

The effectiveness of exercise programmes after lumbar disc surgery: a randomized controlled study

Mustafa Filiz, Aysegul Cakmak and Emel Ozcan Istanbul University, Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Istanbul, Turkey

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Objective: To compare two different exercise programmes versus a control group, after lumbar disc surgery.

Design: A prospective, single-blind, randomized controlled study.

Setting: Outpatient clinic of Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation.

Subjects: Sixty patients diagnosed as having single level lumbar disc herniation with clinical examination and MRI evaluation and who had undergone lumbar discectomy (post-operative first month) at a single level. Patients with serious pathologies involving the cardiac and respiratory systems that could prevent them from doing exercises were excluded.

Intervention: The patients were randomly split into three groups. The first group received an intensive exercise programme and back school education while the second group received a home exercise programme and back school education. The third group was defined as the control group and did not receive education or exercise.

Main measures: The patients were evaluated at the beginning and end of the treatment with clinical parameters, pain levels, endurance tests and weight-lifting tests, modified Oswestry Disability Index, Beck Depression Inventory, Low Back Pain Rating Scale and return to work.

Results: The groups doing exercises experienced a decrease in the severity of pain and disability, also functional parameters showed better improvement than the control group. The intensive exercise programme was better than the home exercise programme.

Conclusions: It seems that intensive exercise is more effective in reduction of pain and disability, but whether it is cost-effective is not clear.

Introduction

Low back pain is a frequently encountered symptom. Although 70–80% of the entire population

have low back pain complaints in their lives, only 2–4% of them require surgical intervention.¹

In all studies of back pain, 10–15% of patients account for 80–90% of the total health care consumption and costs for spinal disorders, and the 1–2% of patients who undergo surgery are the most expensive group.² Therefore, while calculating the cost of surgery in the lumbar region, not only the cost of the operation

Address for correspondence: Aysegul Cakmak, Istanbul University, Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation, 34390 Sehremini – Istanbul, Turkey. e-mail: cakmakaysegul@hotmail.com

but also the period of time away from work, unemployment remunerations paid by the insurance company and/or the state and the cost of other treatments for preoperative and postoperative pain control should be taken into consideration.

In spinal surgery, postoperative clinical complaints persist in varying degrees in 5–20% of the cases.^{3,4} Various researchers attribute the surgical failures to different reasons. Being away from work for a long time in the preoperative period has been shown to be closely related to postoperative failure.^{5,6} This result may be due to an increase in nerve injury because of long-term nerve root compression as well as a functional loss in back muscles due to long-term decreased activity.³ Muscle atrophy due to prolonged activity restriction is expected, especially in the back muscles of patients with disc herniation. Since atrophied muscles will be weak and fatigued, stresses imposed upon fatigued muscles will put a strain especially on the intervertebral disc and ligaments.⁷ Besides inactivity, pain also contributes to atrophy with the reflex inhibition it creates. Higher load is imposed upon the intervertebral discs and apophysial joints, especially in postural changes observed in patients with unilateral pain.^{8,9} Changes in muscle structure and function cannot be corrected even with surgery. On the contrary, long-term retraction of weak muscles during surgery and the severity of pain in the postoperative period may also lead to muscle atrophy.¹⁰

There are various studies indicating that exercise improves pain and disability in chronic low back pain and in those who have had surgery.^{11,12} The main objectives of the postoperative rehabilitation programmes are to accelerate and maximize function recovery as much as possible, and to prevent further injury by restricting the progression of degenerative changes. Studies on patient education and the effectiveness of exercise in reaching this goal are controversial.¹³

In our study, we aimed to determine the effectiveness of exercise programmes versus a control group in Turkish patients who had undergone single level discectomy, with respect to pain, clinical and functional status evaluations.

Methods

Subjects

Sixty patients attending the outpatient clinic of the Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation after lumbar disc surgery were included in this study (Figure 1).

All patients between ages of 20 and 50 who had a lumbar disc operation (single level discectomy) for the first time were referred from the Istanbul Faculty of Medicine, Department of Neurosurgery after surgery.

The patients were evaluated with detailed questionnaires. Patients with complaints compatible with the nerve trace in the neurological examination, with neurological deficits, with additional musculoskeletal pathologies such as spondylosis, spondylolisthesis or osteoporosis, and with a cardiovascular pathology that could prevent doing exercises were excluded from the study.

