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Linköping University Post Print



N.B.: When citing this work, cite the original article.

The original publication is available at www.springerlink.com:

Johanna Wibault, Birgitta Öberg, Åsa Dedring, Håkan Löfgren, Peter Zsigmond, Liselotte Persson and Anneli Peolsson, Individual factors associated with neck disability in patients with cervical radiculopathy scheduled for surgery: a study on physical impairments, psychosocial factors, and life style habits, 2014, European spine journal, (23), 3, 599-605.

<http://dx.doi.org/10.1007/s00586-013-3066-0>

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<http://www.springerlink.com/?MUD=MP>

Postprint available at: Linköping University Electronic Press

<http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-105506>

Individual Factors Associated with Neck Disability in Patients with Cervical Radiculopathy Scheduled for Surgery – a Study on Physical Impairments, Psychosocial Factors, and Life Style Habits

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ACKNOWLEDGEMENT

The authors acknowledge financial support from The Swedish Research Council, The Swedish Society of Medicine, and the Medical Research Council of Southeast Sweden, and thanks Henrik Magnusson and Karl Wahlin at the University of Linköping in Sweden for their help with the statistics.

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ABSTRACT

Purpose: The influence of individual factors on patient -reported outcomes is important in the interpretation of disability and treatment effectiveness. The purpose of this study was to assess how physical impairments, psychosocial factors, and life style habits were associated with neck disability based on the Neck Disability Index (NDI), in patients with cervical radiculopathy scheduled for surgery.

Methods: This cross -sectional study included 201 patients (105 men, 96 women; mean age 50 years). Data included self -reported measures and a clinical examination. Multiple linear regressions were performed to identify significant influencing factors.

Results: Pain, physical impairments in the cervical active range of motion, low self -efficacy, depression and sickness -related absences explained 73 % of the variance in NDI scores ($p < 0.001$).

Conclusion: Assessments of physical impairments and psychosocial factors in patients with cervical radiculopathy could improve the description of neck disability and the interpretation of treatment outcomes in longitudinal studies.

KEY WORDS

Cervical Spine, Radiculopathy, Neck Disability Index, Individual factors, Multiple regression analysis

INTRODUCTION

The effects of surgery on patients with cervical radiculopathy caused by disc disease vary from good to fair depending on the outcome measures used [1-5]. Recently, patient -reported outcome measures that integrate the patient's perspective on disability and functioning have increasingly become the standard for evaluating treatment effectiveness in spine surgery [6].

The Neck Disability Index (NDI) is recommended for patients with cervical radiculopathy [7], and studies have shown that patients reported residual neck disability after surgery [2,4]. Other predictor studies have reported that preoperative patient -reported neck disability scores on the NDI were important for the outcome of surgery in patients with cervical radiculopathy [8-10]. However, patient -reported outcomes integrating several domains are complex to interpret, and few proposals have been offered on how to implement those results into clinical practice [8,9].

A better understanding of how individual factors influence patient -reported disability outcomes is needed as this influence may be critical in the interpretation of disability scores and evaluation of treatment effectiveness. No study has addressed this issue in patients with cervical radiculopathy scheduled for surgery.

The aim of the present study was to assess how physical impairments, psychosocial factors, and life style habits might be associated with patient -reported neck disability in patients with cervical radiculopathy scheduled for surgery.

MATERIALS AND METHODS

Design and participants

This study was a cross-sectional analysis of baseline data from patients with cervical radiculopathy scheduled for surgery. Patients were recruited at four Hospitals in Sweden, between 2009 and 2012, to participate in a prospective, randomized clinical trial designed to compare two postoperative rehabilitation interventions. Inclusion criteria were age 18 to 70 years, cervical radiculopathy symptoms for a minimum of 2 months, and concordant nerve root compression visualized on magnetic resonance imaging (MRI). Exclusion criteria were previous cervical surgery, a previous fracture or luxation of the cervical spine, myelopathy, malignancy or spinal tumor, systemic disease, diagnosis of fibromyalgia or generalized myofascial pain, persistent or recurrent severe back pain, diagnosed psychiatric disorders, alcohol or drug addiction, and lack of familiarity with the Swedish language. The study was approved by the regional ethical review board (Dnr- M126-08). After providing informed consent, a total of 201 patients were included (Table 1). Data was collected from a questionnaire that included patient-reported measures and from a clinical examination performed on the day before surgery by four trained physiotherapists, one at each of the four hospitals.

