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RESEARCH ARTICLE

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Effect of information and exercise programmes after lumbar disc surgery: A randomized controlled trial

Eva Saltskår Jentoft[1] | Alice Kvåle[2] | Jörg Assmus[3] | Vegard Pihl Moen[2,4]

[1]Orthopedic Clinic Kysthospitalet in Hagevik, Haukeland University Hospital, Bergen, Norway

[2]Western Norway University of Applied Sciences, Bergen, Norway

[3]Centre for Clinical Research, Haukeland University Hospital, Bergen, Norway

[4]Centre for Habilitation and Rehabilitation, Haukeland University Hospital, Bergen, Norway

Correspondence
Eva Saltskår Jentoft, Haukeland University Hospital, Jonas Lies vei 65, N-5021 Bergen, Norway.
Email: eva.saltskar.jentoft@helse-bergen.no

Abstract

Objective: The aim of this study was to compare two physiotherapy interventions following lumber disc surgery regarding effect on pain, functioning and fear of movement.

Methods: This study is a prospective randomized controlled study. When admitted to hospital for first time lumbar disc surgery, the participants were randomized to one of two post-operative intervention groups: one group received information only and the other exercise in combination with information. Outcomes were collected at baseline, 6–8 weeks and 12-months post-surgery. The primary outcome was to record changes in back/hip pain and leg pain. Secondary outcomes were evaluation of changes in function, fear-avoidance beliefs and kinesiophobia.

Results: Seventy patients completed the study and were included in the analysis, of which 37 were randomized to the group receiving information only and the remaining 33 receiving both exercise and information. For primary outcomes, at 12 months postoperatively, the group receiving both exercise and information had significantly lower leg pain compared with those receiving only information ($p < .033$). For secondary outcomes, at 12 months postoperatively, a significant difference ($p < .027$) was detected for function, which favoured those that received both exercise and information. There was no significant difference in the results for the other secondary outcomes. Both groups showed clinically important changes in relation to pain and function from baseline to 12 months. The effect of treatment showed a statistically significant difference in favour of exercise and information, but the difference was not clinically relevant.

Conclusion: Exercise in combination with information reduced leg pain and improved function, which was statistically more evident over a period of time. Postoperative physiotherapy after lumbar disc surgery could include exercises in addition to

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information, but perhaps not for all patients, as both groups improved, and the difference between the two groups was not clinically relevant.

KEYWORDS
disc surgery, exercise, information, physiotherapy, postoperative intervention

1 | INTRODUCTION

Physiotherapy has traditionally been part of postoperative rehabilitation after lumbar disc surgery. However, the evidence of its effect is conflicting and there is no consensus in rehabilitation guidelines whether it should be offered or not; nor regarding its content (Oosterhuis et al., 2014; Snowdon & Peiris, 2016).

The primary aim of this study was to compare two physiotherapy interventions following lumber disc surgery in order to contribute to more evidence-based postoperative interventions.