Main measures

Patients were evaluated with the following criteria at the beginning and at the end of treatment (treatment lasted eight weeks). So pretreatment values are one month after surgery and posttreatment values are three months after surgery.

- Progressive Isoinertial Lifting Evaluation (PILE) test to determine weight lifting capacity^{14–17}
- Body endurance test to determine the back and abdominal muscles endurance¹⁸
- Lumbar Schober for mobility¹⁵
- Visual analogue scale (VAS) graded between 0 and 100 for pain¹⁴
- Modified Oswestry Disability Index, Low Back Pain Rating Scale for functional evaluation^{19,20}
- Beck Depression Inventory for depression.²¹

The PILE test is a safe, simple and low-cost test developed at Productive Rehabilitation Institute of Dallas for Ergonomics in 1988. Men (women) must be able to lift 50% (35%) of their body weight from floor to waist level and 40% (25%) of their body weight from waist to shoulder level. These ratios are generally decreased by 40–50% in patients with low back pain.^{16,17}

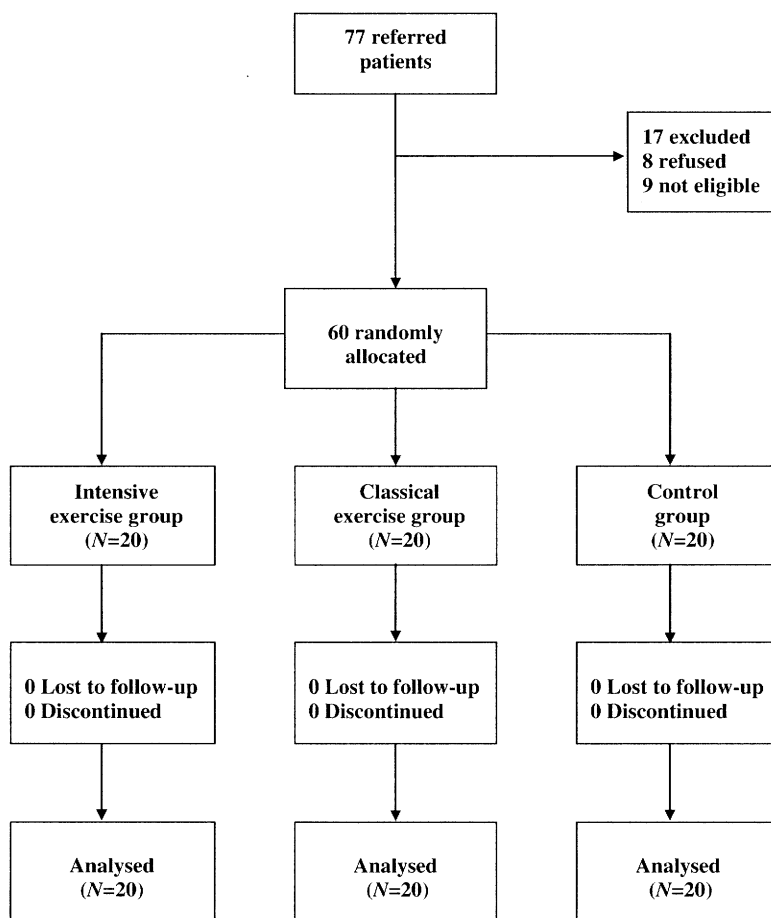


Figure 1 Flow diagram of the study.

In the body endurance test, body flexors and extensors are examined separately. For the examination of flexors, the patient lies in a supine position and brings his or her lower extremities to 90° flexion from the hips and knees. For the examination of extensors, the patient is told to keep the sternum away from the floor while lying in a supine position. In this condition, placing a pillow under the pelvis reduces lumbar lordosis. During both tests the individuals are told to maintain their original positions as long as possible but not exceeding 5 min.¹⁸

Disability was evaluated by Modified Oswestry Disability Index^{19,22} and Low Back Pain Rating Scale. Low Back Pain Rating Scale includes the

three basic disease components of pain, disability and physical insufficiency (impairment). The test total score ranges between 0 and 130, pain is scored between 0 and 60, disability is scored between 0 and 30 points, and physical insufficiency is evaluated on a scale of 40 points.²⁰

Intervention

The study was planned as a prospective, single-blind, randomized controlled study. All the patients were given as much detail as possible about the programme before starting the study and those who accepted signed a voluntary consent form. Two different physicians carried out the treatment and evaluation. The physician who did the evaluation (before and after treatment) was

blinded to the treatment. At the beginning of the programme a nurse prepared 60 sheets of opaque paper, which were folded with the treatment being inside and taped from the corners (in order to prevent the drawer being able to see the method) and put in a box. When the patients were admitted into the programme the second physician who would show and apply the exercises drew a sheet, and thus the patients were divided into groups.