Neck disability outcome

The primary outcome was patient-reported neck disability evaluated with the NDI [11]. Ten items were measured including pain intensity, personal care, lifting, sleeping, driving, recreation, headaches, concentration, reading and work. Items were scored 0 to 5, and scores were summed to a total score expressed as a percentage. Higher scores represented a higher degree of neck disability (Table 1).

Physical impairments

Pain and symptoms

Pain intensity was measured with a visual analogue scale (VAS) ranging from 0 (no pain) to 100 mm (unbearable pain) [12]. Average neck pain, arm pain, and headache were based on the patient rating of their maximal and minimal pain intensity during the past week (Table 1). Duration of neck and arm pain was reported in months (Table 1). The symptom frequencies for neck pain, arm pain, headache, hand numbness, hand

weakness, neck stiffness, and dizziness/ unsteadiness were assessed on a 5 -point scale from 1 (never) to 5 (constant symptoms). Scores were dichotomized into occasional (1-2) or daily symptoms (3-5) (Table 1).

Clinical examination

The neurologic examination included a bilateral assessment of sensibility with a pin prick and a light touch in dermatomes C4-C8; motor function was assessed with manual muscle testing of the C4- C8 myotomes; and reflexes for C5, C6, and C7 were tested with a standard reflex hammer [13]. Any abnormal response or asymmetry in at least one of the tested dermatomes, myotomes, or reflexes was classified as an impairment or asymmetry in sensibility, motor function, or reflexes (Table 1). Bilateral hand grip strength was measured in kg with a Jamar isometric hydraulic hand dynamometer (Sammons Preston, Inc., Bolingbrook) [2]. The percentage difference (imbalance) in hand grip strength between sides was estimated (Table 1).

The cervical active range of motion (AROM) was measured in the sagittal, transversal, and frontal planes of movement with a cervical range of motion (CROM) device (Performance Attainment Associated, Roseville, MN) [2] (Table 1).

Neck -muscle endurance (NME) was evaluated in the supine position for the cervical anterior muscles and in the prone position for the cervical posterior muscles with a 2 kg weight for women and a 4 kg for men [3,14]. Patients loaded their neck in the standardized positions and time was reported in seconds (Table 1).

Psychosocial factors

Patient attitudes and beliefs

Three subscales of the Swedish version of the Coping Strategy Questionnaire [15] were used to assess the patient's current use of coping strategies. The pain catastrophizing subscale (CAT-CSQ; scores 0 - 36) [16] evaluated the use of negative thinking as a reaction to pain; higher scores represented higher levels of pain catastrophizing. The two other subscales (scores 0 - 6) evaluated the patient's belief in their control over pain

and their ability to decrease pain; higher scores represented more perceived control over pain and ability to decrease pain (Table 1).

Self-efficacy was measured with the Self-Efficacy Scale (SES; total score 0-200) [17] which comprised a patient's self-rating of how confident they felt about performing 20 daily activities, despite their pain (scale: 0 = not at all confident; 10 = very confident). Lower scores represented low confidence in performing activities (Table 1).

Recovery expectation [18] was measured on a 4-point scale (1 = expected to be completely restored to 4 = no expectations of recovery or relief); these answers were dichotomized into high (1-2) and low (3-4) recovery expectations (Table 1).

Symptom satisfaction [19] was assessed with the question "How would you feel about having your current symptoms for the rest of your life", on a 7-point scale (1 = delighted to 7 = terribly unhappy); these answers were dichotomized into high (1-3) and low (4-7) symptom satisfaction (Table 1).

Emotional responses

Depression was evaluated with the Modified Self-rating Depression Scale (Zung) [20], which included 23 items and scores of 0 – 69; higher scores were indicative of depressed moods (Table 1).

Somatic anxiety was evaluated with the Modified Somatic Perception Questionnaire (MSPQ) [21], which included 22 items and scores of 0 – 39; higher scores were indicative of a higher level of somatic anxiety (Table 1).

Social factors

Perceived support from relatives and sickness-related absences (full or partial) due to arm/ neck symptoms were assessed on a yes/no scale (Table 1).

Life style habits

Smoking was recorded as yes/no. Patients were also asked to report their daily physical activity and weekly habits of exercise, sports, and open-air activities during the preceding 12 months. Answers to these questions were combined and interpreted on the basis of a 4 -point scale (1= inactivity to 4= high activity) [14]. Then, scores were dichotomized into physically active (3- 4), or physically inactive (1-2) (Table 1).

