Structured postoperative physiotherapy in patients with cervical radiculopathy: 6-month outcomes of a randomized clinical trial

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OBJECTIVE Structured physiotherapy has been suggested as treatment before as well as after surgery to improve clinical outcomes in patients with cervical radiculopathy (CR), but randomized clinical trials to inform evidence-based clinical guidelines for the treatment of patients with CR after surgery are lacking. The aim of this study was to compare the results of structured postoperative physiotherapy combining neck-specific exercises with a behavioral approach to a standard postoperative approach in patients who had undergone surgery for cervical disc disease with CR at 6 months after surgery.

METHODS Patients with cervical disc disease and persistent CR who were scheduled for surgery were randomized preoperatively to structured postoperative physiotherapy (n = 101) or a standard postoperative approach (n = 100). The latter included pragmatic physiotherapy in accordance with the usual Swedish postoperative care. Outcome measures included patient-reported neck disability as measured with the Neck Disability Index (NDI), intensity and frequency of neck and arm pain, global outcome of treatment, and expectation fulfillment, as well as enablement.

RESULTS Patients who received structured postoperative physiotherapy reported greater expectation fulfillment (p = 0.01), and those who attended at least 50% of the treatment sessions reported less neck pain frequency (p = 0.05), greater expectation fulfillment (p = 0.001), and greater enablement (p = 0.04) compared with patients who received the standard postoperative approach. No other difference between treatment groups was found (p > 0.15). The NDI and neck and arm pain intensity were improved in both groups at 6 months after surgery (p < 0.001). Additional use of postoperative physiotherapy was reported by 61% of the patients who received the standard postoperative approach.

CONCLUSIONS The results from this first randomized clinical trial of postoperative physiotherapy showed only minor additional benefit of structured postoperative physiotherapy compared with standard postoperative approach 6 months postoperatively in patients who underwent surgery for cervical disc disease with CR. Patients who received structured postoperative physiotherapy reported higher expectation fulfillment, and many patients in the standard postoperative approach group perceived a need for additional treatments after surgery, suggesting that patients with CR are in need of further postoperative support. The results confirm that neck-specific exercises are tolerated postoperatively by patients with CR, but more studies of postoperative physiotherapy are needed to inform clinical guidelines for this patient group.

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KEY WORDS cervical radiculopathy; postoperative physiotherapy; neck exercises; Neck Disability Index; pain outcomes; enablement

ABBREVIATIONS ACDF = anterior cervical decompression and fusion; CR = cervical radiculopathy; NDI = Neck Disability Index; PCF = posterior cervical foraminotomy; PEI = Patient Enablement Instrument; RCT = randomized clinical trial; SA = standard postoperative approach; SPT = structured postoperative physiotherapy; VAS = visual analog scale.

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CERVICAL radiculopathy (CR) caused by disc disease is a painful and disabling condition characterized by radicular arm pain in combination with neurological impairments in 1 or more affected nerve-root distributions.³ Additionally, neck pain is common,⁴ and the symptoms are often accompanied by physical and psychological disability, absence from work because of health issues, and reduced health and quality of life.⁶

The prognosis of CR is considered to be favorable over time, but patients who report no improvement in symptoms may be referred to surgery.¹ Overall, fair to very good results have been reported with respect to arm pain and neurological symptoms after surgery depending on the outcome measure used and duration of follow-up.^{19,32} The effects on neck function are less clear,^{13,27} and more extensive and structured physiotherapy has been suggested as necessary to improve clinical outcomes regarding persistent activity limitations and participation restriction as well as impairments in neck-related physical function in CR patients after surgery.^{13,14,27} Structured physiotherapy combining neck-specific exercises with a behavioral approach may be suggested as treatment for patients with CR before as well as after surgery.^{7,26} How well patients with CR can tolerate a more active approach is unknown, and loading of the cervical spine in exercises had been questioned by clinicians. The proportion of CR patients who seek additional physiotherapy after surgery is unknown as well. Randomized clinical trials (RCTs) of postoperative physiotherapy to inform evidence-based clinical guidelines for the treatment of patients who have undergone surgery for cervical disc disease with CR are lacking.¹

The aim of the present prospective RCT was to compare structured postoperative physiotherapy combining neck-specific exercises with a behavioral approach to a standard postoperative approach in patients who underwent surgery for cervical disc disease with CR.

