

ORIGINAL REPORT

## A STRUCTURED PHYSIOTHERAPY TREATMENT MODEL CAN PROVIDE RAPID RELIEF TO PATIENTS WHO QUALIFY FOR LUMBAR DISC SURGERY: A PROSPECTIVE COHORT STUDY

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**Objective:** To evaluate a structured physiotherapy treatment model in patients who qualify for lumbar disc surgery.

**Design:** A prospective cohort study.

**Patients:** Forty-one patients with lumbar disc herniation, diagnosed by clinical assessments and magnetic resonance imaging.

**Methods:** Patients followed a structured physiotherapy treatment model, including Mechanical Diagnosis and Therapy (MDT), together with graded trunk stabilization training. Study outcome measures were the Oswestry Disability Index, a visual analogue scale for leg and back pain, the Tampa Scale for Kinesiophobia, the European Quality of Life in 5 Dimensions Questionnaires, the Zung Self-Rating Depression Scale, the Self-Efficacy Scale, work status, and patient satisfaction with treatment. Questionnaires were distributed before treatment and at 3-, 12- and 24-month follow-ups.

**Results:** The patients had already improved significantly ( $p < 0.001$ ) 3 months after the structured physiotherapy treatment model in all assessments: disability, leg and back pain, kinesiophobia, health-related quality of life, depression and self-efficacy. The improvement could still be seen at the 2-year follow-up.

**Conclusion:** This study recommends adopting the structured physiotherapy treatment model before considering surgery for patients with symptoms such as pain and disability due to lumbar disc herniation.

**Key words:** intervertebral disc displacement; rehabilitation; physical therapy modalities.

J Rehabil Med 2014; 46: 233–240

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Accepted Sep 9, 2013; Epub ahead of print Dec 12, 2013

### INTRODUCTION

Symptoms of lumbar disc herniation are relatively common in the general population, although the prevalence rates vary widely between different studies (1). Symptom severity also

varies and, in many patients, pain and loss of function may lead to disability and long periods of sick leave (2). Spontaneous resolution of symptoms after a lumbar disc herniation is regarded as common, which makes it difficult to evaluate the effects of treatment. Furthermore, in studies evaluating spontaneous healing, different physiotherapy treatments are often included, together with pain medication (3–5), which makes it difficult to determine the extent of natural healing. On the other hand, in patients with sciatica, but without confirmed disc herniation on magnetic resonance imaging (MRI), approximately one-third of subjects recover 2 weeks after the onset of sciatica and approximately three-quarters recover after 3 months (6).

In contrast to evaluating spontaneous healing, surgery for lumbar disc herniation has been investigated in numerous studies. Surgery has been compared with a variety of treatments, such as education, chiropractic, unspecified physiotherapy, acupuncture, injections and medication (7–10). The non-surgical treatments have, however, been described only in vague terms, and variations in treatments have been used. Previous studies have reported favourable short-term (after 1 year) outcomes for surgery, but no major differences between surgical and other treatments have been demonstrated in the long term (over 2 years) (7, 10, 11). The conclusions that are drawn from the comparison between surgery and non-systematic non-surgical treatments may thus be misleading. This has been confirmed in a systematic review, which concluded that there is conflicting evidence as to whether surgery is more beneficial than non-surgical care for both short- and long-term follow-up (12).

Kinesiophobia has been evaluated in patients after lumbar disc surgery, and almost 50% of patients were classified as having kinesiophobia (13). To our knowledge kinesiophobia has not been evaluated in patients with lumbar disc herniation treated with a structured physiotherapy treatment.

There are many different non-surgical treatment methods for patients with low-back pain and sciatica. One common management method is Mechanical Diagnosis and Therapy (MDT), also known as the McKenzie method, which aims to eliminate or minimize pain (14). A systematic review from 2004 of the efficacy of MDT showed that patients with low-back pain treated

with MDT reported a greater, more rapid reduction in pain and disability compared with non-steroidal anti-inflammatory drugs (NSAIDs), educational booklets, back massage and back care advice, strength training, spinal mobilization and general exercises (15). In a randomized controlled trial with a 1-year follow-up from 2008, Paatelma and co-workers (16) found that the McKenzie method was only marginally more effective compared with only giving advice to patients with low-back pain. For patients with low-back pain, sciatica and a verified lumbar disc herniation, it has, however, been shown that a selected group of patients who responded to MDT after 5 days of treatment also reported that they were satisfied after 55 weeks (17). The patients started treatment just 12 days after the onset of symptoms and the effects of spontaneous healing cannot therefore be excluded. Taken together, the treatment effects of MDT for patients with a verified lumbar disc herniation appear to require further evaluation.