The first group of patients received an intensive exercise programme and back school education while the second group received a home exercise programme and back school education. The third group were defined as the control group and did not receive education or exercise. All exercise programmes started 30 (± 3) days from the operation.

The first two groups received the back education programme applied in the outpatient clinic of Istanbul Faculty of Medicine, Department of Physical Medicine and Rehabilitation; patients in groups of eight attended a total of four lessons, twice a week. The patients were informed about the appropriate 'use of body mechanics' for the whole body and they were taught back protection methods. (The structure and function of the spine, main causes of low back pain, importance of relaxation and exercises, appropriate standing, sitting, lying down and getting up, sleeping, weight lifting and weight carrying, etc.) The first group also received a total of eight weeks intensive exercise programme three days a week; each session lasted 1.5 hours. The patients were taught relaxation positions and techniques, and were first made to relax for 5–10 min. Afterwards, the patients performed stretching exercises in order to be able to increase soft tissue flexibility and joint mobility. Following these stretches, the determined intensive exercise protocol was applied. The exercise programme was taught as 'dynamic lumbar stabilization exercises' as determined by Saal and Saal.¹³ In this programme, finding a neutral position and strengthening abdominal muscles in this position, bridge building, stepping in bridge position, hamstring stretching, maintaining the neutral position during movement of arms and legs while lying face down, maintaining balance in a four-foot position, stepping while standing up, sliding on the wall, and bending forward in upright position exercises were applied. At first, the exercises were performed in

three sets with five repetitions; later, the number of repetitions was increased by one every day until three sets with 15 repetitions were reached. In dynamic lumbar stabilization exercises, the exercises were first performed on a one-to-one basis. After successful completion of the basic steps, the patients exercised in groups of five people. Each exercise was done for 5 s with 10 s of resting periods between exercises. After the exercise, the patients did an aerobic exercise on the exercise bicycle for 15 min.

The second group received back education involving basic body mechanics as the first group did and were taught classical exercises. This group learned the McKenzie²³ and Williams²⁴ exercises in the clinic and later did these exercises at home three days a week. The home exercise programme was followed up by telephoning the patients once a week.

The third group was defined as the control group and did not receive any education or exercise programme. They were advised to be as active as possible with their daily routines.

The data were evaluated with the SPSS 10.0 program. ANOVA variance analysis and Kruskal–Wallis test were used.

Results

No significant difference with respect to demographic data was observed between the groups at the beginning of treatment as seen in Table 1 ($p > 0.05$).

Since nearly half of our patients were women and most of them were housewives, it was impossible to determine the preoperation loss of working days (because most of them did not remember); therefore it could not be used as an assessment criterion. There were no differences between groups with respect to preoperative pain duration, duration of bed rest and hospital stay in the postoperative period ($p > 0.05$) (Table 1). The time to return to work (for housewives return to daily activities) after the operation was shorter in the intensive exercise group compared with the other groups, and in the classical exercise group it was shorter compared with the control group ($p < 0.001$) (Table 2).

Table 1 Demographics and details of the patients before treatment

	Group 1	Group 2	Group 3	p-value
Gender (male/female)	10/10	12/8	9/11	>0.05
Age	38.20 ± 1.54	41.25 ± 1.18	40.20 ± 1.24	>0.05
Weight (kg)	70.55 ± 1.87	74.25 ± 2.54	72.70 ± 2.19	>0.05
Height (cm)	167.25 ± 1.55	168.95 ± 2.47	164.95 ± 2.30	>0.05
Body mass index	25.24 ± 0.71	26.02 ± 0.82	26.67 ± 0.56	>0.05
Pre-op pain duration (years)	6.35 ± 2.45	6.97 ± 2.65	6.32 ± 2.03	>0.05
Pre-op bed rest (last 3 months) (days)	29.45 ± 8.95	45.35 ± 10.05	43.85 ± 9.55	>0.05
Post-op hospital duration (days)	5.55 ± 1.49	6.40 ± 1.89	6.80 ± 1.95	>0.05

