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PAIN, TRUNK MUSCLE STRENGTH, SPINE MOBILITY AND DISABILITY FOLLOWING LUMBAR DISC SURGERY

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Objective: **To study associations between pain, trunk muscle strength, flexibility and disability in patients with lumbar disc herniation 2 months after surgery.**

Design: **Clinical cross-sectional survey.**

Participants: **172 operated lumbar disc herniation patients.**

Methods: **Back and leg pain on Visual Analogue Scale, Oswestry Disability Index and Brief Depression Scale were applied to assess the subjectively perceived outcome. Isometric and dynamic strength of trunk muscles and mobility of the lumbar spine were measured to mirror physical impairment.**

Results: **Two months after the operation median leg pain had decreased by 87% and back pain by 81%, respectively. However, moderate or severe leg pain was still reported by 25% and back pain by 20% of the patients. Approximately 30% of the patients perceived moderate or severe disability measured by the Oswestry index. Decreased muscle strength and spine mobility caused functional disability, especially in older patients and patients with postoperative pain. Furthermore, the ratio of trunk extension/flexion strength had changed in favour of the flexion muscles, being 0.98. Greater age and depression were associated with poorer postoperative recovery.**

Conclusion: **Pain, decreased trunk muscle strength and decreased mobility still remained in a considerable proportion of patients with lumbar disc herniation 2 months after surgery. Early identification of those patients with restrictions is essential in order to commence rehabilitation.**

Key words: lumbar disc surgery, spine mobility, muscle strength, pain, disability.

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INTRODUCTION

Epidemiological studies have indicated that about 80% of the population experiences back pain during their active lives. In the Mini-Finland Health survey a physician diagnosed sciatica in 5.1% of the 30–64 years old participants (1). Only a minority of patients with sciatica will require surgery (2). In the Central Finland Health Care District the rate of 90 operations per 100,000 inhabitants has been close to the average for the country. In the Netherlands, with a population of about 16 million people, 10,000–11,000 operations are performed each year (3). The main indication for operation is to relieve pain. The success rate for lumbar disc surgery has been reported as 60–90% (4). Comparison between studies is complicated because surgical indication for the operations vary. However, according to different studies, 10–40% of lumbar disc surgery patients do not have a satisfactory outcome and a proportion of the patients continue to experience severe back or leg pain postoperatively (2–5).

According to substantial evidence in recent systematic reviews, work that involves twisting or bending of the trunk, manual heavy material handling or whole body vibration increases the risk of low back disorders. Furthermore, smoking and psychosocial factors, e.g. mental stress and poor job satisfaction, are plausible risk factors both in non-specific low back pain and in sciatic pain (6). In patients with prolapsed intervertebral disc prolonged periods of inactivity due to pain may lead to muscle atrophy in back muscles (7). Posterior lumbar surgery, as such, has also caused muscle and/or nerve damage, resulting in postoperative muscle atrophy (8, 9). The neuromuscular system has an important role to play in the stability and normal function of the lumbar spine (10, 11). Inadequate strength and endurance of back muscles, as well as inadequate mobility of the spine are also identified to be risk factors for low back trouble (12, 13). Adequate function requires sufficient force of the trunk muscles, balance between the agonist-antagonist muscle groups and proper co-ordination (13, 14). Sciatica and surgery-induced pain has also an important role in dysfunction of the lumbar spine. Pain leads to delay in the onset of trunk muscle contraction (14). This change in muscular stabilization decreases the muscular support of the spine and may increase the risk of injury to the spine (11).

In addition to the pain relief, the important goal of the operation is to contribute to a rapid return of the patient to their functional condition prior to the episode of sciatica. Fears of causing re-injury, re-herniation or pain may often delay the return to normal activities. The decrease in physical loading of the back to protect the spine after lumbar disc surgery is

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commonly recommended, although the benefits of these restrictions are not clear. On the other hand, Carragee et al. (15) has reported that decreasing the restrictions on postoperative activity allowed earlier return to work without increasing the rate of complications.