1.1 | Background and objectives

After lumbar disc surgery recovery rates, defined as patients who were fully free from leg or back pain, have been reported to be 91% after 6 months and 83% after 10 years (Findlay, Hall, Musa, Oliveira, & Fear, 1998). The optimal recovery rate after surgery depends on technical outcome and rehabilitation (McGregor, Burton, Sell, & Waddell, 2007). While surgery techniques may influence outcome, especially open lumbar surgery and microdiscectomy (Ozkara et al., 2015), the influence of post-operative interventions remains unclear. So far, studies are inconclusive regarding which interventions are most effective and the underlying mechanisms (Oosterhuis et al., 2014). Strength, endurance, stability- and mobility training, motor control training, information and multidisciplinary programmes consisting of group training and individual sessions, are elements in interventions offered to patients after lumbar disc surgery. Studies indicate that pain and disability are improved by exercise therapy (Oosterhuis et al., 2014). Kjellby-Wendt et al. found that patients who did early active training after lumbar disc surgery had less intense pain 6 and 12 weeks after surgery, compared with the control group who had traditional, less active, training. However, no difference was reported between the intervention groups regarding pain intensity 1 year after surgery (Kjellby-Wendt, Styf, & Carlsson, 2001). In a systematic review of four controlled trials, with altogether 250 participants, early comprehensive physiotherapy after lumbar spine surgery was evaluated. A reduction in pain was found 12–18 months after surgery when compared with a control group receiving no physiotherapy (Snowdon & Peiris, 2016). Trials included in the review were comprehensive with education forming a vital component, and the exercise programmes had a defined intensity. This may lead to the assumption that in order to reduce disability and improve pain post-surgery, education, early comprehensive physiotherapy, and intensity of treatment plays a role (Oosterhuis et al., 2014; Snowdon & Peiris, 2016). Although, Rushton et al. considered pain and disability in their review of postoperative physiotherapy outcomes and they did not find conclusive evidence to support such arguments (Rushton, Wright, Goodwin, Calvert, & Freemantle, 2011). Kulig et al. found exercise and education to improve functional status more than education alone and also participation in physical therapy groups (Kulig et al., 2009). Other studies also found that exercise improved disability (Dolan, Greenfield, Nelson, & Nelson, 2000; Ozkara et al., 2015). The studies were, however, heterogeneous regarding the duration of exercise intervention, assessment time, type of exercise, and intensity of treatment; and also under different outcome measures, such as muscle endurance capacity, electromyography, lumbar mobility, general health status and behavioural status. These variations make it challenging to make recommendations for clinical practise. Furthermore, some studies had small populations with 14–30 participants (Dolan et al., 2000; Ozkara et al., 2015).

While earlier studies mostly focused on physical activity in postoperative management after lumbar surgery, a biopsychosocial approach, promoting increased knowledge and coping, has been used over the last couple of decades. More focus has been placed on evidence-based information, for example, being used in patient booklets (McGregor et al., 2007). A Cochrane review concluded that there is no need for patients to restrict activities after lumbar disc surgery (Oosterhuis et al., 2014). High fear avoidance belief is significantly predictive for low quality of life 12 months after lumbar disc surgery (Johansson, Linton, Rosenblad, Bergkvist, & Nilsson, 2010). Svensson et al. found that nearly 50% of the patients in their study suffered from kinesiophobia 10–34 months after surgery. In addition, patients with fear of movement also experienced more pain and were more disabled (Svensson, Lundberg, Ostgaard, & Wendt, 2011). This may imply that interventions aiming to reduce postoperative uncertainty concerning activities, might decrease patients' anxieties concerning activities in the rehabilitation process. Performance success and aiding patients in effectively mastering specific situations is believed to promote stronger sense of self-efficacy in rehabilitation, than exposing them to perceived threatening situations alone (Bandura, 1977; Williams, Turner, & Peer, 1985). However, there are still inconsistencies and variations in the advice given by health care professionals postoperatively (McGregor et al., 2007) and consequently this might lead to an increase in the patient's uncertainty concerning which activities can be performed. At the Kysthospitalet in Hagavik (KiH), Norway, exercise in combination with information has been given as standard postoperative care by the physiotherapist. As patients undergoing lumbar disc surgery spend less time hospitalized, in this work, it was questioned whether it is necessary for patients to perform exercises or whether information encouraging patients to stay active is sufficient as postoperative treatment.

In the present study, the aim was to compare the effect of two early postoperative physiotherapy interventions in relation to pain, functioning and fear-avoidance behaviour: information only or information in combination with exercise.

2 | METHODS

2.1 | Study design

In this prospective randomized controlled trial, patients who were admitted for lumbar discectomy for the first time were invited. Participants were randomly allocated to either information only (INFo) or exercise and information (EXin) in their postoperative care. Patient-reported outcome measures were collected at the baseline, after 6–8 weeks and at 12 months after surgery. Pain, functioning and fear-avoidance beliefs were measured. The trial was conducted at an orthopaedic hospital on the west coast of Norway, KiH, part of Haukeland University Hospital. Inclusion took place between January 2013 and October 2014. (ClinicalTrials.gov PRS Identifier: NCT01779544; Regional Ethics Committee (REK vest) no. 2012/1861; Full trial protocol can be accessed at: https://clinicaltrials.gov/ct2/show/NCTO1779544)

2.2 | Participants

Patients who had been diagnosed with lumbar disc prolapse and had consented to undergo first time discectomy at KiH were invited to participate in the study upon admission to the hospital. Patients between 18 and 60 years of age were included. Exclusion criteria were previous discectomies, poor understanding of the Norwegian language, and co-morbidity such as spondyloarthritis, joint disease, systemic- or heart disease. Patients were given detailed information about the study and informed written consent was obtained from all participants.

