The variance of the random effect associated with surgeon level was significant; this level was kept for the following sensitivity analyses

[2] Variables which were imbalanced at baseline: Level of education; working status; pre-operative HADS anxiety

[3] Number of participants contributing data for the analysis

Modelling strategy for analysis of LEFS:

Model 1: linear mixed regression adjusted for stratification variables and accounting for clustering within patient.

Model 2: linear mixed regression adjusted for stratification variables and accounting for clustering within patient and surgeon.

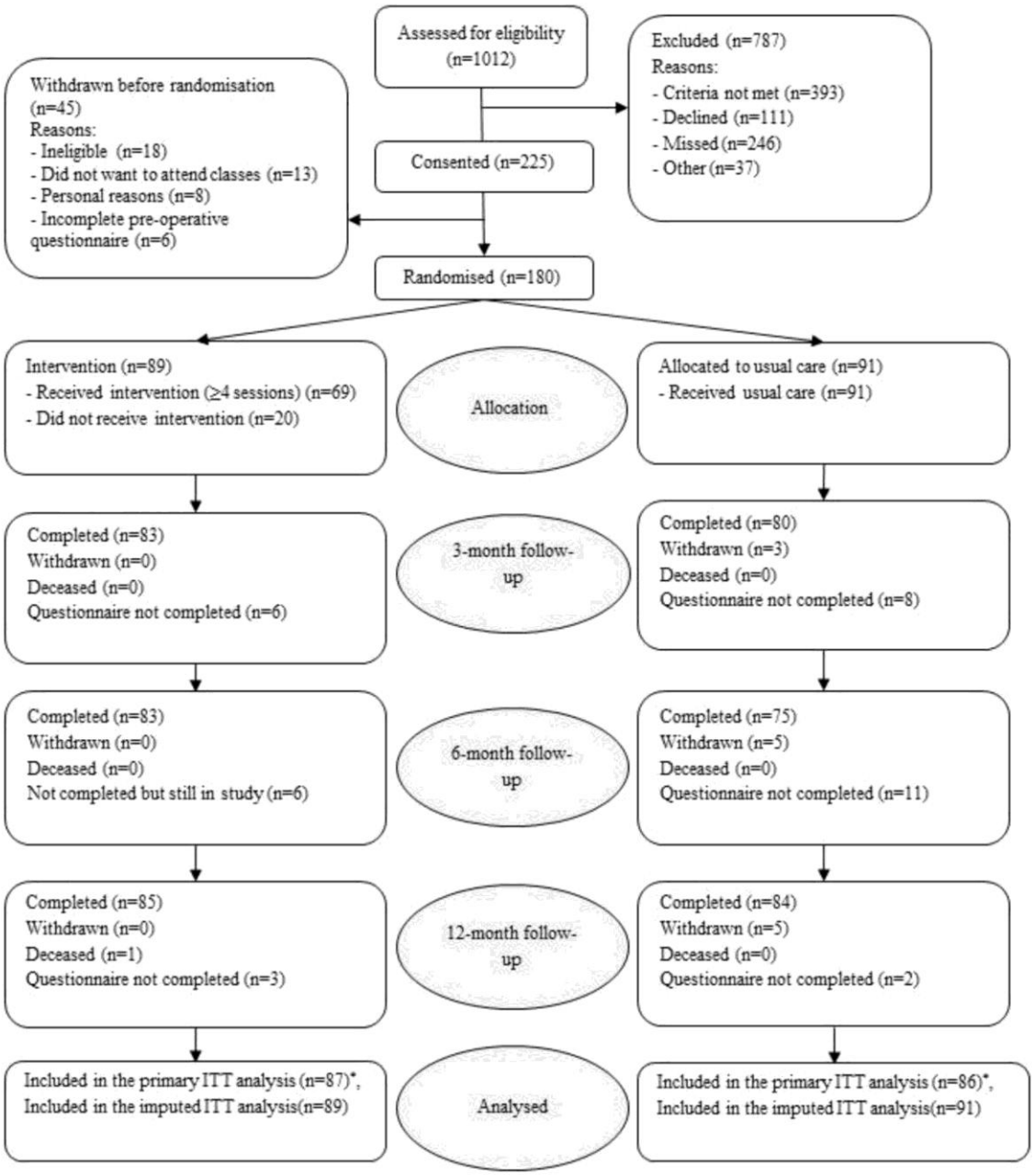
Model 3: linear mixed regression adjusted for stratification variables and baseline imbalance variables (level of education; working status; HADS anxiety) and accounting for clustering within patient and surgeon.

Model 4: linear mixed regression adjusted for stratification variables and whether the patient had received additional physiotherapy during the trial and accounting for clustering within patient and surgeon.

Table 4: Secondary analyses adjusted for stratification variables[1]

	No of patients in analysis		Odds Ratio	95% CI	p-value
	Intervention	Usual care			
KOOS Averaged					
3 months			2.91	(0.62 to 13.67)	0.177
6 months	75	71	2.52	(0.51 to 12.59)	0.260
12 months			2.57	(0.52 to 12.70)	0.247
KOOS QOL					
3 months			1.05	(0.38 to 2.92)	0.926
6 months	84	77	2.37	(0.81 to 6.93)	0.114
12 months			1.84	(0.63 to 5.37)	0.264
KOOS ADL					
3 months			5.37	(1.37 to 21.04)	0.016
6 months	80	75	3.22	(0.76 to 13.59)	0.112
12 months			2.17	(0.52 to 9.11)	0.291
KOOS Pain					
3 months			2.24	(0.70 to 7.13)	0.173
6 months	84	76	1.64	(0.48 to 5.58)	0.426
12 months			2.82	(0.79 to 10.11)	0.111
KOOS Sport/Rec					
3 months	82	74	2.27	(0.62 to 8.32)	0.216
6 months			2.14	(0.61 to 7.54)	0.235
12 months			2.30	(0.65 to 8.19)	0.199
KOOS Symptoms					
3 months			1.74	(0.53 to 5.71)	0.364
6 months	85	77	1.72	(0.49 to 6.02)	0.393
12 months			1.89	(0.49 to 6.50)	0.377
HADS Anxiety					
3 months			1.07	(0.14 to 8.02)	0.946
6 months	84	76	1.61	(0.22 to 11.99)	0.644
12 months			2.48	(0.36 to 17.18)	0.358
HADs Depression					
3 months			0.25	(0.05 to 1.39)	0.114
6 months	84	77	0.77	(0.13 to 4.56)	0.769
12 months			0.57	(0.11 to 2.86)	0.491
Satisfaction with surgery					
3 months			0.82	(0.30 to 2.24)	0.699
6 months	79	71	1.68	(0.57 to 4.98)	0.348
12 months			2.00	(0.74 to 5.39)	0.170
Satisfaction with physiotherapy					
3 months			0.06	(0.02 to 0.20)	<0.001
6 months	84	77	0.14	(0.04 to 0.47)	0.002
12 months			0.10	(0.03 to 0.37)	<0.001

[1] Logistic regression accounting for clustering within patient for repeated measures, adjusting for stratification variables, pre-operative outcome measure and using contrasts to assess odds ratios at 3, 6 and 12 months



* The number of patients who have at least one post-operative LEFS score completed and therefore included in the primary mixed regression analysis
ITT: Intention-to-treat