Trunk stabilization exercises, which aim to restore deep trunk muscle control, have been used for the prevention and rehabilitation of low-back pain (18). A randomized controlled trial revealed a reduction in the recurrence of low-back pain episodes after specific trunk stabilization exercises compared with a control group receiving advice and the use of medication (19). Dynamic lumbar stabilization exercises have been found to relieve pain and improve function in patients who have undergone microdiscectomy (20). The effects of trunk stabilization exercises combined with MDT have, however, not been studied in patients with non-operated lumbar disc herniation.

MDT is seldom recommended for patients with MRI verified lumbar disc herniation with a broken outer annulus. At our hospital, however, we have several years of good clinical experience of a combination of MDT and trunk stabilization exercises for this category of patients. To our knowledge, no previous study has investigated whether patients with a lumbar disc herniation verified by MRI, symptoms for at least 6 weeks (minimizing effects of spontaneous healing) and who qualified for disc surgery could improve with a structured physiotherapy treatment model including MDT and gradually progressive trunk stabilization exercises. The aim of this study was therefore to

evaluate a structured physiotherapy treatment model in patients who qualified for lumbar disc surgery.

## MATERIAL AND METHODS

During the study inclusion period, 150 patients, who were referred to the orthopaedic clinic at Sahlgrenska University Hospital, Gothenburg, from November 2003 to January 2008, were identified as potential participants since disc herniation was confirmed with MRI. Inclusion criteria were: 18–65 years of age; MRI confirming disc herniation explaining the clinical findings; symptoms for at least 6 weeks (minimizing the effects of spontaneous healing) and pain distribution with concomitant neurological disturbances correlated to the affected nerve root. Exclusion criteria were: cauda equina syndrome, previous spinal surgery, other spinal diseases, such as spinal stenosis and spondylolisthesis, and inadequate command of Swedish. However, 70 patients were excluded because of spontaneous resolution of pain and symptoms. The remaining 80 patients met the inclusion criteria and qualified for surgery. Orthopaedic surgeons determined whether the patients qualified for lumbar disc surgery after MRI and physical examination according to the recommendations of the American Academy of Orthopaedic Surgeons for patients with lumbar disc herniation (21).