2.3 | Interventions

Six physiotherapists were involved in the study. Before programme commenced, all physiotherapists were educated regarding the study and received information about both interventions. All participants, regardless of allocated treatment, received standard preoperative information and postoperative advice regarding pain, activity and recovery expectations by their physiotherapist. No restrictions were given for any of the participants for the postoperative rehabilitation. Intervention treatment started on the first day after surgery. All patients had a minimum of two, and a maximum of six treatments with their physiotherapist, lasting 10–30 minutes.

2.4 | Information

Patients in the INFo group met with the physiotherapist the day before and first day after surgery and as necessary until returning home. In addition to standard post-operative mobilization, including the demonstration of ways to move around with a minimum of effort, patients were advised to return home; to live an active life without any restrictions and resume activities of daily living as soon as possible. Education about the structure and functioning of the spine, pain physiology, surgery techniques, postoperative prognosis and suggested activities for promoting recovery, were given both before and after surgery.

2.5 | Exercise and information

Patients in the EXin group met with the physiotherapist the day before and first day after surgery and received the same postoperative mobilization and information as the INFo group but were additionally given two to six treatment sessions depending on the length of their hospital stay. A total of seven exercises were performed in one set of 8–10 repetitions, twice a day at the hospital (Attachment S1). The aim of the Part 1 exercises was to regain general mobility and strength, as well as improve muscle coordination and automatic muscle response time. Patients were instructed to continue exercises when returning home and increase the number of repetitions and sets gradually. At the routine postoperative appointment 6–8 weeks after surgery, patients were introduced to 11 new home exercises and given the same information about gradually increasing exercise workload (Attachment S2). In Part 2 of the exercise programme, improving strength and stretching exercises were emphasized. All patients in the EXin group were asked to daily log their 12 weeks of exercises in a diary. The exercises were based on the most common home-exercises recommended after lumbar disc surgery, collected from six different hospitals in Norway in 2010.

2.6 | Outcome measures

The primary outcome was back/hip pain and leg-pain. Secondary outcomes were disability, fear-avoidance beliefs and kinesiophobia.

Numeric pain rating scale (NPRS) was used to measure pain intensity. Patients were asked to rate their pain from 0 to 10 on an 11-point Likert scale, 0 representing no pain and 10 representing worst pain. The validity of the NPRS has been well documented (Von Korff, Jensen, & Karoly, 2000). Minimal clinical important change (MCIC) can be defined as reduction in low back pain (LBP) from 1.5 to 3.5 points for patients with chronic low back and acute back pain (Abbott & Schmitt, 2014; Ostelo et al., 2008).

Oswestry Disability Index (ODI) is composed of 10 questions measuring activities of daily living likely to be limited in people with LBP (Fairbank & Pynsent, 2000). Each item goes from “no problem,” score 0, to “not possible,” score 5. Total score ranges from 0 to 100, with a higher score representing greater disability. The ODI is a validated and widely used questionnaire for measuring disability in patients with LBP. MCIC of the ODI has been suggested to be 10 points (Ostelo & de Vet, 2005).

Tampa Scale of Kinesiophobia (TSK-13) is a 13-item self-reported questionnaire measuring fear of movement (Monticone, Baiardi, Calabro, Calabro, & Foti, 2010). TSK-13 is used to identify irrational and inhibitory fear of movement in regard to pain and re-injury (Miller, Kori, & Todd, 1991). Each item is scored using a four-point Likert-scale, ranging from 1 strongly disagree to 4 strongly agree. Total score ranges from 13 to 52, and higher scores indicate worse health status. Sub-clinical, mild, moderate and severe scores have been suggested to be 13–22, 23–32, 33–42 and 43–52, respectively (Neblett, Hartzell, Mayer, Bradford, & Gatchel, 2016).