There is a lack of studies showing the deficits of physical function after lumbar disc herniation surgery, although the early identification of these problems may make it possible to shorten the delay in commencing intensive postoperative rehabilitation. Thus, the aim of this cross-sectional study was to evaluate the associations between pain, trunk muscle strength, flexibility and disability in patients with lumbar disc herniation 2 months after operation.

MATERIAL AND METHODS

Subjects

Two hundred and ten consecutive patients were operated due to lumbar disc herniation in Jyväskylä Central Hospital in 1999 according the method described by Wood and Hanley in 1991 (16). Of the 210 patients, 172 (82%) attended the 2-month check-up visit at the outpatient clinic. The remaining 38 patients were not included in the study for the following reasons: 25 did not received the information about the study, 9 were referred to magnetic resonance imaging (MRI) due to severe pain, 2 already had spondylodesis of the lumbar spine, 1 was pregnant and 1 had Parkinson's disease. In the final study group lumbar disk surgery was performed at the level of L1/L2 in 4 patients, at L2/L3 in 4, at L3/L4 in 11, at L4/L5 in 81, and at L5/S1 in 69 patients. In 3 cases 2 levels were operated.

Written instructions for restricted physical activities were given by a physiotherapist for the patients for first 6–8 postoperative weeks. They were advised to avoid sitting and driving for 4 weeks. Lifting, carrying and forward bending of the back were restricted for 6 weeks postoperatively. They were instructed to perform light stretching and mobility exercises during their sick leave period, which has routinely been 6 weeks for physically light work and 2 months for physically heavy work.

The employment status of the patients was recorded before surgery and at the 2-month check-up. The intensity of physical activity at work was assessed on a 7-point scale (from 1 = not at work, to 7 = very heavy manual work) (17). Subjectively perceived back and leg pain before and 2 months after the operation were assessed with a visual analogue scale (VAS) (18). Postoperatively the Oswestry Questionnaire was employed to assess disability (19) and Brief Depression Scale to assess the mood of the patients (20).

The endurance strength of the selected muscle groups was measured by calculating the repetition maximum (21) but so that the maximum amount of repetitions was set at 100. In the repetitive sit-up test for the trunk flexors the subject was in a supine position with the knees flexed at 90° and was held fixed by the tester in the ankle region. The subjects did sit-ups touching their kneecaps with the thenar region. In the repetitive arch-up test for the trunk extensors the subject was lying in a prone position with the arms along their sides, the inguinal region at the edge of the test bench, the upper trunk flexed downward at 45° and the feet fixed from the ankle region. The subject moved the upper trunk up to horizontal and back down. The speed was controlled with a metronome and 22 repetitions were carried out per minute.

Maximal isometric forces of the trunk flexors and extensors were measured using a strain-gauge dynamometer (22) and the results were analysed with an Isopack computer program (Newtest, Oulu, Finland). The subject was standing and the hips were fixed at the level of anterior superior iliac spine. The strap was tightened around the shoulders just below the armpit and horizontally connected to the dynamometer through a steel chain. The best result out of 3 attempts was taken to final analysis.

Spinal flexibility measurements consisted of lumbar flexion by Schober test (23). Extension of the lumbar spine was measured by Dualer® goniometer (24). The subjects were lying in a prone position and arched their back by extending the arms. The goniometers were placed 10 cm apart on the same marks used in Schober test. The tests of physical function were only performed postoperatively because severe pain prevented objective measures before operation.