Table 2 Clinical parameters before and after treatment

	Group 1	Group 2	Group 3	p-value
Post-op return to work (days)	56.07 ± 18.66 ^b	75.00 ± 24.94 ^a	86.25 ± 27.11	<0.001
Lumbar Schober (cm)				
Pretreatment	12.70 ± 0.91	12.27 ± 0.96	12.25 ± 0.90	0.34
Posttreatment	14.05 ± 0.81 ^a	13.55 ± 0.86 ^a	12.75 ± 0.79	<0.001
Visual analogue scale				
Pretreatment	20.50 ± 10.20	22.00 ± 12.23	24.75 ± 14.33	0.66
Posttreatment	4.50 ± 1.59 ^b	12.00 ± 3.67	13.25 ± 7.34	<0.001
PILE–Floor–waist (kg)				
Pretreatment	9.12 ± 2.89	7.87 ± 1.90	9.37 ± 2.93	0.63
Posttreatment	15.37 ± 4.99	14.50 ± 4.81	12.75 ± 3.55	0.35
PILE–Waist–shoulder (kg)				
Pretreatment	12.00 ± 3.91	11.50 ± 3.60	11.75 ± 3.69	0.96
Posttreatment	16.87 ± 5.11	15.87 ± 5.00	15.00 ± 4.77	0.64
Back endurance (s)				
Pretreatment	98.50 ± 52.30	77.60 ± 49.65	58.90 ± 37.68	0.16
Posttreatment	294.00 ± 90.45 ^b	188.00 ± 73.88 ^a	96.00 ± 40.93	<0.001
Abdominal endurance (s)				
Pretreatment	81.75 ± 49.63	88.75 ± 50.64	85.35 ± 52.36	0.94
Posttreatment	236.00 ± 88.46 ^b	161.75 ± 69.44 ^a	65.25 ± 37.99	<0.001
Modified Oswestry Disability Index				
Pretreatment	19.05 ± 6.90	18.25 ± 6.80	19.45 ± 6.85	0.90
Posttreatment	7.05 ± 4.87 ^a	11.65 ± 7.21 ^a	15.10 ± 8.55	<0.001
Beck Depression Inventory				
Pretreatment	8.70 ± 7.75	8.60 ± 7.67	8.50 ± 7.56	0.09
Posttreatment	4.15 ± 4.00 ^a	6.30 ± 6.99	6.50 ± 7.03	<0.001
Low Back Pain Rating Scale				
Pretreatment	41.20 ± 18.43	43.65 ± 19.52	43.90 ± 20.05	0.80
Posttreatment	7.40 ± 6.92 ^b	22.45 ± 13.94 ^a	39.60 ± 20.54	<0.001

^aSignificantly different compared with group 3.

^bSignificantly different compared with group 2 and group 3.

No significant difference with respect to clinical parameters was observed between the groups at the beginning of treatment as seen in Table 2 ($p > 0.05$).

After the treatment, there was no difference among the groups in the weight-lifting test (PILE). The patients' apprehensive attitude towards weight lifting after the lumbar operation and their low physical fitness due to their long-term bed rest in the preoperative period may have led to this result. A significant difference was detected in both exercise groups in lumbar Schober test compared with the control group ($p < 0.001$). The pain score evaluated by VAS was also significantly improved in the intensive exercise group compared with the other two groups ($p < 0.001$). In the back and abdominal body endurance tests both exercise groups had significantly better results than the control group and the intensive exercise group was better than the classical exercise group. Low Back Pain Rating Scale results were same as endurance test results. Both exercise groups had significantly better results than the control group in the Modified Oswestry Disability Index. For the Beck Depression Inventory only the intensive exercise group had better results than the control group (Table 2).

Discussion

Although the effectiveness of an early and intensive rehabilitation programme after lumbar disc surgery is controversial,¹³ in our study we found that the groups doing exercises experienced a decrease in the severity of pain and disability, and that functional parameters showed more improvement than the control group. The intensive exercise programme was better than the home exercise programme.

In a study by Manniche *et al.* conducted in patients undergoing lumbar disc surgery for the first time, it was reported that, compared with a classical exercise programme, intensive exercise was more effective in reducing working day loss and disability.²⁵ Ankjaer-Jehnsen *et al.* found that in a group of 92 patients undergoing a discectomy operation for the first time, a postoperative rehabilitation programme comprising an intensive back

education was more effective than traditional programmes.²⁶ These findings are similar to our results. Maintenance of continuous contact with the patients during the treatment period and the ability of the patients to overcome their fears about activity by consulting their physicians during the intensive exercise programme sessions they attended had a positive impact on the improvement of their physical status.