Fear Avoidance Beliefs Questionnaire (FABQ) is considered useful in evaluating patients' beliefs about how physical activity affects their LBP and can predict future disability and work loss (Fritz, George, & Delitto, 2001; Waddell, Newton, Henderson, Somerville, & Main, 1993). The present study used questions concerning physical activity, ranging questions 2 to 5 from 0 (strongly disagree) to 6 (strongly agree) on a Likert-scale. The total score, in which question 1 is omitted, ranges from 0 to 24 (0 = best score and 24 = worst score), with the suggestion of >14 to be the cut-off score (George, Fritz, & Childs, 2008).

Both TSK-13 and FABQ have been found reliable and valid for pain-related fear of movement in populations suffering from acute back pain (Swinkels-Meewisse, Swinkels, Verbeek, Vlaeyen, & Oostendorp, 2003).

2.7 | Procedure

Calculated sample size per group was 33. Considering dropout of various events, 80 patients were randomized to get 66 completers. The randomization was conducted by the administrator of the study using sequentially numbered opaque sealed envelopes (SNOSE), in blocks of 10. The patient's physiotherapist collected baseline data. The physiotherapist who treated the patient drew the envelope and explained the respective therapy. The follow-up data were collected by the physiotherapist who the patients consulted at the post-operative follow-up, 6–8 weeks after the surgery. The physiotherapist was not blinded to the intervention as he/she introduced the EXin patients to part 2 of the exercises at this point. A physiotherapist posted and collected all the 12 month follow-up data. Power calculation was done based on data from the Norwegian Quality Registry for Spinal Surgery.

Descriptive methods were used to characterize the sample. Intention-to-treat was used as we were interested in a real-life approach. Missing observation for the main analysis appeared only in the dependent variables, that is, multiple imputation would not gain anything and was therefore not used. Differences between the treatment groups were assessed using linear mixed models (LME) for each outcome variable, as well as when testing for differences in the response rate (RR) for NPRS and ODI. The LME consisted of the outcomes at all three time points as dependent variables, and time, treatment type as well as their interaction as independent variables. The technique of simple contrast, that is, estimated changes from baseline to each of the follow-up time points, was used. In these models, the interaction term estimates the treatment effect. The validity of model assumptions was approved using residual analyses. RR for each follow-up time point was compared using the χ^2 test. In this study, a 2-point difference in NPRS and a 10-point difference in ODI were defined as the MCIC. Patients with negative change scores ≥ MCIC were considered as responders of the treatment.

The general significance level was set to .05. The computation was made using SPSS 24 (IBM Corp, Armonk, NY) and R 3.5 (Team, 2019).

3 | RESULTS

Of the 153 patients who underwent lumbar disc surgery during the period of enrolment, 80 were included in the study and 70 patients completed the study, 37 in the information group (INFo) and 33 the in exercise-group (EXin). Further details are shown in the flow chart in Figure 1. Mean age of completers was 39.8 years (*SD* 10.1), and 26 out of 70 were women. For patients not included in the study, 41 of the 73 were women and the mean age was 48 years.

The study had no dropouts, but 10 patients were excluded after surgery. Nine of these were due to a change of surgical technique and therefore did not meet the inclusion criteria, and one withdrew consent and data was deleted so not included in the analysis. No adverse events due to the interventions were registered.

Both groups improved their leg pain and functioning from baseline to 12 months post-surgery, both clinically and statistically. The EXin group continued to improve regarding leg pain and disability, both at 6–8 weeks and 12 months, showing a significant between-group difference in favour of EXin at 12 months post-surgery. The same pattern of change was also found for irrational and inhibitory fear of movement and kinesiophobia, but the tendency was not significant. No significant differences were registered post-operatively at any measured times between the two interventions regarding back and hip pain, kinesiophobia or fear of movement.

3.1 | Baseline data

Groups were well matched with respect to demographic characteristics and values at baseline for outcome measures, Tables 1 and 2.