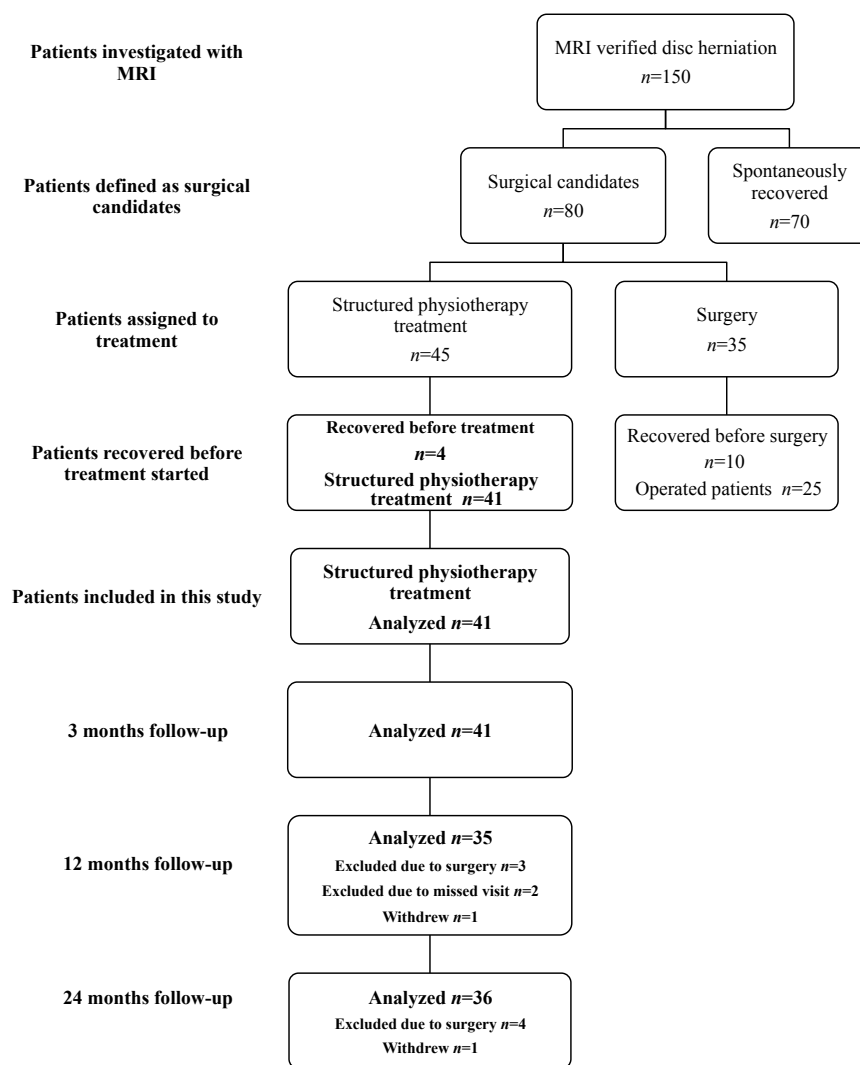


Fig. 1. Study flowchart. MRI: magnetic resonance imaging.

Initially, the study was planned as a randomized controlled trial (RCT) between a structured physiotherapy treatment model and surgery, but the number of patients was not sufficient to obtain acceptable power. Eighteen of the 80 patients were initially randomized to physiotherapy, 17 patients were randomized to surgery and 45 patients did not agree to undergo randomization. Twenty-seven of the 45 patients who did not agree to randomization agreed to take part in the structured physiotherapy treatment and 18 patients agreed to undergo surgery. A decision was therefore made solely to present a cohort of 45 patients treated according to the structured physiotherapy treatment protocol (Fig. 1). Patients were given verbal and written information and informed consent was obtained. The study was approved by the Regional Ethical Review Board.

Before structured physiotherapy treatment began, 4 patients recovered to the extent that they could no longer be accepted as surgical candidates and they were therefore excluded from the study. The remaining 41 patients treated according to the structured physiotherapy model are presented in this paper.

#### *A structured physiotherapy treatment model*

Six physiotherapists with credentialed examinations in MDT, which is an examination within the MDT concept after completing 4 courses of 4 days each for evaluating and treating patients with spinal problems. Following completion of these courses, an extensive literature study and practice in evaluating and treating patients is required before the examination can be completed. The physiotherapists involved in the study had 5–20 years of clinical experience of treating patients with back problems and herniated lumbar disc. The inter-examiner reliability of the MDT assessment has been shown to be good if the examiner is trained in the MDT method (22). The physiotherapists examined and treated the patients during a 9-week period (Table I). For the first 2 weeks of treatment, an MDT protocol was followed, based on clinical examinations of individual mechanical and symptomatic responses to positions and movements, with the aim of minimizing pain and with the emphasis on self-management (14). During the third week of treatment, graded trunk stabilization exercises were added to the MDT protocol. The purpose of graded trunk stabilization exercises was to improve muscle control (23). The low-load muscular endurance exercises were gradually increased in intensity on an individual

basis with respect to the patients' reported leg pain and the observed movement control and quality. During treatment, the patients were encouraged to continue exercising on their own at a gym, or to perform some other type of physical training of their own choice after the structured physiotherapy treatment was concluded. Four weeks after the completion of the 9-week physiotherapy treatment period, the patients attended a follow-up visit with the physiotherapist who had treated them. The aim of this visit was to encourage a high level of compliance with respect to continued trunk stabilization exercises and MDT practice (Table I).

#### *Study outcome measures*

The patients were given a battery of questionnaires to complete. Independent examiners, who were not involved in the treatment, distributed the questionnaires before treatment (baseline) and at the 3-, 12- and 24-month follow-ups.

The primary outcome measures were pain intensity in the leg, rated using a visual analogue scale (VAS) 0–100 mm (24) and the Oswestry Disability Index (ODI) 0–100 % (25). A score of 0–10 mm on the VAS was defined as no pain according to Öberg et al. (26). An ODI score of 0–20% was defined as minimal or no disability, and a score of over 40% was defined as severe disability (25). These primary outcome measures are commonly used in evaluations after surgery for low-back pain and for assessing patients with lumbar disc herniation (27).

