

Late group-based rehabilitation has no advantages compared with supervised home-exercises after total knee arthroplasty

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ABSTRACT

INTRODUCTION: This study aimed to test whether group-based rehabilitation focusing on strength training, education and self-management is more effective than individual, supervised home-training after fast-track total knee arthroplasty (TKA).

MATERIAL AND METHODS: We allocated 80 participants undergoing primary TKA to either group-based rehabilitation or individual, supervised home-training (40 participants in each group). The group-based rehabilitation consisted of 12 outpatient visits during six weeks including strength and endurance exercises, education and self-management combined with home exercises. The primary outcome was Oxford Knee Score; secondary outcomes were EuroQoL-5 Dimensions QoL and Physical Function of the Medical Outcomes Short Form 36. Tertiary outcomes were pain, knee range of motion, tandem test, Leg Extensor Power, 10-m walking test, 30-sec. and five-times sit-to-stand. Outcomes were assessed four weeks, three months and six months after surgery. In addition, the questionnaires were completed before surgery.

RESULTS: We found no difference in gain of function or quality of life between the two groups at three and six months follow-up.

CONCLUSION: Individual, supervised home-training and group-based rehabilitation programmes improved patients' quality of life and physical function equally six months after TKA.

FUNDING: This study was funded by Holstebro Municipality, Region of Central Jutland, and Lundbeck Centre for Fast-Track Hip and Knee Surgery.

TRIAL REGISTRATION: The study was registered in the Danish Data Protection Agency (Registration no.: 1-16-02-41-10) and Clinical Trials (Registration no.: KL24621).

Total knee arthroplasty (TKA) is effective, produces long-lasting improvements of physical function and reduces pain [1]. Nevertheless, TKA patients suffer from lower physical function than the age-matched population 12 months after surgery [1, 2]. Rehabilitation after TKA may reduce this difference, but evidence is weak and conflicting [3]. Some studies have found a faster gain of function in the intervention than in the control group,

but only Petterson et al found a significant long-lasting effect [4-6] using late onset rehabilitation programmes with strengthening exercises [6].

Inspired by the ESCAPE-knee pain programme for osteoarthritis by Hurley et al [7], the hypothesis we propose in the present paper is that a group-based rehabilitation intervention with strength training improves the patient's quality of life and physical function more than an individual, supervised home-exercise programme after TKA.

MATERIAL AND METHODS

The study was a randomized controlled trial conducted from March 2010 to March 2011. Written information was handed out by a nurse at the outpatient visit before surgery. Furthermore, oral information was given by a physiotherapist the day after surgery. Written consent was obtained from each patient within four weeks after surgery. The study was approved by the local research ethics committee (Registration no.: M-20100001) and registered with the Danish Data Protection Agency (Registration no.: 1-16-02-41-10) and clinicaltrials.gov (Clinical Trials Registration no.: KL24621). The Consort guidelines were followed.

ORIGINAL ARTICLE

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Severe osteoarthritis in knee prior to total knee arthroplasty.

 TABLE 1

Plan of the group-based rehabilitation. A repetition maximum is the most weight/load you can lift/press for a defined number of exercise movements.

	Session											
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
<i>Warm-up</i>												
Exercise bike	5 min.											
Squat (no external load)	5-10 repetitions											
<i>Strengthening (machines)</i>												
Test	–	–	–	–	–	–	–	–	Test	–	–	–
Squat		1 set, 10-12 RM	2 sets, 10-12 RM		3 sets, 10-12 RM			2 sets, 6-8 RM			3 sets, 6-8 RM	
Leg press		1 set, 10-12 RM, unilaterally ^a	2 sets, 10-12 RM, unilaterally ^a		3 sets, 10-12 RM, unilaterally ^a			2 sets, 6-8 RM, bilaterally			3 sets, 6-8 RM, bilaterally	
Leg extension		1 set, 10-12 RM, unilaterally ^a	2 sets, 10-12 RM, unilaterally ^a		3 sets, 10-12 RM, unilaterally ^a			2 sets, 6-8 RM, bilaterally			3 sets, 6-8 RM, bilaterally	
Seated curls		1 set, 10-12 RM, unilaterally ^a	2 sets, 10-12 RM, unilaterally ^a		3 sets, 10-12 RM, unilaterally ^a			2 sets, 6-8 RM, bilaterally			3 sets, 6-8 RM, bilaterally	
Back extension		1 set, 10-12 RM	2 sets, 10-12 RM		3 sets, 10-12 RM			2 sets, 10-12 RM			3 sets, 10-12 RM	
Sit-up bench		1 set, 10-12 RM	2 sets, 10-12 RM		3 sets, 10-12 RM			2 sets, 10-12 RM			3 sets, 10-12 RM	
Lat pulley		1 set, 10-12 RM	2 sets, 10-12 RM		3 sets, 10-12 RM			2 sets, 10-12 RM			3 sets, 10-12 RM	
Triceps vertical machine		1 set, 10-12 RM	2 sets, 10-12 RM		3 sets, 10-12 RM			2 sets, 10-12 RM			3 sets, 10-12 RM	
<i>Endurance training</i>												
Exercise bike	(60 + 30) × 3	(60 + 30) × 4	(60 + 30) × 6	(60 + 30) × 7		(60 + 30) × 10	–	–	–	(60 + 20) × 12	(60 + 15) × 12	(60 + 15) × 12
<i>Educational session</i>												
Aims and content	Detraining and convalescence	Setting goals	Plan how to achieve goals	Strength training	Endurance and walking	Mobility and balance	Activity training	Internet, books, DVDs	Possibilities in the local area	Progression and motivation	Evaluation	
<i>Discussion</i>												

