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Is postoperative exercise therapy necessary in patients with degenerative meniscus? A randomized controlled trial with one year follow-up

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Abstract
Purpose There is no consensus on a postoperative rehabilitation regimen for patients who have undergone surgery for medial meniscus damage. The aim of this investigation was to evaluate two rehabilitation approaches after arthroscopic surgery in patients with degenerative meniscus: supervised medical exercise therapy versus no treatment.
Methods A prospective randomized controlled clinical trial. Over 4 months, 70 participants were randomly assigned into either a medical exercise therapy group ($n = 36$) or a control group ($n = 34$). Pain was a composite score of a visual analogue scale (VAS), and function was measured with a functional assessment questionnaire (KOOS), while anxiety and depression were measured with the Hospital Anxiety and Depression Scale. Function was also measured with tests of quadriceps femoris strength and a one-leg jump test.
Results Prognostic variables were similar between the groups at baseline, with five (7 %) patients dropping out during the treatment period and another six (8 %) before the one-year follow-up. After 3 months, the medical exercise therapy group achieved significantly better outcome effects than the control group for pain and function. The results after the 12-month follow-up indicated the same results as at posttest, whereas Hospital Anxiety and Depression Scale, fiveRM and the one-leg hop test also demonstrated a significant difference between the groups from pre- to posttest to follow-up.
Conclusion In patients with surgery for degenerative meniscus damage, postoperative medical exercise therapy is an efficient treatment alternative compared to no treatment.
Level of evidence I.

Keywords Knee function · Rehabilitation · Physical therapy · Knee pain

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Introduction

People with a knee injury who have had meniscectomy surgery report more functional limitations and are more likely to develop radiographic tibiofemoral osteoarthritis than age- and sex-matched controls [9, 22]. Moreover, the importance of muscle function and joint loading could be important predictors of osteoarthritis [3]. Many knee injuries occur without any trauma in physically active- and older people and can be part of early osteoarthritis [28]. Partial arthroscopic ectomy of the meniscus is a common surgical procedure in patients with meniscus injury, while postoperatively, many patients report less pain, better function and a better quality of life [4]. However, many patients do not get back to the same physical activity level as before their meniscus injury [21]. In addition, there is no consensus among orthopaedic surgeons as to whether patients operated on for degenerative meniscus damage should be referred to postoperative physiotherapy for individually tailored exercise therapy.

Arthroscopic partial meniscectomy is a widely applied surgery technique, although the discussion about the postoperative rehabilitation programme continues. Some studies suggest the need for observed physical therapy for optimal results (e.g. [17]), whereas others argue that home exercise programmes are as effective as observed physical therapy [10]. However, a majority of the previous trials has investigated the effect of interventions with low dosages or short intervention periods, but more important is that most previous trials have included acute patients, which is a slightly different group of patients.

Although the importance of early active joint exercises in order to achieve good results postarthroscopic partial meniscectomy rehabilitation is known, there are a limited number of studies that compare the efficacy of physiotherapy in these patients [1]. Physical activity is well documented as an effective treatment for patients with knee degeneration in order to improve function and reduce pain, both in subacute and in long-term patients [5, 15], and there is strong evidence that physical activity can reduce pain and help improve function and the quality of life for people with osteoarthritis [18]. The goal of the rehabilitation period is to regain good knee control, range of motion, strength and knee function, and there are many different protocols for rehabilitation after knee injuries, but no consensus exists. Herrlin et al. [11] revealed no difference between surgery versus conservative treatment at 8 weeks and 6 months for degenerative knee patients, although the exercise programme was low dosed and only carried out two times per week for 8 weeks.

Medical exercise therapy is a rehabilitation treatment approach that uses specially designed exercise equipment for grading exercises [25], as well as a system for applying progressive resistance exercises in which the aim is to use exercise treatment as a "pain treatment" to decrease the subject's pain experience while improving impaired function. The grading of the exercises makes it possible and imperative to exercise close to a pain-free threshold within a comfortable range of motion, with an emphasis on good coordination. An important part of MET is the cognitive approach, which includes a focus on both a reduction of catastrophizing and fear avoidance in order to reduce pain perception and increase physical activity level [25].

The aim of this investigation was to evaluate the clinical improvements of two rehabilitation approaches after arthroscopic surgery in patients with degenerative meniscus: supervised medical exercise therapy versus no supervised treatment.