Secondary outcome measures included pain intensity in the back rated using a VAS and the degree of kinesiophobia using the Tampa Scale for Kinesiophobia (TSK). The TSK score varies between 17 and 68 and a cut-off more than 37 was defined as a high degree of kinesiophobia (28). Health-Related Quality of Life (HRQoL) in the European Quality of Life in 5 Dimensions Questionnaires (EQ-5D) was used. The EQ-5D includes 2 parts, EQ-5D<sup>index</sup> ranges from 0 to 1.0, where 1.0 is optimal health and EQ-5D<sup>VAS</sup> is a vertical visual analogue scale ranging from 0 (worst possible health state) to 100 (best possible health state) (29). The Zung Self-Rating Depression Scale (ZDS) ranges from 20–80 and the more depressed the patient is, the higher score (30). The Self-Efficacy Scale (SES) ranges from 8 to 64, with higher scores indicating more positive beliefs (31) was also used. Work status was measured using a 3-grade Likert scale: working full time, full-time sick leave and part-time sick leave. Likewise, patient

Table I. Treatment procedures

Time period	Treatment
Week 1: First visit	History and physical examination according to MDT Assess direction of preference <sup>a</sup> Patient is given 1 exercise (practice) to perform at home several times a day Posture correction
Week 1–2: 2–3 visits a week	Review patients' home exercise Review whether symptoms and/or mechanical response have changed When needed, change home exercise When needed, progress force Review posture correction
Week 3: 2–3 visits a week	Proceed with treatment according to MDT, see above Beginning of graded trunk stabilization exercise
Week 4–9: 2–3 visits a week	Proceed with treatment according to MDT, see above Proceed and upgrade trunk stabilization exercise Begin with low-load endurance exercises at the physiotherapy department The exercises are gradually increased on an individual basis
End of week 9: Last visit	End of the training at the physiotherapy department Patients are encouraged to continue exercising on their own
Week 14: Follow-up visit	Follow-up visit to the physiotherapist Recovery of function in order to prevent recurrence

<sup>a</sup>Direction of preference describes that referred pain lessens when movement/s or positions in 1 direction are performed, and to worsen if movements or postures in the opposite direction are performed.

MDT: Mechanical Diagnosis and Therapy.

Table II. Baseline characteristics for the 41 patients

Characteristics	
Gender, male, n (%)	19 (46)
Age, mean (SD)	42 (9.1)
Duration of leg symptoms, n (%)	
1.5–3 months	14 (34)
3–12 months	20 (49)
> 12 months	4 (10)
> 24 months	3 (7)
Disc herniation level, n (%)	
L3–L4	2 (5)
L4–L5	13 (32)
L5–S1	25 (61)
L4L5+L5S1	1 (2)

SD: standard deviation.

satisfaction with treatment was measured on a 3-grade Likert scale; satisfied, less satisfied and dissatisfied (32). These secondary outcome measures evaluate bio-psychosocial factors described as important in connection with lumbar disc surgery (33).

Statistical analyses

The results are presented as median values and interquartile range (IQR), except for age, which is presented as the mean and standard deviation (SD). Changes over time within the group were analysed with the Wilcoxon signed-rank test. Statistical significance was set at an alpha level of 0.05.

RESULTS

The baseline characteristics are shown in Table II. No patient had undergone surgery at the 3-month follow-up. At the 12-month follow-up, 3 patients had undergone surgery and, at the 24-month follow-up, 1 additional patient had been operated on. After surgery, these 4 patients were excluded from further follow-ups (Fig. 1).