Methods

Design

This study was a multicenter parallel group RCT (January 2010–December 2014) with a 1:1 allocation ratio and a blinded assessor to collect the outcome measures. The study was approved by the regional ethical review board, performed according to the Declaration of Helsinki, and registered with clinicaltrials.gov (registration no.: NCT01547611), and the study protocol was published.²⁵ The study was reported according to the Consolidated Standards for Reporting of Trials (CONSORT) guidelines.²²

Participants

Patients who had persistent CR symptoms and clinical findings compatible with disc disease verified on MRI and who were scheduled for surgery were recruited from 4 spinal centers in Sweden. The eligibility criteria for the study are described in Table 1. Patients were given oral and written information about the study. A total of 202 patients (mean age 50 years, SD 8.4 years; 105 men and 97 women) with a median duration of symptoms of 12 months (range 2–288 months) were included after providing informed consent. The patients were randomized preoperatively

TABLE 1. Eligibility criteria for participation in the study

Inclusion Criteria	Exclusion Criteria
Age 18–70 yrs	Previous cervical surgery
Presenting w/ persistent symptoms of CR of at least 2 mos' duration	Fracture or traumatic subluxation of cervical column
Clinical findings compatible w/ MRI-verified cervical disc disease	Myelopathy
Referred for surgery btwn February 2009 & November 2012 at one of 4 spinal centers in the south of Sweden	Malignancy or spinal tumor
	Spinal infection
	Any systemic disease implying a contraindication to rehabilitation
	Fibromyalgia or generalized myofascial pain, persistent or recurrent severe back pain
	Diagnosed mental disorder
	Known drug or alcohol addiction
	Not being fluent in the Swedish language

by the central project leader to receive either structured postoperative physiotherapy (SPT group) or a standard postoperative approach (SA group) (Fig. 1). The central project leader was not involved in any of the treatments or measurements but was in contact with the physiotherapists working with the SPT group. Simple randomization was performed using a random computer list developed by an independent statistician.

Surgery

The surgical procedures included anterior cervical discectomy and fusion (ACDF) (n = 163) or posterior cervical foraminotomy (PCF) with or without laminectomy (n = 38) in accordance with current clinical practice at the 4 spinal centers. Cages filled with bone substitute or autologous bone collected during decompression were used to fuse the segment after the disc and osteophyte(s) were removed in 1-level ACDF (n = 99). In 2-level (n = 62) and 3-level (n = 2) fusions, an anterior plate was added in most cases to achieve primary stability. Each spinal center used cages that were standard for that center. No iliac crest graft was taken. PCF was performed at 1 level (n = 7), 2 levels (n = 15), or 3 or more levels (n = 16) without fusion. One patient was excluded from the study because of a cancelled surgery (Fig. 1).

Standard Initial Postoperative Care at the Spinal Centers

During the first 6 weeks after surgery, the same initial postoperative regimen was applied in all cases (Fig. 1). The patients were given advice about good posture and ergonomics, information about movements and tasks to avoid during the first postoperative weeks, and instructions about mobility exercises for the shoulders (Fig. 2). The postoperative regimen included no neck collar in both groups. At 6 weeks after surgery, patients returned to the spinal center for a routine visit to the surgeon and at the same time received instructions from the physiotherapist about mobility exercises for the neck (Fig. 2). No more visits to the spinal center were planned after that.

Interventions

Structured Postoperative Physiotherapy

Six weeks postoperatively, patients randomized to the

FIG. 1. Patient flow diagram for study inclusion. Analyses were performed in complete-case and per-protocol approaches (comparing patients in the SPT group with at least 50% attendance at treatment sessions with patients who received the standard postoperative approach).