Materials and methods

The present study was a randomized controlled clinical trial (RCT) following two groups, a medical exercise therapy group (EG) and a control group with no rehabilitation programme (CG) (see Fig. 1 for flow chart). A computer-generated randomization schedule was used, with annotations for treatment according to medical exercise therapy or no postoperative rehabilitation. To maintain the blinding of the study, four different well-trained physical therapists conducted the testing and exercise intervention. Additionally, this was a multicenter study, in which the intervention was carried out at four different locations.

The inclusion criteria were subjects with knee pain for more than two–three months, being between the ages 35 and 60 years and eligible for arthroscopic partial meniscectomy and having an MRI showing a degenerative meniscus tear, while the exclusion criteria were an ACL rupture, those requiring acute trauma surgeries, those having high-energy traumas with ligament injuries, an osteoarthritis grade of 3–4 [24], hemarthroses and acute cases of locking knee. In addition, the following were also included in the exclusion criteria: symptomatic pain in contrary extremity- and other musculoskeletal comorbidities severely affecting lower extremity muscle function overriding the symptoms from the knee, comorbidities that exclude physical activities and exercise, not being able to speak or read the language of interest, drug abuse or mental problems.

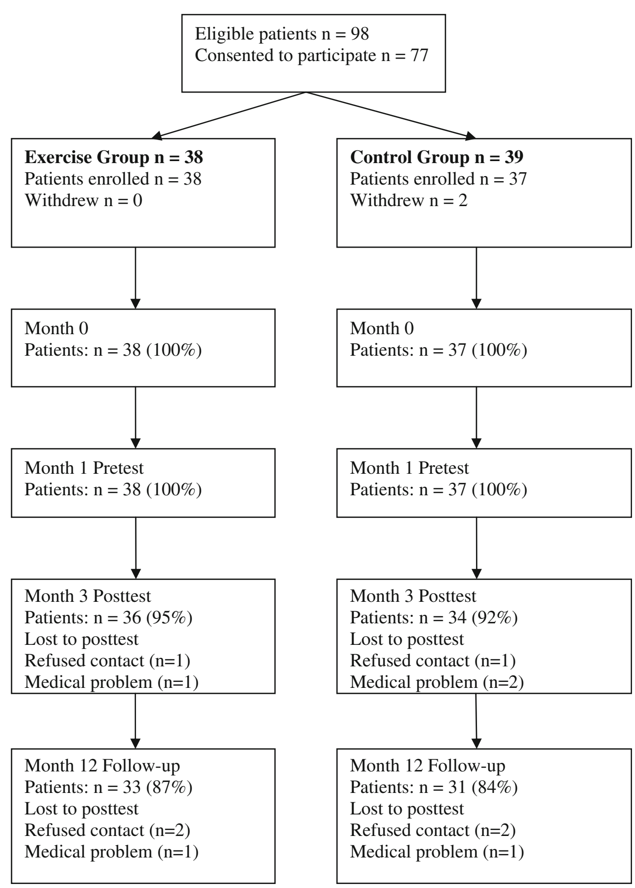

Fig. 1 Subject flow diagram of the patients

Patients were recruited from orthopaedic surgeons in three hospitals in the middle of Norway over a period of 1 year, and the intervention exercises were based on evidence-based training principles such as dynamic- and plyometric performance, with a good coordination and little or no pain. All participation was based on informed consent, voluntariness and the right to withdraw from the study without further consequences, with baseline characteristics of the study population being given in Table 1.

Outcome measures

The primary outcome is pain, which is a subjective score measured with a visual analogue scale (VAS) at rest recorded on a 0- to 100-mm line. The extreme limits were marked by perpendicular lines, using the verbal descriptors "no pain" and the "worst pain I can imagine." The subjects were not shown their previous markings at follow-ups, with the VAS having been shown to be a reliable tool for measuring pain [13]. The secondary outcome was a self-reported composite measure, "Knee Injury and Osteoarthritis Outcome Score" (KOOS), comprising pain, other symptoms, activities in daily living, function in sport and recreation and knee-related quality of life. All items have five possible answer options scored from zero (no problems) to four (heavy problems), and the scores were transformed to a 0–100 scale, in which 100 represented no knee-related problems. The KOOS is a valid and reliable patient-relevant questionnaire for patients with a knee injury and knee osteoarthritis [20]. To detect an average difference between individuals and between groups, a minimal perceptible improvement was set to 10 points, and KOOS was registered at baseline, posttest and follow-up during this trial.

Anxiety and depression were measured by use of a Hospital Anxiety and Depression Scale (HADS) [2], which is a self-screening questionnaire for depression and anxiety. It consisted of 14 questions, seven for anxiety and seven for depression.

