

Early Aggressive Exercise for Postoperative Rehabilitation After Discectomy

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Study Design. A randomized clinical trial of postoperative medical exercise therapy in patients after operation for lumbar disc herniation with blind assessment of clinical outcomes.

Objective. To assess the effect of an early regimen of vigorous medical exercise compared with an ordinary care program.

Summary of Background Data.

Methods. Patients offered an operation for lumbar disc herniation were consecutively randomized to a training group or to a control group. The training consisted of an 8-week active rehabilitation program including a regimen of vigorous lumbar stabilizing exercises. The control subjects participated in a mild program of 2 to 3 back exercises at home, after relaxing and resting their backs for 2 months after the surgery. The outcomes were evaluated 6 and 12 months after the operation. The results are based on intention-to-treat analyses.

Results. Sixty-three of 65 eligible patients agreed to participate in the trial. Fifty-eight and 53 patients attended for evaluation at 6 and 12 months, respectively. There was a significantly larger improvement in the mean Roland's disability index (from 8.9 to 5.4 [$P = 0.02$] at 6 months and from 8.7 to 5.3 [$P = 0.03$] at 12 months) and in reported pain (from 3.7 to 2.0 [$P = 0.04$] at 6 months and from 3.2 to 1.8 [$P = 0.09$] at 12 months) in the training group. A significantly ($P = 0.05$) higher proportion of the training group reported that they participated in daily activities as usual. There were more patients in the training group who reported improvement in self-evaluated health after surgery at both 6 ($P = 0.02$) and at 12 months ($P = 0.05$). Finally, no differences in clinical end points were observed between the groups.

Conclusions. Vigorous medical exercise therapy, started 4 weeks after surgery for lumbar disc herniation, reduced disability and pain after surgery. Because no differences in clinical end points were observed, there is hardly any danger associated with early and vigorous training after operation for disc herniation. [Key words: back, disability, discectomy, outcome, pain, randomized clinical trial surgery] *Spine* 2000;25:1015-1020

than those treated conservatively.^{2,22} Later studies of lumbar disc surgery showing a success rate of 49% to 90%, have not reproduced Weber's results.^{1,4,14-17} The contrasting results from such studies are related to the selection criteria for operation, to the applied operation technique, and to the different rehabilitation programs for both the conservatively treated and the surgically treated patients.^{6,7,11-13,20-22} The effect of the rehabilitation program is shown to have considerable impact on the outcome.^{2,10,13,16} Restricted activity has been recommended for the first 6-8 weeks in Norway after surgery.⁸ The following 4-6 weeks of rehabilitation consist of nonstandardized exercises of low-intensity activity, within pain limits.⁸ Similar rehabilitation programs are recommended elsewhere in the Western world.³ There are, however, some reports on good outcomes after early training programs.^{2,16,17}

The objective of this study was to evaluate the effect of standardized intensive training starting 4 weeks after lumbar discectomy on clinical outcome, length of sick leave, pain reporting, and experienced disability compared with the referred regular care program.⁸

■ Methods

Setting. From November 1992 through November 1995 all patients living in the municipality of Rana, who were offered an operation for lumbar disc herniation at Rana Hospital, Norway, were invited to participate in a randomized controlled study of a postoperative rehabilitation program. To be included, they had to be between 20 and 60 years of age, and besides sciatic symptoms they could have no other diseases that might influence their ability to participate in physical training.

Selection and Randomization of Subjects. After signing the informed consent and at least 1 day ahead of the preoperative examination, patients were randomized by random number tables to either a training or a control group. A secretary at the hospital performed the randomization procedure, and the result of the allocation was handed over to the project coordinator on the day of discharge. The intervention started 4 weeks after the operation. For the first 3 weeks, the training group followed the standard regimen of the control group. The training group took part in a rehabilitation program, three times a week for 8 weeks. The training followed the criteria for medical exercise therapy.⁹ The exercises were exclusively active and were performed with no manual intervention of a physical therapist. Various apparatuses, such as horizontal and vertical pulleys, weights, and exercise tables were used. The purpose of the exercises was to strengthen the muscles of the back, the abdominal muscles, and the muscles in the lower extremities.