SPT group were referred to a physiotherapist working in primary care settings in their neighborhood area who was introduced to the study by the project leader through written and oral communication and a half day of practical training. Physiotherapists were recruited on a geographic basis near the patients' home. Structured postoperative physiotherapy included progressive, specific exercises for the neck muscles combined with a cognitive-behavioral approach to address pain and stress management (Fig. 2) and was based on evidence for the management of other

neck pain disorders.^{11,23} Within a structured standardized frame, the neck-specific exercises started with nonresistance exercises aimed at activating the deep muscles in the neck. Patients then progressed at individually determined rates to isometric and resistance exercises to improve neuromuscular control and endurance of the neck muscles¹⁸ (Fig. 2). Patients also performed resistance exercises for the shoulder and trunk muscles (Fig. 2). The cognitive-behavioral approach included a behavioral analysis of patient problems for goal setting and strategies to increase

FIG. 2. Summary of standard initial postoperative care at the spinal centers, structured postoperative physiotherapy (SPT), and the standard postoperative approach (SA).

self-efficacy as well as coping strategies (Fig. 2).²⁵ The rehabilitation continued for a maximum of 20 weeks, and patients visited the physiotherapist once a week from postoperative Week 6 to Week 12 and twice a week thereafter. Patients were also advised to perform home exercises that were registered in an exercise diary, and the physiotherapists gave feedback on performance during their weekly meetings with the patients. At discharge, patients were encouraged to continue with their home exercises as well as to increase their overall activity level (Fig. 2). Patient adherence rate to treatment sessions was reported by the physiotherapists in the study. Because of the nature of the treatment, neither the patients nor the physiotherapists were blinded.

Standard Postoperative Approach

The standard postoperative approach from 6 weeks after surgery on was in accordance with Swedish usual postoperative care; patients who felt that they needed additional help were advised to contact their primary health care center for additional treatments, which may have included physiotherapy when needed (Fig. 2). Physiotherapy treatments were pragmatic and not specially designed for the study. The proportion of patients in the SA group who reported additional use of postoperative physiotherapy was recorded.

Data Collection

Patients completed a preoperative questionnaire that included questions about sociodemographic variables and patient-reported outcome measures, and then they were asked to complete a set of questionnaires at 6 weeks and 3 and 6 months after surgery. This report presents the results of 2 rehabilitation programs. The primary outcome was the Neck Disability Index (NDI) score, and the secondary outcomes were pain intensity and pain frequency in the neck and the arm, global outcome of treatment, expectation fulfillment, and patient enablement.²⁵

The results for other collected measures²⁵ will be presented later. The questionnaires were sent by postal mail and collected by an independent investigator blinded to the randomization. Reminders were sent to patients who did not return the questionnaire initially and after the patient was considered lost to follow-up. Details about the surgical methods and levels of surgery were collected from medical journals.

Background Variables

Sociodemographic variables and surgical data for the randomization groups included age, sex, duration of neck and arm pain in months, smoking (yes/no), health-related

absence resulting from the symptoms (yes/no), use of preoperative neck-related physiotherapy treatments during the last year (yes/no), ACDF versus PCF, and number of operated levels (Table 2).

Outcome Measures

Primary Outcome

The primary outcome of patient-reported neck disability was measured by the NDI.^{29,31} Patient scores on 10 items, including pain intensity, personal care, lifting, sleeping, driving, recreation, headaches, concentration, reading, and work, were summed up to a total score expressed as a percentage, with a higher score indicating a higher degree of disability.

Secondary Outcomes

Assessment of pain included an evaluation of the intensity of current neck and arm pain using a visual analog scale (VAS) (0–100 mm), where 0 represented “no pain” and 100, “the worst imaginable pain.”²⁵ The frequency of neck and arm pain was assessed on a 5-point scale (1 = never, 2 = sometimes, 3 = several times per week, 4 = daily, and 5 = always), and the scores were dichotomized into either daily symptoms (4–5 points) or occasional symptoms (1–3 points). The global outcome was rated on a 6-point ordinal scale that ranged from “complete recovery” to “much worse,” and the answers were dichotomized into substantial improvement (complete recovery or much better) and no or little improvement (better, unchanged, worse, or much worse).¹⁶ The extent to which participants’ expectations for treatment were fulfilled was assessed with the question: “Have your expectations for rehabilitation been fulfilled?” The allowed answers were “yes,” “partially,” and “no.” The Patient Enablement Instrument

(PEI)²⁸ was used to evaluate the extent to which participants felt enabled and empowered as a result of receiving treatment. The PEI is a 6-item scale that has been used to evaluate quality of care in general practice.¹⁷ The highest possible score is 12, with higher scores indicating greater enablement.