Statistical methods

Descriptive data for the study population was presented as means and standard deviations, medians and interquartile ranges, or proportions (Table 1). When no more than one item was missing in the NDI or SES, and two items in the Zung or MSPQ, the values were substituted with transformed scores; otherwise participants were omitted from the analysis (Table 1). The study of the associations between the independent variables with Durbin- Watson values, variance inflation factors, and tolerances suggested no multicollinearity and that the assumptions of independent errors were met [22]. Variables were arbitrary grouped and exploratory stepwise linear regressions were conducted to assess associations between NDI scores and variables relating to pain and symptoms, clinical examination, patient´ attitudes and beliefs, emotional responses, social factors, and lifestyle habits, after controlling for the influences of sex and age [23]. The adjusted coefficient of determination (Adj. R^2) was used to compare models. Significant factors ($p < 0.05$) were presented with B coefficients, standard errors, and p -values (Table 2). The final model included all the factors identified in the first step and was based on 156 participants. Beta coefficients were presented to compare the influence between factors (Table 3). Analyses were performed with the IBM SPSS statistics 20 program.

RESULTS

Physical impairments associated with higher NDI scores included daily neck pain, daily dizziness/ unsteadiness, high intensity of neck pain and headache scored on the VAS ($p < 0.001$, $R^2 = 0.56$); reduced cervical AROM in the transversal plane, and NME in flexion ($p < 0.001$, $R^2 = 0.15$) (Table 2). Psychosocial factors associated with higher NDI scores included low score on the SES, low symptom satisfaction, high pain catastrophizing ($p < 0.001$, $R^2 = 0.54$); depressed moods and somatic anxiety as scored on the Zung and the MSPQ ($p < 0.001$, $R^2 = 0.37$); and sickness -related absences due to arm/ neck symptoms ($p < 0.001$, $R^2 = 0.14$) (Table 2). Life style habits were not associated with NDI scores. The final model included both physical impairments and psychosocial factors and explained 73 % ($p < 0.001$) of the variation in NDI scores. Score on the SES emerged as the strongest factor (Table 3).

DISCUSSION

This study showed that some physical impairments and psychosocial factors including pain, impairments in the cervical active range of motion, low self- efficacy, depression and sickness- related absences were associated with NDI scores in individuals with cervical radiculopathy scheduled for surgery, but not sex or age. Our model explained 73 % of the variance in NDI scores; this may be regarded as a strong model. The results may be related to the number and spread of the variables included in the analysis, as well as the explorative approach. In comparison another model for patients with chronic neck pain explained only 37 % of the variance in NDI scores [23].

The independent variables entered in the analysis were selected based on results from previous studies in patients with cervical radiculopathy [3,8,9] and chronic neck pain [23,24]. Our results highlighted the importance of the factors identified for explaining neck disability in patients with cervical radiculopathy; moreover, they highlighted the quality of the NDI for integrating a broad patient perspective. Thus, the quantification of physical impairments and psychosocial factors associated with NDI scores improved the description of neck disability in patients with cervical radiculopathy.

We showed that depressed moods scored with the Zung were significantly associated with NDI scores of patients with cervical radiculopathy. Psychological distress was previously reported to remain unchanged after surgery [2], and it was considered a predictor of poor outcome [8]. Moreover, psychological distress was suggested to have a confounding effect on the interpretation of NDI scores in individuals with neck pain; this gave rise to questions regarding the validity and sensitivity of the NDI for evaluating treatment effectiveness [25]. It was suggested that treatment effectiveness might be evaluated more objectively by basing it solely on changes in NDI items that related to activity limitations and participation restrictions [25]. Similarly, our results suggested that depressed moods may have a confounding effect on NDI scores in patients with cervical radiculopathy. Therefore, we recommend that patients with cervical radiculopathy should be assessed for depression to improve interpretations of disability and treatment effectiveness in longitudinal studies.

In the present study, score on the SES emerged as the strongest factor associated with NDI scores; this was similar to results from patients with chronic neck pain [24]. However, the validity and reliability of the SES have

not been assessed for patients with cervical radiculopathy; therefore, our results should be interpreted with caution. Pain and physical impairments in cervical AROM were associated with NDI scores; this was consistent similar with results from other studies [23]. NME in flexion correlated with score on the SES, therefore, it did not remain in the final model. Future studies should consider the possibility of designing rehabilitation approaches that effectively address physical impairments in cervical AROM and low self-efficacy. Furthermore, future studies should investigate the clinical implications of goal-oriented rehabilitation interventions for reducing neck disability and improving outcomes in patients with cervical radiculopathy.