Prior to the functional test and the fiveRM test, subjects warmed up on a stationary bicycle for approximately 10 min. A single-leg hop test was included, as the patients stood still on one leg and jumped as far as possible. First, the patients performed two hops to become familiar with the test, then another two hops were performed and the best result out of these was recorded. Each hop test began on the uninjured side, followed by one on the injured side. One-leg hop test score was calculated (uninjured side score/injured side score) × 100, and a leg extension bench for the evaluation of quadriceps muscle strength deficits was included [12], with a five repetition maximum (RM). The reliability of the muscle test has previously been reported to be satisfactory [7, 12]. One month postoperatively, after the intervention period (3 months) and after 12 months, all patients answered the questionnaires and completed the muscle and functional test.

Intervention

A standard arthroscopic partial meniscectomy (NGD 11) was applied as a surgical intervention and carried out at two hospitals in Norway. Normal procedures for this surgery at the respective hospitals were followed, including a meniscal debridement.

An exercise programme had been developed and tested in a prior trial [28] and was further developed for this particular study, with a focus on coordination, muscle function and strength training. The programme was also individually tailored with respect to rehabilitation performance and progression, and based on clinical experience; the intervention period was 3 months, with the subjects performing the exercise programme three times per week. Symptoms and clinical findings were the basis for choosing individual starting positions, range of motion and weight resistance for each exercise, and the treatment goal in the exercise group was to perform three sets of 30 repetitions. The programme was a combination of global aerobic exercises using a stationary ergometer cycle, treadmill or step machine, as well as semi-global and local exercises using specially designed exercise equipment, which included wall pulleys and quadriceps and hamstring muscle strength training apparatus (Table 2).

Each treatment in the exercise group started with 10–20 min of aerobic work on a stationary ergometer

Table 1 Baseline characteristics of the study population

	Exp group (n = 36)	Con group (n = 34)	Total (n=70)
Age, years	46.3 (8.3)	46.3 (8.9)	46.3 (8.6)
Weight, kg	79.6 (9.8)	80.1 (9.8)	79.9 (9.7)
Height, cm	177.2 (7.6)	176.3 (6.2)	176.7 (6.9)
Duration of symptoms, years	2.1 (2.3)	2.1 (1.6)	2.1 (2.0)
Gender (% female)	12 (33)	11 (32)	23 (33)
Osteoarthritis 1 (%)	9 (25)	6 (18)	15 (21)
Osteoarthritis 2 (%)	3 (8)	7 (21)	10 (14)

Mean (SD) values unless otherwise noted

cycle. Half way through the exercise programme, after four exercises of three sets of 30 repetitions each, the subjects bicycled for 10 min and again after the last four exercises, the subjects did another 10 min on a stationary ergometer cycle. The intensity during the bicycle exercises was moderate to high, that is, a heart rate frequency of 70–80 % of the maximal heart rate. The hypothesis was that the global exercises are important for stimulating the body's pain modulating system through the gate control mechanism in the posterior horn of the spinal cord and for the release of the endogenous neuropeptides in the central nervous system. Moreover, all possible efforts were made to enhance compliance and adherence with the programme.

Statistical analysis

A sample size was calculated using a predetermined difference between groups of a 20 % change in pain on a 10-cm VAS, and this effect is considered to be better than a minimal clinically important difference [6]. A sample size calculation with a standard deviation of 3.2 points on the VAS showed that 32 participants were required in each group in order to have an 80 % power to significantly detect a 20 % difference at the 5 % level. Considering a possible loss of 10 % of the subjects, we determined that each group would contain 38 subjects. Descriptive statistics were performed for demographic variables, normal distributions of outcome variables were estimated by use of a Kolmogorov–Smirnov test and both within- and between mean group differences were analysed by using a general linear model. Intervention (group allocation) and time (between pre- and posttest) were main effects, and baseline values of the primary outcomes were applied as covariates. A Bonferroni test was used to estimate main group differences, though an intention-to-treat analysis was not used because of a low drop-out rate. Each participant's compliance was determined by averaging the compliance reported on compliance logs.

Table 2 The exercise programme for the medical exercise therapy group (EG) performed during the 12 weeks

	Exercise	Dosage
1	Stationary bicycling	10–20 min
2	Deloaded step up	3 × 30 repetitions
3	Deloaded knee extension	3 × 30 repetitions
4	Squat	3 × 30 repetitions
5	Stationary bicycling	10 min
6	Deloaded step down	3 × 30 repetitions
7	Loaded knee extension, open chain	3 × 30 repetitions
8	Deloaded knee extension	3 × 30 repetitions
9	Stationary bicycling	10 min

The number of each exercise (1-9) represents the order of what exercise that thepatients performed.