Statistics

The results were expressed as means with standard deviations (SD) or medians with interquartile (25th–75th percentile) range (IQR). The normality of variables was evaluated by the Kolmogorov-Smirnov statistics, with a Lilliefors significance or Shapiro-Wilk statistics. Crude or age- and sex-adjusted Spearman's correlation coefficient was used to determine the relationships between the variables. Univariate and multivariate logistic-regression analysis were used to identify the appropriate predictors of outcome 2 months after the operation. The most important descriptive values were expressed with 95% confidence interval (Cl). Hommel's adjustment was performed to correct significant levels for the multiple testing. The α-level was set at 0.05 for all tests.

RESULTS

The final study group consisted of 172 patients, age range 16–74 years. There were no differences between the males and females in demographic data or pre-operative pain and thus the results are presented in a single group (Table I). Pre-operatively, 66% of the 124 employed patients were in physically heavy work and 34% in light work. The mean (SD) duration of sick leave during the last year before the operation was 71 (79) days ranging from 0 to 365 days. The length of postoperative sick leave was less than 6 weeks in 15% and less than 2 months in 55% of the patients, while 30% of the patients had not returned to work 2 months after the operation.

Patients suffered from severe back and leg pain before operation (Table II). Median back and leg pain had decreased by 81% and 87% ($p < 0.001$) 2 months after the operation (Fig.

Table I. *Democraphics and pain of 172 patients before lumbar disc herniation operations*

Variables	Male	Female	Total
Number of patients	97	75	172
Mean age, years (SD)	40 (12)	43 (12)	41 (12)
Mean body mass index (SD)	26 (3)	26 (5)	26 (4)
Median duration of back pain, months (IQR)	12 (4, 36)	12 (4, 36)	12 (4, 36)
Median duration of leg pain, months (IQR)	6 (3, 14)	9 (4, 15)	6 (3, 15)
Median back pain before operation (VAS), (IQR)	52 (32, 81)	71 (45, 87)	64 (36, 82)
Median leg pain before operation (VAS), (IQR)	70 (49, 86)	83 (70, 92)	76 (58, 90)

IQR: interquartile range, VAS: visual analogue scale.

Table II. *Descriptive values of clinical outcome measures and their correlation with back and leg pain 2 months after operation*

Variables	Median (IQR)	Back pain two months after operation		Leg pain 2 months after operation	
		r (95% CI)	r*	r (95% CI)	r*
Duration of back pain before operation, (months)	12 (4, 36)	0.36 (0.22 to 0.49)	0.35	0.15 (−0.01 to 0.30)	0.13
Duration of leg pain before operation, (months)	6 (3, 15)	0.21 (0.05 to 0.36)	0.24	0.05 (−0.11 to 0.21)	0.06
Oswestry index	14 (6, 24)	0.71 (0.62 to 0.77)	0.67	0.59 (0.48 to 0 68)	0.53
Brief Depression Scale	3 (1, 5)	0.51 (0.39 to 0.62)	0.47	0.42 (0.29 to 0.54)	0.37
Isometric strength (N):					
trunk flexion	409 (258, 517)	−0.24 (−0.10 to −0.38)	−0.25	−0.27 (−0.13 to −0.41)	−0.18
trunk extension	383 (226, 554)	−0.40 (−0.27 to −0.52)	−0.42	−0.34 (−0.20 to −0.47)	−0.25
Endurance strength (number of repetitions):					
trunk flexion	20 (2, 30)	−0.43 (−0.30 to −0.54)	−0.36	−0.32 (−0.18 to −0.45)	−0.25
trunk extension	30 (12, 41)	−0.48 (−0.35 to −0.59)	−0.42	−0.31 (−0.16 to −0.44)	−0.23
Mobility:					
flexion, (Schober test, cm)	4.3 (3.4, 5.0)	−0.26 (−0.12 to −0.40)	−0.21	−0.27 (−0.12 to −0.40)	−0.21
extension, (degrees)	10 (7, 13)	−0.34 (−0.20 to −0.47)	−0.29	−0.32 (−0.18 to −0.45)	−0.29

*Age and sex adjusted.

1). On the other hand, 5% of them still complained of severe postoperative pain.