Change over time in primary outcome measures

**Disability.** The patients showed significant improvements ( $p < 0.001$ ) in ODI at the 3-month follow-up compared with baseline. The median (IQR) score decreased from 42 (27–53) to 14 (8–33). This improvement could still be seen at 12 and 24 months (Table III and Fig. 2). At baseline, 22 patients reported

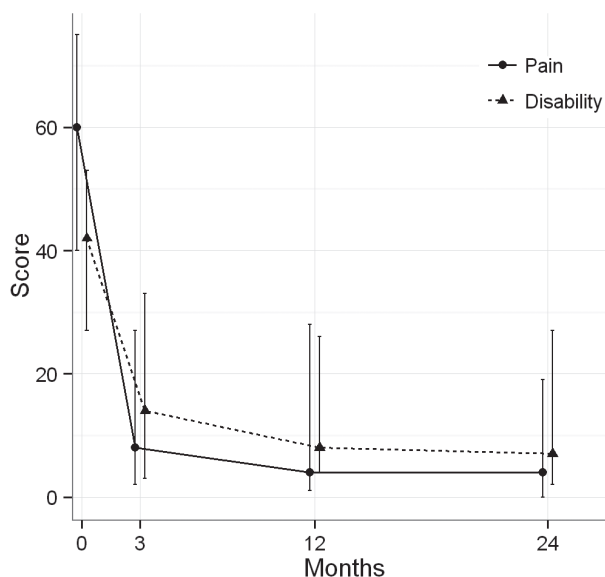


Fig. 2. Visual analogue scale (VAS) leg pain and Oswestry Disability Index at different time intervals, median values and interquartile range.

severe disability (54%) and 3 patients reported no disability. The degree of disability decreased at the 3-month follow-up, as only 9 patients (22%) reported severe disability and 26 (64%) reported no disability. At 12- and 24-month follow-ups only 2 patients (5%) reported severe disability. At 12-month follow-up 26 patients still reported no disability, and at 24-month follow-up 27 patients reported no disability.

**Leg pain.** A significant reduction in patients' leg pain was found at the 3-month follow-up ( $p < 0.001$ ) on the VAS compared with baseline. The median (IQR) on the VAS decreased from 60 (40–75) to 9 (2–27). This improvement could still be seen at the 12- and 24-month follow-ups (Table III and Fig. 2). Before treatment, all patients reported leg pain. Three months after treatment, the median on the VAS was 9 mm, i.e. classified as no leg pain (26). Twenty-three patients (56%) reported no leg pain at the 3-month follow-up. At the 12-month follow-up 22 patients reported no leg pain, and after 24 months 24 patients reported no leg pain.

Table III. Changes over time in primary and secondary outcome measures. Each follow-up visit compared with baseline

Assessments	Baseline values	3-month follow-up		12-month follow-up		24-month follow-up	
	n=41 Median (IQR)	n=41 Median (IQR)	p-value	n=35 Median (IQR)	p-value	n=36 Median (IQR)	p-value
ODI	42 (27–53)	14 (8–33)	<0.001	8 (4–26)	<0.001	6 (2–27)	<0.001
VAS leg pain	60 (40–75)	9 (2–27)	<0.001	4 (1–28)	<0.001	4 (0–19)	<0.001
VAS back pain	40 (18–56)	13 (2–30)	<0.001	7 (2–21)	<0.001	5 (0–31)	<0.001
TSK	42 (35–46)	33 (28–40)	<0.001	31 (26–36)	<0.001	30 (26–37)	<0.001
EQ-5D index	0.36 (0.12–0.69)	0.78 (0.66–0.80)	<0.001	0.80 (0.72–1)	<0.001	0.80 (0.73–1)	<0.001
EQ-5D VAS	40 (30–65)	75 (66–90)	<0.001	83 (75–90)	<0.001	80 (71–90)	<0.001
ZDS	42 (36–46)	33 (28–40)	<0.001	31 (26–36)	<0.001	28 (26–39)	<0.001
SES	32 (26–43)	46 (36–56)	<0.001	52 (43–58)	<0.001	52 (46–59)	<0.001

ODI: Oswestry Disability Index; VAS: visual analogue scale; TSK: Tampa Scale for Kinesiophobia; EQ-5D: European Quality of Life in 5 Dimensions Questionnaires; ZDS: Zung Self-Rating Depression Scale; SES: Self-Efficacy Scale; IQR: interquartile range.