Statistical Analysis

The required sample size was determined based on preliminary findings for the NDI in a previous study that compared structured physiotherapy alone with surgery combined with structured postoperative physiotherapy for patients with CR.⁷ An expected 10% between-group difference in the primary outcome of NDI (mean 27, SD 18) with an α level of 5% and a power goal of 80% resulted in 60 patients being required for each treatment arm. To allow for dropouts, a total of 202 patients were recruited.²⁵ Descriptive statistics are reported as mean and SD, median and interquartile range, or proportions. Preoperative between-group differences were analyzed with parametric or nonparametric statistics depending on the data level. All patients with follow-up data at 6 months were included in a complete case analysis. In a per-protocol approach only patients in the SPT group with a treatment-session attendance rate of more than 50% (SPT $\geq$ 50%) were included in the analysis. When no more than 1 item was missing in the NDI, the missing value was substituted by the average item score of the questionnaire for that participant; otherwise, the participant was excluded from the analysis. The differences in outcome measures between the treatment groups as determined at the 6-month follow-up assessment were analyzed using the independent t-test, the Mann-Whitney U-test, or the chi-square test, depending on the data level. Differences between the treatment groups

TABLE 2. Background variables for the 201 patients with CR included in the study

Variable	SPT Group (n = 101)		SA Group (n = 100)		p Value
	No. of Pts	Value	No. of Pts	Value	
Age in yrs, mean (SD)	101	50 (8.2)	100	50 (8.7)	0.70
Male sex, n (%)	101	51 (51)	100	54 (54)	0.62
Duration of neck pain in mos	84		89		0.03
Median		18		12	
IQR		10–36.5		8–24	
Duration of arm pain in mos	84		82		0.02
Median		15		12	
IQR		10–36		7–19	
Smoking, n (%)	98	24 (25)	96	25 (26)	0.80
Health-related absence from work due to neck/arm symptoms, n (%)	92	52 (57)	86	48 (56)	0.92
Preop neck-related PT treatments during the last yr, n (%)	95	63 (66)	92	61 (66)	0.99
ACDF, n (%)	101	77 (76)	100	86 (86)	0.08
No. of operated levels, n (%)	101		100		0.58
1		56 (55)		50 (50)	
2		35 (35)		42 (42)	
$\geq$ 3		10 (10)		8 (8)	

IQR = interquartile range; SA = standard postoperative approach; SPT = structured postoperative physiotherapy.

Boldface type indicates statistical significance. Group comparisons used independent t-test, Mann-Whitney U-test, or chi-square test depending on the data level.

in terms of changes in the NDI and changes in VAS scores for neck and arm pain before surgery versus 6 months after surgery were analyzed with repeated-measure analysis of variance (ANOVA) with the Greenhouse-Geisser correction, depending on sphericity. The statistical software package SPSS version 22.0 (IBM Corp.) was used for all analyzes, and the significance level was set at $p \leq 0.05$.

Results

Differences Between Treatment Groups at 6 Months' Follow-Up

At 6 months after surgery, patients in the SPT group reported higher expectation fulfillment ($p = 0.01$) than patients in the SA group. No other differences between treatment groups were found in the complete case analysis ($p = 0.21$ to $p = 0.82$). In a per-protocol approach, patients in the SPT group who attended at least 50% of treatment sessions were found to report less neck pain frequency ($p = 0.05$), higher expectation fulfillment ($p = 0.001$), and greater enablement ($p = 0.04$) at the 6-month follow-up evaluation than patients in the SA group. There were no other differences between the treatment groups using a per-protocol approach ($p = 0.15$ to $p = 0.58$). Descriptive statistics for the outcome measures in the treatment groups are presented in Tables 3 and 4.