According to the Oswestry index, 25% of the patients perceived moderate disability and 7% severe disability 2 months postoperatively. The Brief Depression Scale suggested that 12% of the patients had mild depression and 6% severe depression. Table II shows that the age- and sex-adjusted correlations between Oswestry or depression indices and back or leg pain 2 months after the operation were the highest.

The trunk extension/flexion strength ratio was 0.98. In addition, the mean (SD) isometric strength values of 427 (170) N and 433 (206) N in the trunk flexors and extensors in patients under 50 years of age ($n = 133$), were significantly higher compared with respective values of 301 (165) N and 292 (185) N of 50 years or older patients ($n = 39$) ($p < 0.001$). The differences between the age groups were also significant in endurance strength of the trunk extensors [34(23) vs 14(14)] and flexors [25(22) vs 10(11) repetitions] as well as in the spine extension [11(5) vs 8(3) repetitions] ($p = 0.036$–0.001). The correlation between trunk muscle strength and mobility measures with postoperative back and leg pain are presented in Table II.

In logistic-regression analysis higher age and depression were associated with increased risk of postoperative back and leg pain (Table III).

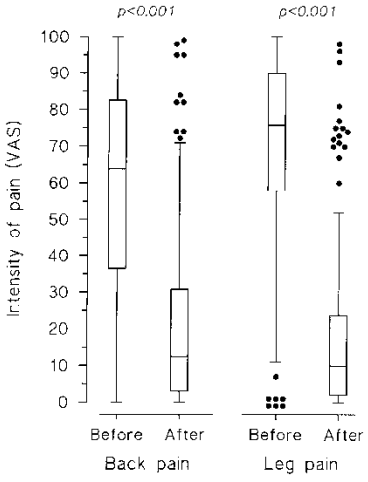

Fig. 1. Leg (A) and back pain (B) before and 2 months after the lumbar disc operation. Box shows median (50th percentile) and interquartile (25th and 75th percentile) ranges, and plots shows the outlier values.

DISCUSSION

Two months after the operation, moderate or severe back or leg pain was reported by 20% and 25% of the patients and approximately 30% of the patients perceived moderate or severe disability. Furthermore, decreased muscle strength and mobility of the spine was found especially in older patients and/or in postoperatively painful patients. In addition, the balance between trunk extension and flexion strength had been disturbed.

It is well established that adequate function requires sufficient force of the trunk muscles, balance between the agonist-antagonist muscle groups and proper co-ordination (11, 14). The earlier studies have demonstrated that patients with lumbar disc herniation have impaired mobility of the spine (25), lowered lumbar muscle mass (26, 27) and muscle strength (28). These changes together with degeneration may be related to unfavourable results for lumbar disc herniation surgery. In the present study, both the mobility and muscle strength values were decreased, especially in the older subjects. Moreover, it was also interesting to find that the trunk extension/flexion strength ratio was 0.98. The finding clearly differs from 2 earlier studies in which healthy subjects have shown isometric trunk extension/flexion ratio values of 1.3–1.6 (22, 29). Thus, these operated lumbar disc surgery patients showed imbalance between these muscle groups in the early postoperative phase. However, Kjellby-Wendt (30) has measured isokinetic extension-flexion

Table III. *Logistic-regression analysis for odd ratios (OR) to pain (middle and highest tertiles) 2 months after the operation*