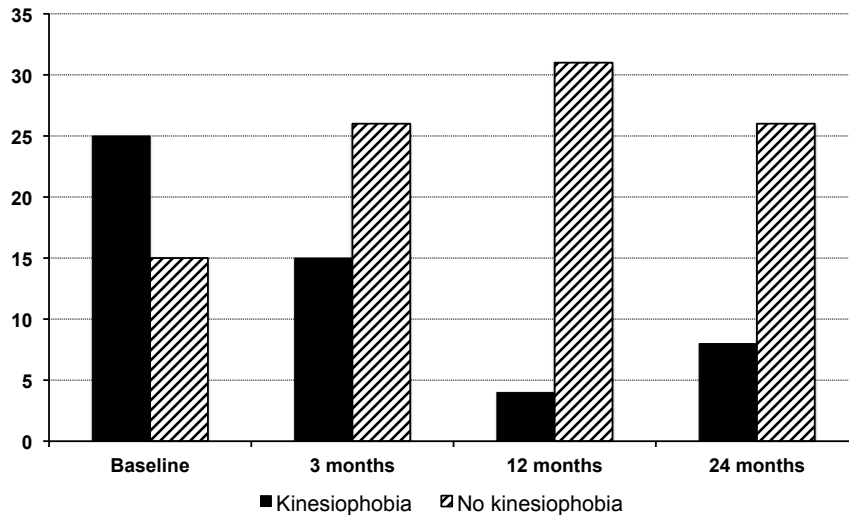


Fig. 3. Number of patients classified with kinesiophobia at baseline and after 3, 12 and 24 months. Kinesiophobia > 37 on Tampa Scale for Kinesiophobia.

*Change in secondary outcome measures over time*

**Back pain.** A significant improvement in back pain was found at the 3-month follow-up ( $p < 0.001$ ) on the VAS compared with baseline. This improvement could still be seen at 12 and 24 months (Table III). At baseline, 6 patients (15%) reported no back pain. Three months after treatment began, 20 patients (49%) reported no back pain.

**Kinesiophobia.** The degree of kinesiophobia showed a significant improvement at the 3-month follow-up ( $p < 0.001$ ) and the improvement could be seen throughout the follow-up period (Table III). Before treatment, 25 patients (61%) were classified as having kinesiophobia and 15 patients (37%) had no kinesiophobia, while data for 1 patient was missing. After 3 months, 15 patients (37%) had kinesiophobia and 26 (63%) had no kinesiophobia. At the 12-month follow-up, the number of patients with kinesiophobia had reduced to 4 (11%) (Fig. 3).

**Health-related quality of life, depression and self-efficacy.** All 4 assessments (EQ-5D<sup>index</sup>, EQ-5D<sup>VAS</sup>, ZDS and SES) showed significant improvements at the 3-month follow-up ( $p < 0.001$ ). This improvement could still be seen at 12 and 24 months (Table III).

**Sick leave.** At baseline, 22 patients (54%) were on full-time sick leave (Table IV), compared with 9 (22%) patients at

the 3-month follow-up. At baseline, 14 patients (34%) were working full time, compared with 22 (54%) at the 3-month follow-up.

*Satisfaction with treatment*

At the 3-month follow-up, 32 (78%) of 41 patients were satisfied with the structured physiotherapy treatment. Seven patients were less satisfied and 2 patients were dissatisfied. Both of the dissatisfied patients were later operated. At the 2-year follow-up, the number of satisfied patients was 29 (80%) of 36. Seven patients were less satisfied, but none dissatisfied after structured physiotherapy treatment.

DISCUSSION

The principal finding of this study was that patients who qualified for lumbar disc surgery improved to a statistically significant and clinically substantial degree just 3 months after the start of the structured physiotherapy treatment in all assessments: disability, leg and back pain, kinesiophobia, health-related quality of life, depression and self-efficacy. The improvements could still be seen at the 2-year follow-up.

The natural course of healing must be considered carefully, especially when evaluating treatment effects in patients with disc herniation. The symptoms often vary over time and many discs heal spontaneously and the symptoms cease. Approximately 75% of patients with sciatica, without an MRI-verified disc herniation, recover within 3 months, and approximately one-third of patients recover within 2 weeks after the onset of sciatica (6). The natural course of sciatica was evaluated in a randomized controlled trial (34), which compared NSAIDs with placebo. The patients were, however, examined within 14 days after the onset of radiating leg pain. After 3 months, 60% of the patients had recovered and, after 12 months, 70% had recovered. In order to minimize the influence of spontaneous healing in the present study, the patients were therefore

Table IV. Number of patients (%) on sick leave at each follow-up

	Baseline values n=41	3-month follow-up n=41	12-month follow-up n=35	24-month follow-up n=36
Sick leave	n (%)	n (%)	n (%)	n (%)
Full-time sick leave	22 (54)	9 (22)	2 (6)	1 (3)
Part-time sick leave	5 (12)	10 (24)	4 (11)	3 (8)
At work	14 (32)	22 (54)	29 (83)	32 (89)

included only if they had had persistent pain and disability for more than 6 weeks. In fact, the majority of the patients had had pain and disability for more than 3 months. It is therefore most likely that the effects of treatment seen in the present study are, in the majority of patients, an effect of the structured physiotherapy treatment model and not a result of spontaneous healing.

