# Early active rehabilitation after surgery for lumbar disc herniation

## A prospective, randomized study of psychometric assessment in 50 patients

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**ABSTRACT – In a randomized study, using psychometric assessment, we evaluated two training programs before and after surgical treatment of lumbar disc herniation. 26 patients were treated according to an early active training program (treatment group). 24 patients followed a traditional less active training program (control group). Before surgery, the patients filled in the following questionnaires 3 and 12 months after surgery: Multidimensional Pain Inventory (MPI), State and Trait Anxiety Inventory, and Beck Depression Inventory. Pain was assessed by the patient's pain drawing and a visual analog scale.**

**Both groups improved as regards pain severity and state of anxiety. The MPI parameter, pain interference, improved more in the early active treatment group than in the control group. This suggests that the early active training program has a positive effect on the way patients cope with pain in their daily lives.**

The prevalence of back or leg pain after surgery is reported to be between 40% and 60% (Dvorak et al. 1988, Dolan et al. 2000). After surgery for lumbar disc herniation, some unsuccessfully treated patients may develop chronic pain syndrome. A bio-psycho-social model for the development of chronic pain and associated dysfunction suggests that physiological, psychological and social factors interact in the longer term (Dworkin et al. 1992). Early intervention and prevention programs should therefore be evaluated. Using psychometric methods mirroring psychological aspects of disability, we studied the effects of early active rehabilitation after surgery for lumbar disc herniation in two groups of patients.

## Patients and methods

The study population was selected from patients with sciatica, who had been operated on in our Department of Orthopedics at Sahlgrenska University Hospital, Östra, Gothenburg, Sweden, during 1992–1994. 60 consecutive patients were randomized into 2 treatment groups. They were allocated according to a table of random numbers. The patient inclusion criteria were: 1) men and women 16–70 years of age, 2) symptoms or neuromuscular dysfunction elicited by lumbar disc herniation in patients not responding for at least 4–8 weeks to non-surgical treatment. The exclusion criteria were: 1) reoperation for disc herniation, 2) a different surgical procedure, such as total laminectomy. 10 patients did not complete the study, for the following reasons: 2 of them, one in each group, were reoperated on at another level in the lumbar spine. 1 in the control group was reoperated at the same level of the lumbar spine. 1 patient in the EAT group and 2 in the control group dropped out, declining further participation in the study. Spondylolisthesis was diagnosed in 1 patient in the EAT group. A different method of operation was used in 1 patient in the control group. 2 patients in the latter group were excluded after the randomization, because they were unable to fill in the ques-

tionnaire properly due to lack of fluency in Swedish. Thus, the treatment group comprised 26 and the control group 24 patients.

In the treatment group, 8 were women and 18 men, and in the control group, 6 were women and 18 men. The mean age was 41 (24–68) years in the treatment group and 37 (26–66) years in the control group. The duration of leg pain before surgery was 8.4 (1–48) months in the treatment group and 6.4 (0–30) months in the control group ($p = 0.3$). The duration of back pain was 18 (0–49) months in the treatment group and 13.6 (0–60) months in the control group ($p = 0.6$). All patients gave their informed written consent. The study was approved by the Ethics Committee at the Göteborg University.

### *Methods of treatment*

*Surgical treatment.* Indications for surgery followed criteria of the American Academy of Orthopedic Surgeons in 1991: 1) functionally incapacitating leg pain, extending below the knee with a nerve root distribution, 2) signs of nerve root tension (positive SLR test) with or without neurological abnormalities, in accordance with the radiculopathy, 3) no improvement after non-operative treatment, 4) confirmation by imaging study, which correlated with the physical signs and distribution of pain

All patients underwent a lumbar microdiscectomy, without the use of a microscope. The levels of disc herniation were distributed alike in the groups. The L4–L5 level was involved in 14 patients in the treatment group and 9 in the control group and the L5–S1 level was involved in 10 patients in the EAT group and 13 in the control group. Two patients in each group were operated on at the L3–L4 level.

*Physiotherapy.* The first part of the training programs started on the day after surgery in both groups. The second part of the training programs, which was more intensive started 6 weeks after surgery. The training session was 12 weeks in each group. Patients in the treatment program received instructions from the physiotherapist on four occasions, and those in the control group on three occasions within the 12 weeks. The daily training for patients in the former group lasted 17 minutes longer than in the control group, during the first 6 weeks. The treatment program lasted 21 minutes longer during the second training session (6–12 weeks). The treatment program was taught to the patients by one of the authors (G K-W). The control program was taught by physiotherapists in the Orthopedic Department at the hospital. The training programs for both groups were designed to be done at home and are described elsewhere (Kjellby-Wendt and Styf 1998).