The patients performed the same type of exercises, but the

Some 15 years have passed since Weber documented that patients with lumbar disc herniation treated with lumbar disc surgery had less pain and were mobilized earlier

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Supported by grants from the Norwegian Fund for postgraduate training of physiotherapists.

Acknowledgment date: September 18, 1998.

First revision date: December 17, 1998.

Acceptance date: July 24, 1999.

Device status category: 1.

Conflict of interest category: 14.

Table 1. The Age and Sex Distribution, the Working Status and the Level of Leisure Activity Preoperatively in the Training and Control Groups. Rana 1996.

	Training Group (N = 39)		Control Group (N = 24)		P-Value
Age (years)					
Mean	37,6		42,4		0,05
Median	38,0		41,5		
Range	22–58		28–57		
	n	%	n	%	
Sex					
Female proportion	15	38,5%	7	29,2%	0,50
Working status					
Full time work	34	87,2%	20	83,3%	0,43
Others	5	12,8%	3	12,5%	
Missing	0	0%	1	0%	
Work load					
Heavy work	16	4,4%	12	52,2%	0,3
Easy/sitting work	20	55,6%	10	43,5%	
Missing	0		1		
Level of leisure activity					
High	8	20,5%	2	8,3%	0,4
Medium	20	51,3%	15	62,5%	
Low	9	23,1%	7	29,2%	
Missing	2		0		

load and the repetitions of each exercise were adjusted to each patient's condition. The number of repetitions of each exercise varied from 2×15 at the beginning of the training period to 3×30 at the end. Each sequence of training lasted 40 minutes.

The control group was assigned to follow-up consultations (information on the clinical course and clinical examination) with the physiotherapist every 2 weeks. The control group was given the standard formula when they left the hospital 1 week after the operation. This formula provides the information on how patients newly operated on should spend their first 2 months, including a description of a mild program for exercises at home. Beyond this, patients should concentrate on relaxing and resting the back, resume daily activities gradually, and avoid any kind of heavy work at home. Both groups filled in a pain registration journal on a daily basis. The information was handed over to the physiotherapist every 2 weeks.

Before surgery, all patients had a clinical examination, a myelogram, and a computed tomographic scan and completed visual analog scale (VAS) scoring for pain, a standardized pain drawing, Roland's disability questionnaire, and Wonca's functional status measures.^{19,23} Roland's questionnaire is a validated instrument to measure self-rated disability due to back pain.¹⁹ Patients are given a score of 1 point for each of the 24 items on the questionnaire. An individual patient's score can thus vary from zero (no disability) to 24 (severe disability).

Wonca's functional status consists of six charts.^{18,23} The charts are simple self-administrated questions with representative diagrams that assess physical, emotional, and social functioning, daily activities, overall health status, and change in health status. The highest possible score is five, consistent with severe disability, and the lowest is one.

All patients were clinically re-examined, and they provided the same data at 6 and 12 months. Three examinations were

Table 2. The Reported Preoperative Pain, Disability, Sick Leave, Participation in Daily Activities, and the Experience of Health Condition in the Training and Control Groups. Rana 1996.

	Training Group (N = 39)		Control Group (N = 24)		P-Value
Pain (VAS)					
Mean (0–10 cm)	6,0		5,6		0,7
	(5, 2–6, 8)		(4, 5–6, 7)		
Roland					
Mean (0–24)	14,0		11,6		0,03
	(12, 6–15, 4)		(9, 6–13, 6)		
Sick leave					
Mean (weeks)	16,1		7,6		0,01
	(12, 0–20, 2)		(4, 6–10, 6)		
	n	%	n	%	
Participation in daily activities					
-as usual or almost without difficulties	6	15,4%	4	16,7%	0,9
-with some or great difficulties	33	84,6%	20	83,3%	
Overall health					
-good to excellent	16	41,0%	14	58,3%	0,18
-fair to poor	23	59,0%	10	41,7%	

VAS = visual analogue scale.

performed by a physiotherapist blinded to group allocation, as was the reading of the VAS forms.