In the study by Weber et al. (34), the VAS leg pain mean score was reduced from 54 mm at baseline to 19 mm within 4 weeks for all 183 patients, regardless of treatment. After 1 year, the VAS leg pain mean score was 17 mm. The patients in the present study who were a little worse at baseline (60 mm) reported 9 mm on the VAS leg pain just 3 months after treatment. Consequently, in the present study, the median VAS level had already been reduced to under the no-pain score, defined as 0–10 on the VAS (26), at the 3-month follow-up and this was maintained to the 12- and 24-month follow-ups.

Physiotherapy treatment for patients with lumbar disc herniation can lead to improvements. Brötz et al. (17) included a selected group of patients who responded with the centralization of pain after the first 5 daily sessions of treatment according to the MDT method. Centralization of pain is defined as a clinically induced change in the location of pain referred from the spine, that moves from the most distal position toward the lumbar midline (35). However, the patients' medium duration of symptoms before treatment was only 12 days and the possibility that patients recovered naturally cannot therefore be excluded (17).

In a retrospective study, 95 patients were treated with a functional restoration programme (36). The patients achieved significant improvements after a mean treatment period of 8.7 months. The evaluation was performed at discharge only. With a treatment period of this length, it is, however, difficult to differentiate between the effects of treatment and the natural healing process. In the present study, a shorter treatment period was adopted, and large and significant improvements were found after just 3 months and were still present at the 24-month follow-up. It is therefore not likely that the natural healing process was responsible for the positive results in the present study.

In a prospective study of 82 consecutive patients with acute severe sciatica, included for conservative management, only a minority of the patients had made a full recovery after 12 months (37). Twenty-five percent of the patients underwent surgery within 4 months and one-third had surgery within 1 year. In spite of the fact that the inclusion criteria in the present study followed the recommendations for surgery (21, 38), no patient required surgery at the 3-month follow-up and, after 12 months, only 3 patients (7%) had undergone surgery. The interpretation of the divergence could be that the structured physiotherapy treatment model used in the present study appeared to influence patients with lumbar disc herniation in a very positive direction. One recommendation is therefore to follow the structured physiotherapy treatment model before considering surgery.

In this study, MRI verification of disc herniation was an inclusion criterion. In clinical practice, MRI verification is not

mandatory, as it is in surgical treatment, before introducing structured physiotherapy treatment to patients with symptoms from a disc herniation. Consequently, treatment according to the structured physiotherapy treatment model can start early after the commencement of symptoms, as it is not necessary to wait for an MRI. It is possible to speculate that, if treatment with a structured physiotherapy model starts earlier than in the present study, the improvements would be even better, further reducing the risk of persistent pain and accompanying problems. Moreover, the need for MRI is likely to diminish; this, however, should be further evaluated in future studies.

One explanation for the good results of this study could be that the patients followed a structured physiotherapy treatment model, comprising MDT and trunk stabilization exercises, allowing for an individual design and progression of the treatment. Similar results were described in a retrospective cohort study (39) using several treatment methods for pain control as well as for exercise training for patients with lumbar disc herniation. The evaluation was not carried out until approximately 31 months after treatment. The results of Saal et al. (39) and of the present study are in agreement, in that structured physiotherapy treatment can reduce symptoms, but symptoms were relieved much more rapidly in the present study.

In a multicentre study comprising 501 patients, randomized to surgery or non-operative care, 18% of the patients assigned to non-operative treatment underwent surgery within 6 weeks and 30% had surgery at approximately 3 months (7). The non-operative treatment group received non-specified "usual care", which could include a variety of different treatment methods. In contrast, the patients in the present study were offered a structured physiotherapy treatment model that included both bio-psychological and social components, as described in the International Classification of Functioning, Disability and Health (40).