RM = repetition maximum.

a) Unilaterally unless leg asymmetry less than 10%.

Inclusion and exclusion criteria

The participants were included four weeks after surgery at the standard physiotherapist follow-up at the hospital. The inclusion criteria were: 1) age 18 years or more, 2) primary TKA for osteoarthritis, 3) patient living in one of three municipalities, 4) patient able to travel to the rehabilitation centre independently. Exclusion criteria at the four-week outpatient follow-up were: 1) neuromuscular or neurodegenerative diseases, 2) knee infection after TKA or other major complications (e.g. loosening or embolism excluding superficial thrombophlebitis), 3) problems related to mobility, muscle strength or excessive pain preventing the patient from following the rehabilitation programme, 4) patient unable to understand the instructions due to dementia or language problems.

Patient pathways

All included patients underwent TKA in a standardized fast-track regime [8-10]. The mobilization started on the day of surgery. Supervised training continued throughout the hospitalization. Training included supervision in home-exercises (focus on knee range of motion and

isometric strength of the lower extremity). Four weeks after surgery, the patients visited a physiotherapist at the hospital and the home-exercise plan was adjusted (focus on endurance, dynamic strength of lower extremity and functional exercises). No additional rehabilitation is standard at our hospital after TKA surgery.

When written consent was obtained, an individual rehabilitation plan was made and sent to the rehabilitation centre. At the rehabilitation centre, a person, not otherwise involved in the study drew an envelope assigning the participant to either the intervention or the control group.

The intervention group

The intervention was a group-based programme that included two sessions per week for six weeks combined with home exercises. Each session (S1 to S12) consisted of three elements as shown in **Table 1**: 1) strength and endurance training in machines, 2) an educational session where a physiotherapist introduced the topic of the day, 3) a discussion session where participants shared experiences and discussed the topic of the day. The external load was increased continuously, and the partici-

pants were tested at S1 and S9 to find the right unilateral and bilateral loads, respectively. The home exercises included programmes of strength training, endurance training on an exercise bike and walking, balance training, and muscle strength training of the hip and knee. Patients were expected to follow the programmes twice a week. The rehabilitation was designed to start between four and eight weeks after surgery. A team consisted of four to eight participants with one or two supervising physiotherapists.

Control group

The control group performed home exercises and had 1-2 planned visits with a local physiotherapist. At these visits, the physiotherapist could adjust the home exercises and perform other physiotherapeutic interventions. Home exercises were the same as those the intervention group were instructed to perform. Furthermore, participants with physical limitations were allowed more outpatient visits, though without exceeding 12 treatments within six weeks. The first outpatient visit was designed to take place 8-12 weeks after surgery.