The aim of the exercises in the treatment program was to reduce local edema by concentric muscular activity, to maintain mobility of the gliding surfaces, e.g., to restore the mobility of the structures which are stretched by a straight leg raising test, to maintain and increase range of motion of the trunk, to increase trunk strength in functional positions, and to teach the patient a correct working posture. Those in the treatment group were encouraged to perform physical activities such as swimming and jogging. The treatment program also included an active way to cope with pain in the back or leg (extension of the lumbar spine while standing or lying down, if pain or discomfort was felt in the back or leg).

Patients in the control group followed a traditional less active training program after surgical treatment for lumbar disc herniation. More intensive cardiovascular exercises were not encouraged in the control group. Instructions on pain management in the control group consisted of resting in a semi-Fowler's position for a maximum of 15–20 minutes.

In summary, the main differences between the programs were that the treatment program included exercises to increase the range of motion of the trunk and leg, which the control program did not. The strengthening exercises focused on the trunk extensors, while the control program focused on strengthening the abdominal muscles. In the treatment group, the pain-coping model was active and in the control group, it was passive.

### *Methods of measurement*

The psychometric assessment was performed in the Department of Orthopedics. The questionnaires, Multidimensional Pain Inventory, Beck Depression Inventory and State and Trait Anxiety Inventory, were presented to the patients as part of the routine investigation before surgery, as well as 3 and 12 months after surgery.

*Multidimensional Pain Inventory (MPI).* The West Haven-Yale Multidimensional Pain Inventory is a 61-item questionnaire based on psychosocial and behavioral data about chronic pain (Kerns et al. 1985). It consists of three parts. The first assesses pain severity, pain interference (how pain interferes with their lives), support (appraisal of the amount of support received from significant others), life control (perceived life control) and affective distress. The second part assesses how patients perceive behavioral responses of significant others (spouse, close friends) caused by their pain and the third part assesses general activity (activities checklist). Good reliability and validity have been demonstrated (Kerns et al. 1985, Bergstrom et al. 1998). In this study the parameters pain interference and general activity were primarily analyzed as important dependent measures in evaluation of the treatment approaches.

*Beck Depression Inventory (BDI).* The BDI (Beck et al. 1961) is a 21-item self-administered questionnaire. It provides a quantitative measure of depressive symptoms. Each item has a 0–3 response format, giving a theoretical maximum score of 63. The following cut-off scores are recommended: scores 0–9 little, if any, depression, 10–18 mild depression, 19–29 moderate depression, and 30–63 severe depression (Beck and Steer 1996, Beck et al. 1988). The psychometric quality of the questionnaire is very good (Beck et al. 1961, 1988, Kendall et al. 1978). It has also been recommended to be inclusion in the clinical and radiological assessments routinely done before operating on patients with lumbar disc herniation (Junge et al. 1995).

*State and Trait Anxiety Inventory (STAI).* The STAI is a 40-item self-administered questionnaire that measures state (temporary) and trait (more stable) anxiety. Its reliability and validity have been documented (Spielberger et al. 1983). The raw score of STAI can be compared to percentile ranks for normal adults in three age groups (Spielberger et al. 1983, Hallberg and Carlsson 1998).

*Pain.* Intensity of pain was estimated using a visual analog scale (VAS) (no pain at 0 cm and worst conceivable pain at 10 cm). Scores less than 0.5 were recorded as no pain.

*Physical examination.* Motion of the lumbar spine, the straight leg raising (SLR) test, and the flexibility of the hamstring muscles were assessed by an unbiased observer. These results have been published elsewhere (Kjellby-Wendt and Styf 1998). The duration of sick-leave after surgery was determined by the orthopedic surgeon who operated the patient. The surgeon was blinded as to the type of physicotherapy which the patient had been given postoperatively.

2 years (1–3 years) after surgery, 47 of the 50 patients completed a questionnaire on residual sciatica, back pain, and their satisfaction with the results of the operation.

*Statistics.* No power analysis was done before the study. The Mann-Whitney U-test was used to compare the two groups. Changes over time within groups were analyzed with the Wilcoxon signed rank test. The differences shown are based on individual values. We used Fisher's exact test to compare proportions between the two groups. A correction factor was used in analyzing data due to multiple comparison. All significance tests were two-tailed and p-values less than 0.05 were considered to represent a significant difference.