There are many possible explanations for the positive effects seen in this present study, and 5 of these will now be discussed. Firstly, the patients were well informed about the design of the structured physiotherapy treatment model, including the timetable for different phases of the treatment and when the treatment was planned to end. This information enhanced the patients' opportunity for self-management and gave them an active role in treatment decision-making.

Secondly, the patients acquired strategies to deal with their pain by using the different activities and movements in order to reduce pain according to the MDT method (14). The MDT method aims to enhance the patients' ability to cope with the symptoms, motivate the patient to comply with the treatment and empower them to achieve independence. Leijon et al. (41) have shown that low levels of motivation plus pain are important factors that enhance non-adherence to physical activity. It therefore appears important to reduce pain and increase motivation as early as possible. It is reasonable to believe that, when the patients participated in the evaluation of different activities and exercises, this augmented their opportunity to discover the connection between activities and the following reduction or increase in symptoms. This could have led to the

increased self-efficacy and empowerment of the patients. The use of empowerment in physiotherapy has been recommended in a review by Perrault (42), who argues that empowerment improves the intervention.

Thirdly, the intensity of exercises was gradually increased on an individual basis with respect to the patients' reported pain. The objective was to strengthen the patients' self-efficacy, which also improved significantly in the present study. Fourthly, the trunk stabilization exercises were conducted with the aim of increasing deep trunk muscle control (23). It can be speculated that the physiological effects of training may also have led to reduced pain through increased blood circulation, muscle relaxation and the release of pain-reducing substances, such as endorphins.

Finally, one reason for the improvements could be that the physiotherapists were experienced and well educated in the MDT method. Subsequently, the physiotherapists were able to guide the patients during the rehabilitation process. It is, however, not possible to determine whether and how much each of the reasons discussed above contributed to the improvements. It seems reasonable to assume that all 5 factors were operating.

In this study, the majority of patients experienced kinesiophobia before treatment started. As early as 3 months after the structured physiotherapy treatment started, the number of patients with kinesiophobia fell dramatically and the majority of patients no longer experienced kinesiophobia. These results are in agreement with those of a study of patients with chronic pain and high kinesiophobia who increased their physical activity level after a pain management programme designed to enable the patients to regain overall function (43).

There are some limitations to this study. It is not possible to exclude the possibility that some patients may have improved spontaneously without treatment. Measures were taken to limit this risk by using symptoms for at least 6 weeks as an inclusion criterion. Again, the majority of patients had symptoms for more than 3 months. Another limitation might relate to whether the patients were selected accurately for the study. Clinically experienced orthopaedic surgeons evaluated the clinical findings and the MRI scans and classified the patients as surgical candidates based on recommendations from the American Academy of Orthopaedic Surgeons for intervention for disc herniation published in 1993 (21). The patients included in the present study also fulfilled the recommendations as presented by Bono and co-workers in 2006 (38). The patients can therefore be regarded as serving as their own controls, and comparisons can be made with baseline symptoms and with patients from other studies. An RCT would have been the best way to explore different treatment options; however, we did not reach the number of patients required for an RCT. As the treatment model used in the present study has not been evaluated previously in a group of patients with long-standing pain, with the majority of the patients having pain for more than 3 months due to disc herniation, and, as the results are clinically interesting, it was decided to present the results as a cohort study.

In conclusion, this study shows that patients eligible for lumbar disc surgery improved significantly after treatment with the structured physiotherapy model, as early as 3 months after treatment, and the results could still be seen at the 24-month follow-up. Consequently, these patients did not qualify for lumbar disc surgery 3 months after the physiotherapy treatment started. Moreover, the majority of patients had symptoms for more than 3 months at the start of treatment and, for this reason, most of the spontaneous healing ought to have occurred before this study started. This study therefore recommends adoption of the structured physiotherapy treatment model before considering surgery when patients report symptoms such as pain and disability due to lumbar disc herniation.

#### ACKNOWLEDGEMENTS

The authors would like to thank physiotherapists Patrik Drevander, Christina Grundén, Sofia Fridén and Eva Fahlgrén for treating the patients and Valter Sundh for statistical support. This study was supported by grants from the Health & Medical Care Committee of the Västra Götaland Region, Renée Eander's Foundation and Wilhelm & Martina Lundgren's Foundation of Science.

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