Between-Group Comparison of Changes in the NDI and VAS Pain Scores

There was no between-group difference in changes in the NDI scores and VAS scores for neck and arm pain from before surgery to 6 months after surgery in a complete case analysis ($p > 0.43$) or a per-protocol approach ($p > 0.44$). The NDI and VAS neck and arm pain scores improved significantly from before surgery to 6 months after surgery in both groups ($p < 0.001$).

Treatment Groups at Baseline and Patients Lost to Follow-up

Patients randomized to SPT had a longer preoperative duration of neck and arm pain ($p = 0.02$ to $p = 0.03$) and a higher frequency of arm pain symptoms ($p = 0.05$) compared with patients randomized to SA (Tables 2 and 3). No other differences between the treatment groups were found at baseline ($p = 0.08$ to $p = 0.99$). No differences were found between the treatment groups at baseline using a per-protocol approach ($p = 0.09$ to $p = 0.82$). Patients lost to follow-up (15%) for the primary outcome (i.e., NDI) did not differ in terms of background variables and outcome measures at baseline from patients who were followed up ($p = 0.06$ to $p = 0.78$), except for significantly worse scores on the NDI ($p = 0.004$) and a lower rate of PCF (7% vs 21%, $p = 0.05$).

Treatment-Session Attendance in the SPT Group

The physiotherapists in the study reported a treatment-session attendance rate of 50% or more in 67% of the patients who received SPT (SPT $\geq 50\%$, $n = 67$, mean age 51 years, SD 8.2 years; 33 men and 34 women). Lack of time and difficulties with absences from work for training ($n =$

TABLE 3. Neck disability and pain before surgery and at 6 weeks and 3 and 6 months after surgery

Variable	Preop			6 Wks Postop			3 Mos Postop			6 Mos Postop		
	SPT	SPT $\geq 50\%$	SA	SPT	SPT $\geq 50\%$	SA	SPT	SPT $\geq 50\%$	SA	SPT	SPT $\geq 50\%$	SA
NDI												
No. of patients	97	63	95				91	65	79	89	64	81
Mean (SD)	42.4 (15.1)	40.8 (15.9)	43.3 (15.3)				30.6 (18.1)	28.0 (16.8)	27.0 (16.0)	24.5 (18.5)	20.4 (16.2)	22.3 (17.3)
Neck pain VAS												
No. of patients	99	65	97	94	63	88	91	64	82	90	65	82
Mean (SD)	56.1 (25.3)	55.1 (25.3)	56.7 (23.5)	29.2 (24.4)	24.8 (20.9)	26.5 (24.1)	24.9 (24.3)	21.9 (23.4)	22.0 (24.3)	21.5 (25.4)	19.1 (25.0)	22.8 (25.4)
Arm pain VAS												
No. of patients	99	65	94	94	63	87	90	63	80	89	65	79
Mean (SD)	53.3 (27.1)	52.4 (27.7)	47.5 (29.4)	23.0 (25.5)	22.0 (25.4)	20.9 (26.4)	21.5 (25.3)	19.4 (23.3)	17.7 (24.3)	17.3 (23.9)	12.8 (19.8)	18.2 (25.2)
Frequency of symptoms												
No. of patients	96	63	96				92	65	80	89	65	82
Daily neck pain, %	92	92	91				49	46	46	33	26	42
Daily arm pain, %	89	89	78				36	35	26	37	32	28

TABLE 4. Global outcome of treatment, expectation fulfillment, and patient enablement at 6 months after surgery

Variable & No. of Patients	SPT	SPT ≥50%	SA
Global outcome			
No. of patients	89	64	80
"Substantial improvement," %*	60	67	56
Expectation fulfillment			
No. of patients	90	65	80
Yes, %	62	71	43
Partial, %	28	23	41
No, %	10	6	16
PEI†			
No. of patients	79	56	66
Median	6.0	7.0	5.0
IQR	2–9	4–11	1–8

* Includes patients who reported being completely recovered or much better.

† Score range 0–12.

19), not starting the intervention for unknown reasons ($n = 10$), and missing reports for attendance rates ($n = 5$) were the reasons for excluding 34 patients (mean age 48 years, SD 8.1 years; 18 men and 16 women) in the per-protocol approach (Fig. 1). No difference was found between the patients excluded in the per-protocol approach and the SPT $\geq 50\%$ subgroup with respect to background variables or outcome measures at baseline ($p = 0.11$ to $p = 0.71$), except that there were more smokers among those who were excluded (41% vs 16%, $p = 0.005$). No serious adverse event during rehabilitation was reported.