3.2 | Primary and secondary outcomes

For the primary outcome pain intensity, a significant difference was found between the INFo and EXin groups at 12 months post-surgery for leg pain, in favour of EXin ($p < .033$), NPRS being 2.7 for INFo and 1.8 for EXin. For secondary outcomes, a significant difference was detected at 12 months post-surgery in favour of EXin for functioning

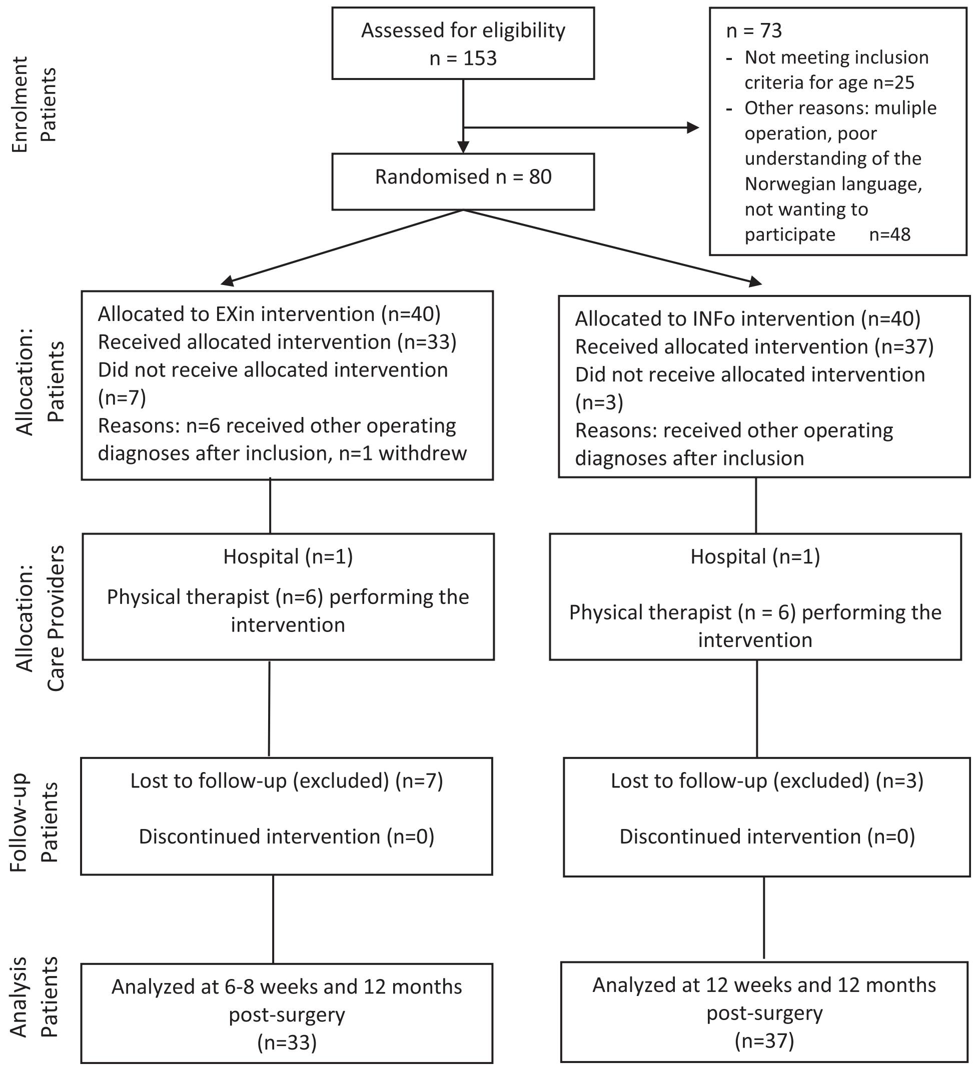

FIGURE 1 Design and participants flow through the trial (modified Consort form)