Outcome measurements

The Danish version of Oxford Knee Score (OKS) was the primary outcome measure. Secondary outcomes were Physical Function of the Medical Outcomes Short Form 36 (PF of SF36) and quality of life using the EuroQoL-5 Dimensions (EQ-5D); in both cases, the validated Danish versions were used [11, 12]. Tertiary outcomes were: 1) maximum active knee range of motion using a goniometer (measured as the best of two measurements), 2) peak Leg Extensor Power (LEP) using the Nottingham Leg Extensor Power Rig [13] adjusted for weight (unilaterally; tested until peak followed by two additional attempts; a maximum of ten attempts), 3) balance using the tandem test (10 sec. each in side-by-side, semi-tandem and tandem stand), 4) 10-m walking test (standing start on a 12-m track; the best of three measurements; if necessary with walking aid), 5) the 30-sec. sit-to-stand test and the five-times sit-to-stand test, 6) pain level on visual analogue scale (VAS) during the LEP test, before and after the test set. Outcomes were assessed four weeks (baseline), three months, and six months after surgery. In addition, the questionnaires were completed the day before surgery. Physiotherapists testing the participants were blinded with regard to allocation.

Statistics

OKS was scored between 0 and 48, with 48 being the best score [14]. PF of the SF36 was scored between 0 and 100 with 100 being the best score [11], and EQ-5D was scored using the Danish TTO value set for the EQ-5D [15]. We used Student's unpaired t-test to compare the

intervention group with the control group with the exception of proportions which were assessed by the χ^2 -test, and VAS which was assessed by the Mann-Whitney non-parametric test. The sample size was estimated using a minimum relevant difference on OKS ≥ 5 (standard deviation (SD) = 7), a power of 80% and a statistical significance of $p < 0.05$. At least 31 patients were needed in both groups; and 80 patients were included to compensate for loss to follow-up.

Trial registration: The study was registered with the Danish Data Protection Agency (Reg. no.: 1-16-02-41-10) and with Clinical Trials.

RESULTS

A total of 40 participants were allocated to each group as shown in **Figure 1**.

Table 2 presents the preoperative characteristics of the two groups. At baseline, the participants in the intervention group walked significantly faster ($p = 0.03$) and finished the five-times sit-to-stand significantly faster ($p = 0.03$) than the participants in the control group. LEP-values (W/kg) tended to be larger in the intervention than in the control group (non-operated leg: $p = 0.053$; operated leg: $p = 0.06$). Otherwise, no differences were found between the two groups at baseline.

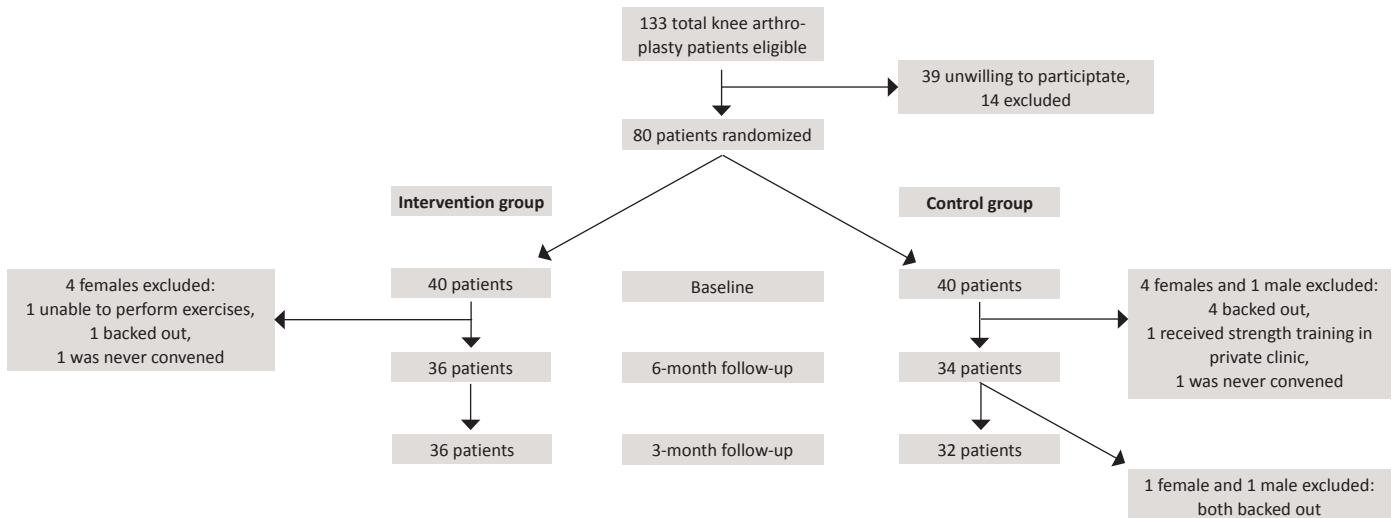
At three and six month of follow-up, participants in the intervention group walked significantly faster ($p = 0.01$ and $p = 0.01$, respectively) and had higher LEP-values ($p = 0.04$ and $p = 0.03$, respectively) of the operated leg than the participants in the control group. Furthermore, the intervention group exceeded the control group in five-times sit-to-stand at the six-month follow-up ($p = 0.045$). On the other hand, when adjusting for the baseline differences, no significant difference was found between the two groups as shown in **Table 3**. Only improvement of the LEP asymmetry tended to be better in the intervention group. Pain showed no difference as both groups had a median of zero at three and six months of follow-up.