## Result

The preoperative median intensities of pain, according to the VAS, were 6.3 (0.8–10) in the treatment group and 6.5 (1.6–9.8)in the control group. At 3 months follow-up, the median pain intensities were 0.8 (0–7.4) in the treatment group and 0.5 (0–8) in the control group. Pain intensities at the 12-month follow-up were 1.5 (0–8) in the treatment group and 1.3 (0–8) in the control group. Pain intensities were not significantly different between the groups

The differences in pain interference (MPI parameter) preoperatively to the 3-month follow-up in treatment group were 2.1 (95% CI 1.4–2.8), and 1.1 (95% CI 0.3–1.8) in the control group and to the 12-month follow-up 2.8 (CI 2.1–3.6) in the treatment group and 1.5 (CI 0.5–2.5) in the control group. Pain interference improved over time in both groups. However, those in the treatment group improved significantly more from the preoperative to the 3-month postoperative ($p = 0.02$) and from the preoperative to the 12-month postoperative ($p = 0.02$) than the control group. General activity improved significantly in the treatment

**Table 1. Results of Multidimensional Pain Inventory: pain interference and general activity before surgery, 3 months and 12 months after surgery**

| | Preoperative | | | 3 months postoperative | | | 12 months postoperative | | |
|---|---|---|---|---|---|---|---|---|---|
| | Treatment group | Control group | P-value | Treatment group | Control group | P-value | Treatment group | Control group | P-value |
| *Interference* | | | | | | | | | |
| Median | 4.5 | 4.8 | 0.71 | 2.2 | 3.0 | 0.062 | 1.1 | 2.2 | 0.11 |
| Change | | | | 2.5 b | 0.5 a | 0.015 | 3.2 [b] | 1.1 a | 0.019 |
| Range | 1.8–5.9 | 0.5–5.5 | | 0–5.4 | 0.1–5.5 | | 0–4.4 | 0–5.6 | |
| n | 22 | 21 | | 23 | 17 | | 25 | 18 | |
| *General activity* | | | | | | | | | |
| Median | 2.6 | 2.6 | 0.75 | 3.1 | 2.8 | 0.43 | 3.1 | 3.3 | 0.57 |
| Change | | | | –0.5 [a] | 0 | 0.142 | –0.6 | –0.6 | 0.987 |
| Range | 0.6–4.4 | 0.2–4.9 | | 1.1–4.7 | 0.1–4.1 | | 0.15–4.8 | 0.9–4.2 | |
| n | 22 | 21 | | 23 | 17 | | 23 | 17 | |

P-value in comparison between the two groups, significant changes over time within groups from preoperative values: [a] = $p < 0.05$, [b] = $p < 0.005$, change indicates the difference between 3 and 12 months postoperatively and the preoperative value.

**Table 2. Results of STAI state and BDI before surgery, 3 months and 12 months after surgery**

| | Preop | | | 3 months postoperative | | | 12 months postoperative | | |
|---|---|---|---|---|---|---|---|---|---|
| | Treatment group | Control group | P-value | Treatment group | Control group | P-value | Treatment group | Control group | P-value |
| *STAI state* | | | | | | | | | |
| Median | 35 | 45 | 0.048 | 33 | 38 | 0.238 | 31.0 | 29.5 | 0.853 |
| Change | | | | 5.0 | 10.5 [b] | 0.264 | 4.0 [a] | 9.5 [b] | 0.141 |
| Range | 24–70 | 21–63 | | 9–59 | 24–61 | | 20–47 | 20–70 | |
| n | 22 | 20 | | 24 | 17 | | 25 | 18 | |
| *BDI* | | | | | | | | | |
| Median | 7.0 | 6.0 | 0.4 | 3.0 | 7.0 | 0.038 | 2.0 | 4.0 | 0.484 |
| Change | | | | 0.5 | 3.0 | 0.9 | 2.0 | 1.0 | 0.36 |
| Range | 0–27 | 1–24 | | 0–27 | 0–19 | | 0–25 | 0–56 | |
| n | 21 | 21 | | 23 | 17 | | 25 | 18 | |

P-value in comparison between the two groups, significant changes over time within groups from preoperative values [a] = $p < 0.05$ [b] = $p < 0.005$, change indicates the difference between 3 and 12 months postoperatively and the preoperative value.

group from before surgery to 3 months after surgery ($p = 0.01$). The improvement was not significantly different between the groups (Table 1).

The scores for state anxiety improved significantly over time in both groups at the 12-month follow-up (treatment group $p = 0.01$, control group $p = 0.002$) (Table 2). The scores for trait anxiety (median (range)) were 33.5 (20–63) preoperatively in the treatment group and 36 (16–71) in the control group. Trait anxiety decreased over time in both groups. The differences to 3 months were 0.5 (–12–21) in the treatment group and 1.0 (–13–16) in the control group. The differences from the preoperative values to the 3 and 12-month follow-ups were small.

In the treatment group, the BDI scores decreased significantly from before surgery to 12 months after surgery ($p = 0.007$), but the improvement was not significantly different between the groups.

3 months after surgery, 15 patients in the treatment group and 9 in the control group had returned to work. 10 patients in the treatment group and

14 in the control group were still on sick-leave (p = 0.3). Before surgery, 1 patient in each group had retired from work due to age. Patients in the treatment group were on sick-leave for median 94 (18–365) days and those in the control group for 117 (40–365 ) days (p = 0.3) during the first post-operative year.