TABLE 1 Demographic characteristics of the participants

	INFo (*n* = 37)		EXin (*n* = 33)	
Characteristics	**N**	**Value**	**N**	**Value**
Age (year), mean (*SD*)	33	39.4 (10.3)	37	40.2 (10.2)
Female, *n* (%)	33	14 (42.4%)	37	12 (32.4%)
Married, cohabitant, *n* (%)	25	17 (51.5%)	34	26 (70.2%)
Education, *n* (%)	25		34	
Low ≤ 10 years		2 (6.1%)		4 (10.8%)
Middle ≤ 13/14 years		11 (33.3%)		16 43.2%)
High ≥ 15 years		12 (36.4%)		14 (37.8%)
Employed, *n* (%)	25	11 (44%)	34	8 (21.6%)
Smoking, *n* (%)	25	10 (40%)	34	13 (38.2%)
BMI, *n* (*SD*)	25	25.4 (4.4)	34	25.4 (3.0)
Duration radiating pain, *n* (%)	24		33	
< 3 months		4 (12.1%)		8 (21.6%)
3–12 months		16 (48.5%)		11 (29.7%)
>12 months		3 (9.1%)		6 (16.2%)

TABLE 2 Comparison of clinical outcomes in the two treatment groups (INFo and EXin) using linear mixed models

	INFo			EXin			p	
Outcome measures	N	Mean (95% CI)	Response	N	Mean (95% CI)	Response	LME	RR
Pain intensity leg (NPRS)								
Baseline	34	5.8 (5.1. 6.6)	—	24	6.8 (6.1. 7.5)	—	—	—
6–8 weeks	35	2.0 (1.2. 2.8)	19 (54%)	32	2.4 (1.5. 3.3)	17 (53%)	0.412	0.406
12 months	28	2.7 (1.6. 3.7)	16 (57%)	18	1.8 (0.7. 2.9)	15 (83%)	**0.033**	0.127
Pain intensity back-hip (NPRS)								
Baseline	33	5.3 (4.4. 6.2)	—	24	5.6 (4.8. 6.4)	—	—	—
6–8 weeks	35	2.9 (2.1. 3.7)	13 (37%)	32	3.1 (2.2. 4.0)	12 (38%)	0.856	0.638
12 months	28	3.3 (2.2. 4.5)	9 (32%)	18	2.6 (1.6. 3.7)	11 (61%)	0.210	0.126
Functional status (ODI, 0–100)								
Baseline	34	38.1 (32.7. 43.6)	—	25	45.6 (39.8. 51.5)	—	—	—
6–8 weeks	33	17.2 (11.2. 23.1)	21 (64%)	31	15.1 (11.2. 18.9)	18 (58%)	0.051	0.718
12 months	28	17.6 (10.5. 24.7)	19 (69%)	18	13.2 (6.6. 19.7)	14 (78%)	**0.027**	0.694
Kinesiophobia (TSK-13, 13–52)								
Baseline	34	29.7 (27.0. 32.4)	—	29	30.0 (27.9. 32.1)	—	—	—
6–8 weeks	33	28.2 (25.1. 31.2)	—	29	26.9 (24.0. 29.7)	—	0.232	—
12 months	31	27.5 (23.6. 31.3)	—	20	24.4 (22.0. 26.7)	—	0.126	—
Fear avoidance (FABQ, 0–24)								
Baseline	37	13.5 (11.4. 15.5)	—	33	13.2 (11.3. 15.0)	—	—	—
6–8 weeks	32	10.2 (7.8. 12.6)	—	32	8.9 (7.0. 10.8)	—	0.431	—
12 months	30	8.3 (5.8. 10.7)	—	22	9.2 (7.3. 11.1)	—	0.464	—

Abbreviations: FABQ = Fear-avoidance beliefs questionnaire (0 = best score, 24 = worst score); Response, patients with negative change scores ≥ MCIC; LME, linear mixed effect; NPRS, numerical pain rating scale (0 = no pain, 10 = worst pain); RR, response rate; ODI, Oswestry disability index (0 = best score, 100 = worst score); TSK-13, Tampa Scale of Kinesiophobia 13-item version (13 = best score, 52 = worst score).

(ODI) only ($p < .027$), ODI being 17.6 for INFo and 13.2 for EXin. Between-group differences were not found for NPRS back/hip, TSK and FABQ at 12 months post-surgery (Table 2).

Regarding improvement in the two groups post-surgery, 54% of the INFo patients had a CIC response of their leg pain at 6–8 weeks and 57% at 12 months. The equivalent improvement in the EXin was 53% and 83% (see Table 2). For functioning, CIC for INFo was 64% at 6–8 weeks and 69% at 12 months post-surgery. The equivalent improvement values for EXin were 58% and 78%, respectively.