Additional Use of Postoperative Physiotherapy in the SA Group

Additional use of postoperative pragmatic physiotherapy was reported by 61% ($n = 47$) of the patients who were followed up in the SA group.

Discussion

This RCT is the first to investigate the additional benefit of structured physiotherapy compared with a standard pragmatic approach in patients who have undergone surgery for cervical disc disease with CR. Except for higher expectation fulfillment in patients who received structured physiotherapy, no between-group differences in outcome measures were found at the 6 months' postoperative follow-up. In a per-protocol approach, patients in the SPT group who attended at least 50% of the treatment sessions (SPT $\geq 50\%$) reported less neck pain frequency, higher expectation fulfillment, and greater enablement at the 6-month follow-up assessment compared with patients in the SA group. Moreover, there was a tendency for global outcome and frequency of neck pain to improve more in SPT group during the postoperative period. The importance of supervised treatment sessions for perceived treatment effects has been suggested previously in physiotherapy.¹² Global outcome has been suggested to reflect patients' judgment of the clinical importance of their changes;⁹ thus this result may reflect changes in domains that are important to

the patients following structured physiotherapy that may not have been captured by the other outcome measures.⁸ The long-term effects on future health care utilization of reported greater enablement in patients who received structured physiotherapy should be investigated in future studies.

No differences were found between the treatment groups for patient-reported neck disability and pain intensity in the neck and the arm at the 6-month follow-up using either a complete case analysis or a per-protocol approach. Large improvements in the NDI and VAS neck and arm pain were observed in both groups at 3 months compared with older studies,^{13,27} suggesting improved surgical techniques and patient selection for surgery. Consequently, there may have been limited potential for physiotherapy to further improve NDI and VAS outcomes in the immediate postoperative period. Six months after surgery, 26% of the patients in the SPT group and 27% of the patients in the SA group were classified as having no disability (NDI score $< 8\%$).²⁰ A floor effect in the NDI has been suggested to occur when $\geq 15\%$ of participants achieve the lowest score,²¹ and the responsiveness of the NDI to detect changes in the postoperative period is somewhat controversial.^{15,30}

Structured physiotherapy that combines neck-specific exercises with a behavioral approach has been suggested previously as treatment for patients with cervical disc disease and CR preoperatively as well as after surgery during postoperative rehabilitation.^{7,26} The results of this study confirm that patients with CR tolerate neck-specific exercises after surgery and improve over time. In addition, there was a tendency for a slightly better outcome in some variables for patients attending structured physiotherapy sessions compared with those who were offered the option of additional pragmatic therapy as part of a standard approach. The idea that CR patients will tolerate neck-specific training after surgery has been controversial among surgeons and physiotherapists. The results of the present study provide important and new information for the development of a more active and specific rehabilitation approach that hopefully may benefit CR patients in the future. More research within this area is needed. Moreover, more than half of the patients in the SA group reported the additional use of postoperative physiotherapy at 6 months' follow-up. This result suggests that many CR patients perceived a need for additional treatment after surgery, probably because of persistent symptoms, and that more studies are needed to inform evidence-based clinical guidelines for the postoperative treatment of CR patients. However, these patients constitute a heterogeneous group, which includes different subgroups. This may explain why it is difficult to obtain statistically significant and clinically important between-group differences in an RCT of postoperative physiotherapy. More individualized physiotherapy might be needed, and treatment-based approaches may have better effects than a standardized package. In a treatment-based approach those with greater needs after surgery can be identified and offered targeted interventions.

Strengths and Limitations

This first RCT of postoperative physiotherapy in pa-

tients with CR had a pragmatic design with the objective of improving external validity as well as generalizability of the results. The involved physiotherapists were recruited on a geographic basis to facilitate patient access to rehabilitation. Larger treatment effects might have been observed with physiotherapists who specialized in musculoskeletal disorders. This would, however, have compromised the generalizability of the results.