Participation in the rehabilitation programmes

In the intervention group, the participants completed an average of 10.5 training sessions (SD = 1.8, range 4-12 sessions) with a compliance level of 87%. Eleven (31%) participants completed all 12 sessions. Known reasons for missed sessions were: vacation (four participants), work (one participant), and suspicion of infection of the operated knee (one participant). Furthermore, 12 participants were unable to perform at least one strengthening exercise due to nausea (two participants), back trouble (two participants), spinal stenosis (one participant), osteoporosis (one participant), osteoarthritis of the contralateral knee (one participant) and infection of the

FIGURE 1

Flow chart illustrating patient flow in the study.



operated knee (one participant). One participant was allowed three additional outpatient visits due to an extension defect. The time from surgery to rehabilitation start ranged from five to 12 weeks with an average of 7.2 weeks.

In the control group, 31 participants had 1-4 (mean of 2.1 (SD 0.9)) outpatient visits. The last participant visited the physiotherapist 24 times. The time from surgery to the first outpatient visit (not including the standard outpatient visit four weeks after surgery) ranged from 4.4 to 14 weeks with an average of 6.7 weeks.

DISCUSSION

This study aimed to determine whether a group-based rehabilitation focusing on strength training, education and self-management exceeded individual, supervised home-exercises after TKA. Neither physical measure-

ments nor questionnaires showed a clinically relevant difference at three or six months of follow-up. Only LEP asymmetry tended to decrease more in the intervention group than in control group from baseline to the six-month follow-up. LEP asymmetry in women correlates with slow walking and inability to maintain tandem stand, especially combined with a low LEP-value [16]. Nevertheless, both groups improved physical function equally, and the difference in LEP asymmetry is therefore not clinically relevant.

Nevertheless, at the six-month follow-up, the intervention group exceeded the 12-month average of standard care patients at the Regional Hospital Holstebro on PF of the SF36, whereas the control group equalled the average [2]. The intervention may hence reduce the recovery period compared with standard care. Unlike the present study, earlier studies showing positive effects of a late-onset six-week rehabilitation programme including strengthening exercises were applied individually [4, 6]. Furthermore, positive outcomes are physical measurements, whereas the present study used OKS as its primary outcome because self-evaluated function was considered to be more relevant. Consequently, the sample size may be too small to find a significant difference in the physical measurements. But as the present study showed no clinical difference, a larger sample size would not be relevant. Furthermore, by doing multiple comparisons, the Bonferroni correction could be used and lead to an even lower level of significance, which indicates that the possibility of missing a difference due to a small sample size is very small.

Conducting a group-based rehabilitation pro-

TABLE 2

Questionnaire before surgery.

	Intervention	Control	p-value
Age, years, mean \pm SD	66.9 \pm 8.5	66.2 \pm 8.2	0.7 ^a
Women, n (%)	17 (47)	16 (50)	0.9 ^b
Weight, kg, mean \pm SD	82.7 \pm 14.9	88.0 \pm 12.1	0.1 ^a
EQ-5D, mean \pm SD	0.73 \pm 0.12	0.69 \pm 0.13	0.3 ^a
PF SF36, mean \pm SD	53.6 \pm 20.6	53.9 \pm 19.3	0.9 ^a
Oxford Knee Score, mean \pm SD	27.8 \pm 7.5	26.4 \pm 8.8	0.5 ^a

EQ-5D = EuroQoL-5 Dimensions; PF SF36 = Physical Function of the Medical Outcomes Short Form 36; SD = standard deviation.

a) Student's unpaired t-test; b) χ^2 -test.



TABLE 3

Changes from baseline. Values are stated as mean \pm SD.