In the present study, sex, age and levels of pain and disability for the sample were comparable to those in other longitudinal studies on patients with cervical radiculopathy scheduled for surgery [2,9]. However, a selection bias cannot be excluded due to the specific study criteria. A major strength of this study was the broad perspective of independent variables included in the regression analysis. Furthermore, an explorative approach was used to identify the most relevant model. On the other hand, the study had some limitations. We could not include factors related to radiological findings in the analysis [9], because they were not available. Also, the cross-sectional design did not allow consideration of cause-and-effect relationships between variables. The final model included 14 variables with a sample size of 156 subjects and might be questioned. However, examination of the residuals suggested the model had not been overfit and was considered stable.

CONCLUSION

This study showed that some physical impairments and psychosocial factors including pain, impairments in the cervical range of motion, low self- efficacy, depression and sickness- related absences were independently associated with neck disability in patients with cervical radiculopathy scheduled for surgery. These factors explained 73 % of the variance in NDI scores. The description of neck disability and interpretations of treatment effectiveness in longitudinal studies on cervical radiculopathy would improve with a broader assessment of patients that includes both measures of physical impairments and psychosocial factors. Future studies should consider designing rehabilitation strategies that effectively address physical impairments and psychosocial factors associated with neck disability, and investigate the clinical implications of those strategies on outcomes for patient with cervical radiculopathy.

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Table 1: Descriptive data for patients with cervical radiculopathy scheduled for surgery (n = 166 to 201).

	n	Scores	Ranges
Demographic variables	201		
Male sex, n (%)		105 (52)	
Age, years (mean, SD)		50 (8.4)	22-70
Height, cm (mean, SD)		174 (8.9)	152-195
Weight, kg (mean, SD)		81 (15.0)	50-125
Body Mass Index, kg/m ² (mean, SD)		27 (3.9)	19-38
Right hand dominant, n (%)		188 (95)	
Unilateral symptoms, n (%)		176 (92)	
Dependent variable			
Neck Disability Index ^a (NDI, 0-100 %), (mean, SD)	189	43 (15.3)	4-84
Independent variables			
Physical impairments			
Pain and symptoms			
Mean intensity of neck pain past week, mm VAS (mean, SD)	195	55 (21.8)	0-100
Mean intensity of arm pain past week, mm VAS (mean, SD)	191	50 (24.7)	0-99
Mean intensity of headache past week, mm VAS (mean, SD)	193	27 (25.5)	0-100
Duration of neck pain, months (mean, SD)	173	32 (44.6)	0-288
Duration of arm pain, months (mean, SD)	166	27 (40.0)	0-288
Daily neck pain, n (%)	194	177 (91)	
Daily arm pain, n (%)	192	160 (83)	
Daily headache, n (%)	190	64 (34)	
Daily hand numbness, n (%)	192	156 (81)	
Daily hand weakness, n (%)	186	118 (63)	
Daily neck stiffness, n (%)	191	157 (82)	
Daily dizziness/ unsteadiness, n (%)	193	40 (21)	
Clinical examination			
Cervical range of motion in the sagittal plane, degrees (mean, SD)	198	83 (26.7)	17-160
Cervical range of motion in the transversal plane, degrees (mean, SD)	198	100 (25.5)	7-175
Cervical range of motion in the frontal plane, degrees (mean, SD)	198	55 (17.8)	14-120
Imbalance in hand- strength, %, (mean, SD)	196	26 (23.1)	0-100
Ventral neck muscle endurance in men, seconds (median, IQR)	100	45 (75)	0-300
Ventral neck muscle endurance in women, seconds (median, IQR)	92	22 (27)	0-135
Dorsal neck muscle endurance in men, seconds (median, IQR)	99	71 (135)	0-757
Dorsal neck muscle endurance in women, seconds (median, IQR)	92	29 (54)	0-390
Impairment in sensibility, n (%)	191	165 (85)	
Impairment in motor function, n (%)	191	150 (78)	
Asymmetry in reflexes, n (%)	191	103 (57)	
Psychosocial factors			
Attitudes and beliefs			
Self -Efficacy Scale ^a (scale 0-200) (median, IQR)	188	128 (56)	22-200
Pain catastrophizing (scale 0-36) (median, IQR)	191	13 (12)	0-33
Control over pain (scale 0-6), (median, IQR)	191	3 (1)	0-6
Ability to decrease pain (scale 0-6), (median, IQR)	191	2 (2)	0-6