Loss of patients to follow-up and missing data are limitations of RCTs.¹⁰ In the present study, the attrition rate for the primary outcome of NDI at follow-up (15%) was considered satisfactory. According to standard ethical principles of the Declaration of Helsinki, participation in the study was voluntary, and patients were informed at inclusion that they could discontinue their participation at any time during the study period. Significantly higher scores on the NDI were reported at baseline for the patients lost to follow-up, and future studies should investigate the reasons why some patients decline further participation in rehabilitation studies. The exact effect on the results stemming from this potential bias is uncertain. However, the patients who were lost to follow-up did not differ significantly between randomization groups and they were considered not to have influenced the studied between-group differences. A number of patients in the SPT group either did not start or interrupted the rehabilitation intervention because of problems getting time off from work for rehabilitation once they returned to work. However, 67 patients had a training-session attendance rate of 50% or more, which could be considered a good rate of attendance and supported the per-protocol analyses.

The sample size estimation used in this study was based on preliminary findings for the NDI scores in a previous study.⁷ According to the power analysis, a sample size of 60 participants in each group would be enough to detect a 10% between-group difference in the primary outcome variable. However, the probability of detecting a 10% between-group difference in the NDI at 6 months after surgery was questionable, considering that only small changes in the NDI were observed in both groups during the postoperative period. The responsiveness of the NDI to clinically relevant postoperative changes in CR patients may be limited by a potential floor effect in the outcome measure. Thus, the ability for further studies to demonstrate benefits of postoperative physiotherapy may depend on the outcome measure. The preoperative NDI score was comparable to those of other reports,^{7,27} suggesting that the sample was representative of patients with CR undergoing surgery.

The difference between randomization groups in neck and arm symptom duration at baseline occurred by chance, and the influence of symptom duration on postoperative outcomes is not clear.^{2,24} In the present study, symptom duration at baseline was not associated with any outcomes at 6 months ($p = 0.09$ to $p = 0.80$), except for a significant but very weak association between arm symptom duration at baseline and the NDI score at 6 months (Spearman correlation $r = 0.17$, $p = 0.05$).

Despite its limitations, the present study is unique in that it is the first RCT to investigate postoperative rehabilitation strategies after surgery for CR caused by cervical

disc disease. Earlier studies^{13,14,27} reported that up to two-thirds of patients have remaining neck-specific disability and low health-related quality of life after surgery for CR. Thus, the present study is of great clinical importance, since it confirms^{7,26} that patients with CR can tolerate the neck-specific exercises that are recommended for other patients with neck pain.¹¹ New information—that as many as 61% of the CR patients in the usual care group sought additional physiotherapy—is also presented.

Conclusions

In this first RCT of postoperative physiotherapy in patients who have undergone surgery for cervical disc disease with CR, no additional benefit of structured physiotherapy compared with a standard postoperative approach was reported at 6 months after surgery based on patient-reported measures of neck disability, pain, global outcome, or enablement after treatment. Nevertheless, patients who received structured physiotherapy reported greater expectation fulfillment 6 months after surgery compared with patients who received the standard approach, and in a per-protocol analysis, patients in the structured physiotherapy group with a training-session attendance rate of 50% or more reported less frequent neck pain, greater expectation fulfillment, and greater enablement compared with patients in the standard approach group. Many patients in the standard approach group reported additional use of postoperative physiotherapy 6 months after surgery, suggesting that patients who have undergone surgery for cervical disc disease with CR perceive a need for additional postoperative treatment. The results confirm that patients who undergo surgery for cervical disc disease with CR can tolerate neck-specific exercises after surgery, but more studies are needed to inform evidence-based clinical guidelines for the postoperative treatment of these patients.

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Disclosures

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Author Contributions

Conception and design: Öberg, Löfgren, Zsigmond. Acquisition of data: Wibault, Dederer, Löfgren, Zsigmond, Peolsson. Analysis and interpretation of data: Wibault, Peolsson. Drafting the article: Wibault, Peolsson. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Statistical analysis: Wibault, Peolsson. Funding: Wibault, Peolsson.

Supplemental Information

Previous Presentations

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