On the basis of the VAS, 11 patients in the treatment group and 8 in the control group had no pain 1 year after surgery and 14 patients in the treatment group and 11 patients in the control group had pain (p = 0.8). 2 years after surgery, 10 patients in the treatment group and 8 in the control group had no pain while 15 patients in the treatment group and 14 in the control group felt pain (p = 1.0). 22 patients in the treatment group and 15 in the control group were satisfied with the treatment outcome 2 years after surgery, but 3 patients in the treatment group and 7 in the control group were not (p = 0.2). 1 patient in the treatment group and 2 patients in the control group were not available at the 2-year follow-up.

## Discussion

Rehabilitation after surgical treatment for lumbar disc herniation has been evaluated in studies with various approaches to rehabilitation (Alaranta et al. 1986, Manniche et al. 1993a, Brennan et al. 1994, Johannsen et al. 1994, Kjellby-Wendt and Styf 1998, Danielsen et al. 2000, Dolan et al. 2000). Some studies in which rehabilitation was started 4 or 6 weeks after surgical treatment for lumbar disc herniation, except in the study by Kjellby-Wendt and Styf, showed reductions in disability and pain after surgery (Kjellby-Wendt and Styf 1998, Danielsen et al. 2000, Dolan et al. 2000). The psychometric assessment in this study aimed to mirror the psychological aspects of disability after early active rehabilitation.

The interference score of the Multidimensional Pain Inventory measures how patients are affected by pain in their lives, e.g., their ability to work and participate in daily and social activities, as well as the amount of satisfaction from work and social and family activities. The treatment program seems to affect the way patients cope with their pain, since the scores of interference improved. The scores of interference were still improved at 12 months of follow-up, which means that the patients could maintain their interference improvement at the 3-month and 12-month follow-ups.

The scores of state anxiety improved in both groups, but those of trait anxiety showed less improvement which was expected, because the questionnaire measures a more stable form of anxiety. The results of trait anxiety were not expected to be changed by the rehabilitation programs in this study. However, it may be important to measure because the prevalence and intensity of stable anxiety in the two groups may affect the results.

There was a tendency for the scores of depression (BDI) and general activity to improve in the treatment group. Rush et al. (2000) stated that there is a relation between the degree of physical activity and presence or absence of depression among chronic low back pain patients. Those who were more physically active ran a lower risk for depression than those who were less.

According to the Paris Task Force on back pain, there is scientific evidence that training programs for patients with chronic low back pain should include combined strength training, stretching and/or fitness (Abenhaim et al. 2000). Exercises of this kind are recommended for patients with low back pain and sciatica. The treatment program included the exercises recommended for low back pain and sciatica although we tried to increase the range of motion of the spine and leg repetitive movements instead of stretching exercises.

Patients in the control group started the rehabilitation as early as those in the treatment group and they were also involved in a physically active program. The differences between the groups might have been more marked if there had been wider variations in time and the design of the training programs between the methods of physical rehabilitation.

During healing after a lumbar discectomy, pain and activity will probably be positively correlated. The patients were therefore told to reduce or increase the number of exercises accordingly. In those with established chronic pain, the number of exercises should not be limited due to increasing pain because it may reinforce pain behavior (Fordyce et al. 1981). Another study showed that patients who began high-intensity exercises 5

weeks after surgery, with no regard to back pain or fear of activity, showed greater improvement in the disability index and working ability at the 26-week follow-up a control group, who followed a mild mobility exercise program (Mannicahe et al. 1993b). In our study, it seemed reasonable to adjust the number of exercises to patients' experience of pain since it was started immediately after the operation.

The basic idea of the EAT program was to tell patients about the programs, activity level and pain-management, so that they understood the aims of rehabilitation, and therefore could take personal responsibility for it. If active rehabilitation is introduced shortly after the operation, and the patient is encouraged to take an active role in it, the risk of developing chronic pain behavior may be less.

Using the Low Back Outcome Score and Roland Disability Questionnaire, some authors have reported reductions in disability and pain after active postoperative rehabilitation which was started 4 or 6 weeks after surgery (Danielsen et al. 2000, Dolan et al. 2000). In the study by Dolan, the exercise program consisted of two 1-hour sessions a week for 4 weeks, that was supervised by an experienced physiotherapist. In the study by Danielsen et al., the training group took part in a rehabilitation program, based on criteria for medical therapy, three times a week for 8 weeks. The differences between these two studies and this one is that the rehabilitation in ours was based on home training programs, which is probably less time consuming and more cost effective than supervised training. With supervised training, the physiotherapist is better possable to explain, and guide the patients the exercises and encourage them. However, the rehabilitation in our study was enough to affect pain interference.

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