Results

The subjects completed 90 % of the rehabilitation programme. Five (7 %) patients dropped out during the treatment period, whereas another six (8 %) dropped out before the one-year follow-up.

After 3 months, the EG achieved significantly better outcome effects than the CG on pain (VAS reduced 1.9 in the EG and 0.6 in the CG) and function (KOOS decreased 18.0 points in the EG and 6.5 in the CG). The results after the 12-month follow-up indicated the same results as at posttest: the VAS reduced another 0.8 in the EG and 0.4 in the CG, while the KOOS decreased another 10.3 points in the EG and 4.5 points in the CG. The HADS, fiveRM and one-leg hop test also exhibited significant difference between the groups from pre- to posttest and follow-up (Table 3).

Discussion

The most important finding of the present study was that in patients with surgery for degenerative meniscus damage, postoperative medical exercise therapy is an efficient treatment alternative compared to no treatment. This is one of the first studies to compare medical exercise therapy with no supervised rehabilitation in subjects with degenerative meniscus damage. There appeared to be no significant differences between groups with respect to pain and function, with all in favour of the medical exercise therapy group. The pain level after the three-month intervention period decreased in the EG group from 33 mm to 14 mm on the VAS, which is a decrease in pain of 57 %. The CG group had a slight decrease in pain, as measured by a reduction on the VAS from 29 mm to 23 mm, which is approximately 21 %. The difference between the groups is both statistically and clinically significant, with the increased difference between the groups at the 12-month follow-ups being of particular interest. The results after the 12-month follow-up indicated the same results as at the posttest: the VAS reduced another 0.8 in the EG and 0.4 in the CG, while the KOOS decreased another 10.3 points in the EG and only 4.5 points in the CG. Table 3 presents that the EG was better at the start of the study than the EG when it comes to KOOS as well as the one-leg hop and worse when it comes to HADS. This is a study weakness and must be a reminder when it comes to implications of the study.

Moffet et al. [16] conducted a randomized controlled trial on the efficacy of an early, intensive, supervised

Table 3 Mean (SD) pain and function in the groups at pre- and posttest and follow-up, mean (SD) within groups changes, and adjusted mean (95 % CI) difference between groups after intervention and between posttest and follow-up

Outcome	Groups					
	Pretest		Posttest (3 months)		Follow-up (12 months)	
	Exp ($n = 36$)	Con ($n = 34$)	Exp ($n = 36$)	Con ($n = 34$)	Exp ($n = 33$)	Con ($n = 31$)
VAS	3.3 (2.1)	2.9 (1.5)	1.4 (1.4)	2.3 (1.3)	0.5 (0.6)	2.0 (1.0)
FiveRM	11.6 (4.3)	12.5 (5.2)	20.2 (5.4)	14.5 (5.2)	22.8 (4.1)	14.4 (4.1)
KOOS	48.0 (21.7)	43.4 (22.9)	30.0 (17.7)	36.9 (23.1)	19.2 (9.2)	33.1 (17.7)
HAD	6.8 (3.8)	5.5 (4.7)	4.4 (2.8)	5.1 (4.3)	3.9 (2.3)	5.5 (3.9)
One-leg hop (%)	85.6 (7.8)	73.2 (8.5)	93.1 (6.2)	78.0 (7.9)	96.7 (5.1)	81.4 (8.3)

Difference within groups[a]					Adjusted difference between groups[b]	
	From pre- to posttest		From posttest to follow-up		From pre- to posttest	From posttest to follow-up
	Exp	Con	Exp	Con		
VAS (0 = no pain, 10 = max)	−1.9 (1.6)	−0.6 (0.6)	−0.8 (1.2)	−0.4 (0.7)	−1.1* (−1.5 to −0.6)	−1.0* (−1.3 to −0.6)
FiveRM	8.6 (3.8)	2.0 (2.3)	2.5 (3.2)	0.1 (2.1)	6.5* (5.0 to 8.0)	4.4* (3.2 to 5.6)
KOOS	−18.0 (10.9)	−6.5 (6.4)	−10.3 (11.2)	−4.5 (7.8)	−10.7* (−14.7 to −6.7)	−8.9* (−−11.9 to −5.9)
HAD	−2.4 (1.9)	−0.4 (0.9)	−0.4 (0.7)	0.1 (1.1)	−1.7* (−2.3 to −1.2)	−0.7* (−1.1 to −0.3)
One-leg hop	7.5 (5.6)	4.9 (3.6)	3.7 (3.5)	3.7 (4.5)	6.2* (3.7 to 8.7)	3.3* (0.6 to 6.1)