	Intervention	Control	p-value ^a
<i>ROM, degrees</i>			
3 months	13.4 \pm 12.2	13.3 \pm 10.5	0.9
6 months	19.8 \pm 14.7	17.3 \pm 13.0	0.5
<i>Balance</i>			
3 months	0.2 \pm 3.9	1.5 \pm 4.8	0.2
6 months	0.2 \pm 3.1	0.9 \pm 4.7	0.5
<i>Peak LEP, non-operated leg, W/kg</i>			
3 months	0.13 \pm 0.35	0.15 \pm 0.20	0.8
6 months	0.13 \pm 0.33	0.19 \pm 0.34	0.5
<i>Peak LEP, operated leg, W/kg</i>			
3 months	0.59 \pm 0.44	0.45 \pm 0.36	0.2
6 months	0.75 \pm 0.39	0.60 \pm 0.36	0.1
<i>Asymmetry LEP, W/kg</i>			
3 months	-0.46 \pm 0.47	-0.31 \pm 0.32	0.1
6 months	-0.61 \pm 0.44	-0.41 \pm 0.38	0.05
<i>30-sec. sit-to-stand, repetitions</i>			
3 months	3.7 \pm 3.6	3.5 \pm 2.6	0.8
6 months	5.0 \pm 4.0	4.0 \pm 3.2	0.2
<i>5-times sit-to-stand, sec.</i>			
3 months	-2.6 \pm 2.7	-3.7 \pm 4.0	0.2
6 months	-3.5 \pm 2.6	-4.8 \pm 3.7	0.1
<i>Walking velocity</i>			
3 months	0.32 \pm 0.21	0.3 \pm 0.2	0.7
6 months	0.40 \pm 0.22	0.36 \pm 0.22	0.5
<i>EQ-5D</i>			
3 months	0.09 \pm 0.13	0.09 \pm 0.15	0.9
6 months	0.13 \pm 0.12	0.10 \pm 0.20	0.5
<i>PF of SF36</i>			
3 months	16.8 \pm 14.2	18.0 \pm 16.6	0.7
6 months	22.6 \pm 19.4	19.5 \pm 19.4	0.5
<i>Oxford Knee Score</i>			
3 months	7.9 \pm 5.9	8.4 \pm 6.7	0.7
6 months	10.5 \pm 7.5	9.7 \pm 8.5	0.7

EQ-5D = EuroQoL-5 Dimensions; LEP = Leg Extensor Power; PF of SF36 = Physical Function of the Medical Outcomes Short Form 36; ROM = range of movement; SD = standard deviation.

a) Unpaired t-test.

gramme can be difficult due to low attendance as missed sessions cannot be rescheduled. Hurley et al reported that 55% of the participants in group rehabilitation attended ten or more sessions [7], whereas the percentage was 88% in the present study. The overall compliance level corresponds well with LaStayo et al, who reported 87% and 89%, respectively [17]. Consequently, the attendance achieved in the present study is acceptable. Furthermore, allocation of participants to teams was problematic as only five of the 11 teams included four or more participants, and participants started on average 7.2 weeks after surgery. Including more participants may reduce this problem.

Another problem concerning the intervention may

be the patients' lacking ability to perform all strength exercises due to age and co-morbidities. This may make the training less effective for some TKA-patients. In this study, 12 participants were unable to perform at least one exercise and one participant was excluded due to physical limitations.

The results of this study cannot be generalized to all TKA patients. Firstly, the participants consisted of approximately 50% women, whereas the Danish TKA population consists of approximately 60% women [18]. Secondly, the participants belonged to the best half of patients before surgery, and they are therefore comparable with the normal age- and gender-matched Danish population 12 months after surgery according to Larsen et al [2]. On the other hand, the other half of patients scored significantly lower than the age- and gender-matched Danish population 12 months after surgery [2]. These patients may therefore benefit from a group-based rehabilitation and thereby improve their physical function to the level of the normal Danish age- and gender-matched population.

New studies indicate that TKA patients may benefit from early onset strengthening training [19, 20]. Jakobsen et al initiated progressive strengthening exercises 1- to 2 days after TKA and found improved functional performance without increased knee pain and knee joint effusion [20]. Therefore, further studies are needed to investigate the effect of early progressive strengthening training after fast track TKA.

This study indicates that patients receiving group-based rehabilitation do not recover faster than patients receiving supervised home-exercises in a selected group of TKA patients. Potentially, the TKA patients with lower scores before surgery may benefit from the group-based rehabilitation and such rehabilitation may allow this group to reach the level of the best patients and the normal Danish age- and gender-matched population 12 months after surgery.

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