In the studies conducted by Dolan *et al.*, despite their limited number of cases, the superiority of an intensive exercise program starting six weeks after discectomy and continuing for four weeks over the control group with respect to pain, disability and spinal functions was emphasized. The researchers report that this difference also persists at the follow-up at the end of the first year.³ In our study the pain score evaluated by VAS was also significantly improved in the intensive exercise group over that in the other two groups ($p < 0.001$). Besides an increase in muscle strength with the intensive exercise programme, an increase in lumbosacral region joint mobility, the fact that the patients were in continuous contact with the physician while doing controlled exercises three days a week, and their experiencing a feeling of psychological well-being may have led to this result.

However, in a study with one-year follow-up conducted by Danielsen *et al.*, while they reported better results for intensive exercises than for classical exercises with respect to disability and pain severity at six months, they added that this difference was no longer observed at the end of the first year.¹¹ Johannsen *et al.* reported that there was no statistically significant difference in the follow-up criteria of the postoperatively followed-up patients between an intensive programme and a home programme, and that there was no need for an intensive program.²⁷ Although the follow-up period was short in our study, both exercise groups were significantly better than the control group with respect to back and abdominal muscle endurance, modified Oswestry Disability Index and Low Back Pain Rating Scale. A significant reduction in modified Oswestry Disability Index of both exercise groups in our study reveals the effect of activity increase on quality of life. However Low Back Pain Rating Scale also includes the subgroups of physical impairment and disability

besides pain. When the total score is taken into consideration, the importance of exercising may be emphasized, yet intensive group exercise under the control of a physician in the clinic decreases the patients' perception of disability and physical impairment to a greater extent, and pain is alleviated faster and quality of life improves more rapidly.

One of the reasons for the decreasing superiority of the exercise programme over the control group in time may be the patients' cessation of the regular exercises. In the study by Kjellby-Wendt *et al.*, patients taken into a postoperative intensive exercise programme and a classical exercise programme were evaluated by mail 5–7 years later, and it was determined that none of them exercised regularly.²⁸ In our study, the long-term posttreatment results of the patients are not known.

Limitations of our study

- Short-term follow-up
- Relatively small number of patients
- Patients with relatively good clinical conditions
- Cost-effectiveness analysis was not considered
- Control group should have had at least back school education.

In conclusion, postoperatively applied education and exercise applications should be part of treatment with respect to the patients' earlier return to work and quicker recovery. Further studies on patient education and the effectiveness of different exercise programme in reaching this goal are

needed possibly with larger patient groups and longer follow-ups. Also cost-effectiveness studies should be considered.

References

- 1 Rosomoff RS. Back school programs. The pain patient. *Occup Med* 1992; **7**: 93–103.
- 2 Waddell G, Gibson JNA, Grant I. Surgical treatment of lumbar disc prolapse and degenerative lumbar disc disease. In: Nachemson AL, Johnsson E eds. *Neck and back pain: the scientific evidence of causes, diagnosis and treatment*. Philadelphia: Lippincott Williams and Wilkins, 2000: 305–25.
- 3 Dolan P, Greenfield K, Nelson RJ, Nelson IW. Can exercise therapy improve the outcome of microdiscectomy? *Spine* 2000; **25**: 1523–32.
- 4 Waddell G. Failure of disc surgery and repeat surgery. *Acta Orthop Belg* 1987; **53**: 300–302.
- 5 Donceel P, Du Bois M. Fitness for work after surgery for lumbar disc herniation: A retrospective study. *Eur Spine J* 1998; **7**: 29–35.
- 6 Hurme M, Alaranta H. Factors predicting the result of surgery for lumbar intervertebral disc herniation. *Spine* 1986; **9**: 933–38.
- 7 Hides HJ, Stokes MJ, Saide M, Jull GA, Cooper DH. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. *Spine* 1994; **19**: 165–72.
- 8 Adams MA, McNally DM, Chinn H, Dolan P. Posture and the compressive strength of the lumbar spine. International Society of Biomechanics Award Paper. *Clin Biomech* 1994; **9**: 5–14.
- 9 Stokes MJ, Young A. The contribution of reflex inhibition to arthrogenous muscle weakness. *Clin Sci* 1984; **67**: 7–14.
- 10 Gejo R, Matsui H, Kawaguchi Y, Ishihara H, Tsuji H. Serial changes in trunk muscle performance after posterior lumbar surgery. *Spine* 1999; **24**: 1023–28.
- 11 Danielsen JM, Johnsen R, Kibsgaard SK, Hellevik E. Early aggressive exercise for postoperative rehabilitation after discectomy. *Spine* 2000; **25**: 1015–20.
- 12 Carragee EJ, Han MY, Yang B, Kim DH, Kraemer H, Billys J. Activity restrictions after posterior lumbar discectomy. A prospective study of outcomes in 152 cases with no postoperative restrictions. *Spine* 1999; **24**: 2346–51.
- 13 Saal JA, Saal JS. Postoperative rehabilitation and training. Subacute spinal disorders. In: Mayer TG, Mooney V, Gatchel RF eds. *Contemporary conservative care for painful spinal disorders*. Philadelphia: Lea and Febiger 1991: 318–27.