Exp, experimental group (EG); Con, control group (CG)

* The adjusted difference between groups were all significant at $p < 0.01$, all in favour of the experimental group

[a] Post minus pre; change scores

[b] Posttest and follow-up scores of the primary outcomes were all adjusted for baseline values

rehabilitation programme on knee strength recovery in the first 3 weeks after meniscectomy. They demonstrated that patients who received nine supervised physical therapy visits had better knee extensor strength recovery than patients who only received a home-based programme ($p < .001$).

It is interesting to observe that during the follow-up period assessing pain and function after 12 months, the EG continued to get better. There are probably several explanations for this. One possibility is that the EG had an intense and time consuming training programme, three times a week for 3 months, exercising 60–70 min each treatment, which may have decreased pain and improved function so much that patients were able to return to normal activities. That was obviously not the case for the subjects in the CG. Additionally, none of the subjects in the two groups were given prescribed home exercises or continued to receive supervised exercise therapy after the end of the three-month treatment period.

In this study, the HADS changed significantly, both within groups and in the adjusted difference between groups, in favour of the EG, though the experimental group reported more problems at the start of the study. The idea that the fear of pain and potential reinjury may be more disabling than the pain itself is well known [27]. An increasing number of primarily cross-sectional studies have shown that pain-related fear is indeed one of the most potent predictors of observable physical performance and self-reported disability level. The possible mechanisms could be bodily sensations, inaccurate predictions about pain, physical deconditioning, hypervigilance and muscular reactivity [26]. Nevertheless, there is still no consensus on clinical guidelines in patients with prolonged pain—as in the present study—of how one might approach this. One important factor in medical exercise therapy consists of a graded exposure to the situations the patients have identified as "dangerous" or "threatening", meaning there could be an increase in knee discomfort and even pain. Such an approach, with a relatively low external load in the exercises and a high volume of endurance pain-modifying training, might give the individuals an opportunity to correct inaccurate predictions regarding the effects of physical activity and harm. Despite a lack of knowledge about fear avoidance in degenerative meniscus patients, pain-related fear and fear of movement reinjury, in particular, should be addressed in further research.

Roos et al. [23] found that 259 meniscectomized patients gradually decreased their overall knee function at the seven-year follow-up, pointing to the potential importance of qualified postoperative rehabilitation. In the present study, the EG improved overall at all test parameters in the one-year follow-up, while there was a tendency towards a decreased function in the CG. Further follow-up studies with longer intervention periods and/or more control of the patients' physical activity level are needed to shed more light on the potential to positively affect further joint pathology.

The mechanisms behind the treatment effects are most likely several, ranging from effects on a cellular level in the knee joint to cognitive functions such as coping and self-efficacy [8, 14, 19]. Thus, there is a need for more research to help better explain and understand the mechanisms that underlie why the exercise therapy used in the present study may be a potent treatment for this subject category.

A limitation in this study is that the measurements were undertaken by the treating physiotherapists and not by another person; however, this was a multicenter study with four physiotherapists. The outcome measurements were also not obtained by a blinded assessor, which is a major limitation, as blinded assessment is considered to be essential to prevent bias and assure internal validity in a clinical trial. Three outcome measures were self-reports (pain, HADS and KOOS), so there could not be blinding to group allocation, though we acknowledge the lack of blinding as a limitation. Another limitation is the lack of knowledge of factors that could have affected the assessments at both posttest and follow-up. Many patients know that physical activity and/or strength training could be beneficial in their situation, and despite no individually supervised rehabilitation programme, they may have completed parts of the intervention in the EG. In addition, if the patients did not go back to their previous physical activity level, they may not responded validly on pain assessment, and only since the knee strain had been reduced and the expectations of knee function had been lowered.

The clinical relevance of the present study may be that surgeons should reconsider their routines regarding physical therapy prescriptions of this group of patients. This work can be useful in the day by day clinical work for treating physical therapists through the focus of importance of postoperative rehabilitation. Further research among degenerative meniscus patients may show if the postoperative medical exercise therapy can increase quality of life several years after end of treatment.

Conclusion

Clinicians may utilize an early progressive return to actively following knee meniscal repair surgery. With the methodological limitations in mind, this trial suggests that medical exercise therapy is an efficient approach.

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