3.3 | Compliance

In EXin, 15 out of 33 participants completed the daily log documenting their compliance with the home-exercises by 50% or more. No significant differences were found in outcomes between patients whether or not they returned their exercise diary or documented less than 50% compliance.

4 | DISCUSSION

The purpose of this study was to analyse two physiotherapy interventions following lumber disc surgery, comparing information alone with standard post-operative exercises. The results indicate that exercise in combination with information gave significantly less pain and improved functioning, compared with those who got information alone; although both groups improved. Our results are in line with other studies suggesting that early post-operative exercise therapy reduces pain and disability. A review by Snowdon and Peiris concluded that early comprehensive physiotherapy, starting 1–15 days after surgery in patients diagnosed with lumbar disc herniation, led to less pain both at 12 weeks and at 12 to 18 months follow-up compared with the control groups. These control groups received no physiotherapy, only education, standard post-operative care, rest or sham physiotherapy interventions (Snowdon & Peiris, 2016).

Success rates after lumbar disc surgery has been reported to be between 91% and 83% 6–120 months after surgery (Findlay et al., 1998). According to the Norwegian Registry for Spine Surgery (NORSpine), improvement in functioning and pain reported in patients that undergo discectomy at KiH (Nasjonalt kvalitetsregister for ryggkirugi, Solberg,, & Olsen, 2017), is consistent with results found in other studies (Oosterhuis et al., 2014).

Previously, it has been difficult to establish to what extent post-operative physiotherapy intervention contributes to the success rate. Muscle function is often impaired after awaiting surgery. Dysfunction in back muscles is not corrected by surgery, implying that exercise has a place in post-surgery treatment. Exercise has been shown to improve disability in patients with LBP (Gordon & Bloxham, 2016). Regarding pain coping mechanisms, it is suggested that rehabilitation-based treatment modalities could restore functioning using physical activity to desensitize and normalize sympathetic feedback in affected limbs (Fishman, Ballantyne, & Rathmell, 2009, pp. 321–322). Addressing inactivity developed as a consequence to pain, early mobilization has also been stressed to avoid further complications and muscular atrophy (Fishman et al., 2009, pp. 321–322; Raastad, Paulsen, Refsnes, Rønnestad, & Wisnes, 2010, pp. 268–277; Waddell, 1998, pp. 290–330). As approximately 20% of patients continue to have LBP after microdiscetomy, it might be important to provide an early increase in a patient's confidence in their ability to exercise and also after the post-surgery exercise programme has ended; keeping active in their daily lives thus improving their health in the long term (Dolan et al., 2000). A positive effect of exercises may explain results in our study, where pain and disability continued to improve at 12 months post-surgery in EXin, whereas in INFo the opposite effect was observed.

Ostelo et al. questioned if all patients should be treated or only those with symptoms 4–6 weeks post-surgery (Ostelo et al., 2003). In a study of outcomes after disc surgery, 36 of 80 patients reported having kinesiophobia 10–34 months after lumbar disc surgery (Svensson et al., 2011). In relation to outcome, patients with kinesiophobia had significantly poorer results in 8 out of 10 outcome measures than those without kinesiophobia. These patients had more pain, were more disabled and depressed, had more catastrophic thoughts and poorer health-related quality of life, compared with those without kinesiophobia (Svensson et al., 2011). Archer et al. suggested early post-surgery screening for fear of movement in those who do not acutely improve after spinal surgery, and that cognitive and behavioural strategies in patients with high fear of movement may be beneficial. In our study, we saw a tendency of a relation between exercise and reduction of kinesiophobia over time; however, it was not statistically significant. Attempting to improve patients outcome post-surgery, identifying patients with kinesiophobia and tailoring individual intervention containing exercise in combination with information, might be one way to improve success rate after surgery and has been suggested by others (Oosterhuis et al., 2014), although further studies are warranted.