Clinical messages

- Exercise programmes seem to be effective in patients who have undergone single level discectomy, with respect to pain, clinical and functional status evaluations.
- Further studies on patient education and the effectiveness of different exercise programmes in reaching this goal are needed, possibly with larger patient groups and longer follow-ups. Also cost-effectiveness studies should be considered.

- 14 Hazard RG, Haugh LD, Green PA, Jones PL. Chronic low back pain. *Spine* 1994; **19**: 881–87.
- 15 Lindström I, Öhlund C, Eek C, Wallin L, Peterson LE, Nachemson A. Mobility, strength, and fitness after a graded activity program for patients with subacute low back pain. *Spine* 1992; **17**: 641–52.
- 16 Curtis L, Mayer TG, Gatchel RJ. Physical progress and residual impairment quantification after functional restoration. Part III: Isokinetic and isoinertial capacity. *Spine* 1994; **19**: 401–405.
- 17 Matheson LN. Evaluation of lifting. In: Liebenson C ed. *Rehabilitation of the spine: a practitioner's manual*. Pennsylvania: Williams and Wilkins 1996: 143–51.
- 18 Ito T, Shirado O, Suzuki H, Takahashi M, Kaneda K, Strax TE. Lumbar trunk muscle endurance testing: An inexpensive alternative to a machine for evaluation. *Arch Phys Med Rehabil* 1996; **77**: 75–79.
- 19 Hudson-Cook N, Tomes-Nicholson K, Breen A. A revised Oswestry Disability Questionnaire. In: Roland MO, Jenner JR eds. *Back pain: new approaches to rehabilitation and education*. Manchester: Manchester University Press, 1989: 187–204.
- 20 Manniche C, Asmussen K, Lauritsen B, Vinterberg H, Kreiner S, Jordan A. Low Back Pain Rating scale: validation of a tool for assessment of low back pain. *Pain* 1994; **57**: 317–26.
- 21 Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961; **4**: 53–63.
- 22 Duruöz MT, Özcan E, Ketenci A, Karan A, Kiralp MZ. Cross cultural validation of the Revised Oswestry Pain Questionnaire (RODQ) in a Turkish population. *Arthr Rheumat* 1999; **42** (09 Suppl): 270.
- 23 McKenzie RA. *The lumbar spine*. New Zealand: Spinal Publications, 1981.
- 24 Williams PC. *The lumbosacral spine: emphasizing conservative management*. New York: McGraw-Hill, 1965.
- 25 Manniche C, Skall HF, Braendholt L *et al.* Clinical trial of postoperative dynamic back exercises after first lumbar discectomy. *Spine* 1993; **18**: 92–97.
- 26 Ankjaer-Jensen A, Manniche C, Nielsen H. Postoperative rehabilitation of patients operated for lumbar disc prolapse. An analysis of the socioeconomic consequences. *Ugeskr-Laeger* 1994; **156**: 647–52.
- 27 Johannsen F, Remvig L, Kryger P *et al.* Supervised endurance exercise training compared to home training after first lumbar discectomy: a clinical trial. *Clin Exp Rheumatol* 1994; **12**: 609–14.
- 28 Kjellby-Wendt G, Carlsson SG, Styf J. Results of early active rehabilitation 5–7 years after surgical treatment for lumbar disc herniation. *J Spinal Disord Tech* 2002; **15**: 404–409.