	Back pain 2 months after operation		Leg pain 2 months after operation	
Variables	Univariate OR (95% CI)	Multivariate OR (95% CI)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Sex (male)	0.89 (0.47 to 1.67)	0.96 (0.45 to 2.06)	0.77 (0.40 to 1.47)	0.86 (0.41 to 1.80)
Age per 5 years	1.40 (1.19 to 1.65)	1.25 (1.05 to 1.49)	1.40 (1.19 to 1.66)	1.30 (1.09 to 1.56)
Duration of back pain before operation	1.01 (1.00 to 1.02)	1.01 (0.99 to 1.01)	1.01 (0.99 to 1.01)	1.00 (0.99 to 1.01)
Brief Depression Scale	1.35 (1.17 to 1.55)	1.35 (1.15 to 1.59)	1.19 (1.06 to 1.33)	1.14 (1.01 to 1.29)

ratios of 1.4–1.5 1 year after surgery indicating that the low ratio values may normalize over time. The importance of this muscle imbalance in relation to back pain and lumbar disc surgery is not clear and requires further investigation. However, in addition to earlier mentioned surgery induced reasons, part of the observed decrease in trunk muscle strength may been explained by age-related muscle atrophy and higher rate of degenerative changes in the spine of older patients compared with younger ones (31). Muscle strength and spine mobility scores after the operation may also be decreased due to neuromuscular inhibition and disturbed muscle innervation related to the leg and back pain (32). Nowadays improved surgical techniques induce smaller skin incision causing minimal trauma to the tissues as well as less manipulation to neural elements and muscles (33). It has also been shown that reducing the restrictions on postoperative activity (15) and starting intensive physical training 4–5 weeks after the operation (34) has lead to improvements in work capacity and to a reduction in patients' self-related disability. Restricted activities were instructed for the present patients for the first 6–8 postoperative weeks. This practice has already changed to more active direction after detecting the physical disabilities in this analysis. The measurements of physical function can be useful in determining these physical deficiencies, in following the profitability of the rehabilitation, in motivating the patients to carry out normal daily activities and physical exercise, and in removing their fears of re-injury if straining their back.

The median duration of pre-operative sciatica-induced leg pain was 6 months and that of back pain 12 months, respectively. The duration of pre-operative leg pain did not correlate with the amount of postoperative leg pain. Nygaard et al. (35) has reported that leg pain lasting more than 8 months correlated with unfavourable postoperative outcome. An important goal of lumbar disc surgery is to relieve the nerve from compression and thus alleviate pain. In the present study 54% and 45% of the patients reported complete or almost complete relief of leg and back pain (VAS under 10 mm), respectively. Weir (36) reported that 73% of the patients were without leg pain and 63% without back pain 1 year postoperatively. In long-term follow-ups Davis (37) reported the pain-free portion to be 66% (mean follow-up time 10.8 years) and Dvorak et al. (38) reported 45% of the patients to have residual sciatica and 23% to complain of constant heavy back pain 4–17 years after the operation. It is very difficult to compare the results of various studies objectively because the follow-up times varied in different studies. In the present study the follow-up time is quite short with respect to the natural course of recovery from this type of back operation. However, the early identification of unsatisfied postoperative recovery is important to get rehabilitation started without delay.

In the present study the median depression scale was 3 and the percentage of depressive patients was 18%. In the normal Finnish population the prevalence of depressive episodes has been reported to be about 9% (39). In logistic regression analysis, depressiveness proved to increase the risk for poorer early postoperative outcome. Kjellby-Wendt et al. (40) has also shown in their 2-year follow-up that assessment of depression was a valuable tool for predicting the outcome after lumbar disc surgery. Further, Hasenbring et al. (41) has reported that the psychological tests predicted the recovery after the lumbar disc surgery even better than clinical examination, findings during the operation, X-ray or MRI. On the other hand, Kjellby-Wendt et al. (42) reported in their more recent report that the patients with signs of depression before surgery were not significantly less satisfied with the outcome than patients with no signs of depression before surgery.

Two months after the lumbar disc surgery moderate or severe back or leg pain was reported by 20% and 25% of the patients. Decreased muscle strength and mobility of the spine also increased early postoperative disability, especially in older patients. Furthermore, patients showed an imbalance between trunk extension and flexion strength. Thus, the selected part of the patients may benefit from early identification of these restrictions and the rehabilitation should concentrate on physical conditioning and pain relieving aspects.

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