High recovery expectations, n (%)	195	187 (96)	
Low satisfaction with symptoms, n (%)	195	186 (95)	
Emotional responses			
Depression ^a	194	25 (12)	4-57
(Modified Zung scale 0-69), (median, IQR)			
Somatic anxiety ^a	195	7 (7)	0-23
(Modified Somatic Perception Questionnaire 0-39), (median, IQR)			
Social factors			
Sickness- related absences (partial or full) due to arm/ neck symptoms, n (%)	181	100 (55.2)	
Perceived support from relatives, n (%)	191	167 (87)	
Life style habits			
Smoking yes, n (%)	194	49 (25)	
Physically active, n (%)	195	96 (49)	

^a Transformation score: when no more than one item in the NDI or SES, and two items in the Modified Zung scale or the Modified Somatic Perception Questionnaire were missing, it was replaced by the average score of all other items on the questionnaire for that patient

VAS: visual analog scale

IQR: interquartile range

Table 2: Factors associated with the Neck Disability Index score in patients with cervical radiculopathy scheduled for surgical intervention. Significant variables ($p < 0.05$) after controlling for the influence of age and sex are presented with B coefficients (B), standard errors (Std error) and p values. The models showed $p < 0.001$: results are presented with the adjusted R^2 (Adj. R^2).

	B	Std error	p value	Adj. R^2
Pain and symptoms ^a (n=184)				0.56
Constant	22.30	5.72		
Daily dizziness/ unsteadiness	8.13	1.93	< 0.001	
Daily neck pain	6.60	2.95	0.03	
Mean intensity neck pain past week	0.25	0.04	< 0.001	
Mean intensity headache past week	0.22	0.03	< 0.001	
Clinical examination ^a (n = 179)				0.15
Constant	78.64	8.54		
Cervical range of motion in the transverse plane	-0.12	0.04	0.004	
Neck muscle endurance in flexion	-0.09	0.02	< 0.001	
Attitudes and beliefs ^a (n = 177)				0.54
Constant	68.23	7.84		
Low satisfaction with symptoms	13.01	3.91	0.001	
Pain Catastrophizing (CSQ-CAT)	0.25	0.11	0.02	
Self -Efficacy Scale	-0.23	0.02	< 0.001	
Emotional responses ^a (n = 186)				0.37
Constant	27.39	6.66		
Depression (Modified Zung scale)	0.71	0.12	< 0.001	
Somatic anxiety (Modified Somatic Perception Questionnaire)	0.63	0.22	0.006	
Social factors ^a (n = 173)				0.14
Constant	53.84	(7.16)		
Sickness- related absences due to arm/ neck symptoms	9.84	2.10	< 0.001	

^a Residual scatter-plots and normal probability plots did not reveal evidence of violated assumptions

Table 3: Final model of factors associated with the Neck Disability Index score ($R^2 = 0.73$; $p < 0.001$) in patients with cervical radiculopathy scheduled for surgery ($n = 156$) Significant factors ($p < 0.05$) are presented with B coefficients (B), standard errors (Std error), Beta coefficients (Beta) and p values.

		B	Std error	Beta	p value
Constant		44.43	8.07		
Demographic variables	Age	-	-		ns
	Sex	-	-		ns
Pain and symptoms	Daily neck pain	6.93	2.51	0.14	0.007
	Daily dizziness/ unsteadiness	6.50	1.90	0.17	0.001
	Mean intensity neck pain past week	0.14	0.04	0.20	0.001
	Mean intensity headache past week	0.13	0.03	0.22	<0.001
Clinical examination	Cervical range of motion in the transverse plane (degrees)	- 0.06	0.03	-0.10	0.03
	Neck muscle endurance in flexion	-	-	-	ns
Attitudes and Beliefs	Self -Efficacy Scale	- 0.13	0.02	- 0.34	<0.001
	Pain Catastrophizing (CSQ- CAT)	-	-	-	ns
	Low satisfaction with symptoms	-	-	-	ns
Emotional responses	Depression (Modified Zung scale)	0.27	0.10	0.18	0.01
	Somatic anxiety (Modified Somatic Perceived Questionnaire)	-	-	-	ns
Social factors	Sickness- related absences due to arm/ neck symptoms	3.71	1.40	0.13	0.009

Residual scatter-plots and normal probability plots did not reveal evidence of violated assumptions