Even taken into account a slight difference between the two groups at baseline, the difference was not clinical important. In our study the EXin group improvements in pain and functioning, although significant, did not meet suggested values for CIC at 12 months post-surgery. It has been claimed that in order to prevent misinterpretation of results, RCTs should also present the number of patients in a study that experienced important improvement and not only report mean differences (Guyatt, Juniper, Walter, Griffith, & Goldstein, 1998). Ostelo et al. suggested 30% as a meaningful improvement in ODI and NPRS from baseline to follow-up and could also reflect CIC between groups (Ostelo et al., 2008). In line with this measure, both groups experienced clinical important change (CIC≥30%) from baseline to 6–8 weeks and 12 months follow-up (Table 2). Although EXin had a 26% higher number of patients with clinical important change in leg pain and 9% higher number with CIC of functioning compared with INFo, the results did not meet the threshold of 30% with CIC between the two groups, as suggested by Ostelo et al.

4.1 | Limitations

In this study, physioterapists and patients could not be blinded, and it was emphasized that participants could only be randomized to one of the two interventions. We had no reason to believe that one intervention was better than the other. Randomization and baseline measures took place before surgery. If randomization had been done after surgery, exclusion of patients due to change in technique would not have been necessary. However, informed consent had to be collected when patients were without medication.

This study relied on self-reporting of data only. Having exercise as one of the interventions, physical tests could have strengthened or nuanced the data on functioning. The method of using a written diary to measure compliance has some weaknesses, and a closer control to follow-up of these would have been be favourable as less than half of the participants returned their exercise diaries with more than 50% compliance. It was not known if patients exercised more than they reported, or if those who did not return their exercise diary still followed the EXin protocol. We did not ask the INFo group to keep a diary. That could have provided us with information about how active the INFo group was in comparison with EXin group.

Our study used data from NORSpine regarding post-operative pain and disability status. NORSpine is a government funded clinical registry for quality control and research, collecting patient data from hospitals where spine surgery are performed. In retrospect, as NPRS and ODI had more missing data than the questionnaires collected solely by physiotherapists for this study, all data should have been collected by the project group. Unfortunately, there were more missing data in EXin than in INFo at 12 months follow-up. This might be a statistic challenge in our study as small sample studies are vulnerable to extreme single events (Dworkin et al., 2009).

In conclusion, an RCT was undertaken comparing two interventions, and followed patients for a year after lumbar surgery. Our findings indicate that patients may benefit from doing exercise, which is in line with other studies, suggesting that exercise in combination with information contributes to improvements in pain and disability. However, recommending whether all patients should be enrolled in an exercise intervention after lumbar disc surgery or only those with high fear of movement and kinesiophobia, this study is too small to make strong recommendation for clinical practise.

4.2 | Implications for physical therapy practice

Results regarding leg pain and functioning were statistically significant but did not reach the standard for CIC. Lumbar disc surgery does not repair dysfunction in muscle impaired as a consequence of a prolonged wait for surgery; however, exercise has been shown to improve disability and pain in LBP patients. Providing exercises addresses the inactivity in patients, which may lead to pain, and can additionally help alleviate possible further complications and muscular atrophy. Activity can further provide an early increase in a patient's coping and confidence in returning to daily activities. Recognizing that there can be a close relationship between exercise and a reduction in kinesiophobia, implies that exercise has a place in post-surgical treatment; at least for some. Post-operatively, most patients are in need of information and advice, adding exercise to this consultation is not overly time-consuming or expensive. In line with this, the results show that the current practise of offering post-operative physiotherapy after lumbar disc surgery with exercises in combination with information should still be offered.

This study suggest that modalities aiming on early restoration of functioning and pain reduction, by promoting muscle strength, flexibility and endurance, using exercise in combination with information to influence normalization of daily life activity and desensitizing sympathetic feedback, are warranted. Future studies are needed to investigate which sub-groups have most benefit from post-operative exercise after lumbar surgery.

4.3 | Generalizability

Exercises used in the study are based on collection of post-operative exercises from six different hospitals in Norway. The inclusion criteria used for surgery and for the study population are similar to other hospitals. This implies that results may be valid as post-operative intervention.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ORCID

Eva Saltskår Jentoft https://orcid.org/0000-0003-2734-6741
Vegard Pihl Moen https://orcid.org/0000-0001-7063-0049

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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