Rana Hospital performs lumbar disc surgery on approximately 60 patients per year. Less than half of those live in the municipality of Rana. Of 65 eligible persons with lumbar disc prolapse, 63 patients (average age, 39.3 years) agreed to participate in the study (41 men, 22 women). Two persons declined to attend the study for personal reasons. In the training group, three patients withdrew: One did not attend any of the training sessions, and two were unable to begin training because of postoperative pain. At 6 months two more had withdrawn; one patient in the training group did not attend follow-up, and one patient in the control group had a new operation 5 months after the first surgery. After 1 year, an additional five persons withdrew: two patients in the training group did not attend, and three patients had a second operation between the 6- and 12-month follow-ups, two in the training group and one in the control group. In all, 58 patients completed the follow-up at 6 months and 53 at 12 months.

Operation Procedures. The surgical technique was arcotomy in 36 patients and microsurgical in 27, with equal distribution of the techniques within the groups. All surgeries were performed by the same surgeon.

Three patients had surgery on at L3–L4, 34 at L4–L5, and 24 on at L5–S1. None had surgery on more than one level. Two patients in the training group and three in the control group had a second operation, but on a different level. Four patients had another operation during the follow-up period within 12 months, 2 in the training group and 2 in the control group.

Sample Size and Statistical Analysis. A difference of 50% in pain reduction, assessed by VAS, or an identical difference in reduction of reported disability assessed by Roland in the in-

Table 3. Intention-to-Treat Analysis (Dropouts are Given the Appropriate Preoperative Value or the Value at the First Control) of the Absolute Values and the Mean Improvement of Disability, Measured by Roland's Disability Questionnaire and Pain, Assessed by a 100mm VAS at 6 and 12 Months After Surgery, in the Training Group and the Control Group (95% Confidence Intervals in Brackets). Rana 1996.

	At 6 months			At 12 months		
	Training Group (N = 39)	Control Group (N = 24)	P-Value	Training Group (N = 39)	Control Group (N = 24)	P-Value
Roland						
Mean absolute values	5, 1 (3, 1-7, 1) <i>5, 1*</i> (2, 2-7, 1)	6, 2 (4, 1-8, 4) <i>6, 1</i> (3, 6-8, 7)	0, 5	5, 3 (3, 2-7, 4) <i>5, 4</i> (3, 3-7, 6)	6, 3 (3, 8-8, 8) <i>6, 1</i> (3, 3-8, 9)	0, 5
Roland						
Mean improvement	8, 9 (7, 0-10, 8) <i>8, 9</i> (6, 7-10, 8)	5, 4 (3, 0-7, 8) <i>5, 5</i> (2, 9-8, 1)	0, 02	8, 7 (6, 8-10, 6) <i>8, 6</i> (6, 5-10, 6)	5, 3 (2, 6-8, 0) <i>5, 6</i> (2, 9-8, 2)	0, 03
VAS						
Mean (cm) absolute values	2, 3 (1, 5-3, 1) <i>2, 3</i> (1, 4-3, 1)	3, 6 (2, 5-4, 7) <i>3, 7</i> (2, 6-4, 8)	0, 05	2, 8 (1, 9-3, 7) <i>2, 7</i> (1, 7-3, 6)	3, 9 (2, 6-5, 7) <i>4, 1</i> (2, 8-5, 3)	0, 2
VAS						
Mean improvement	3, 7 (2, 7-4, 7) <i>3, 5</i> (2, 5-4, 6)	2, 0 (0, 7-3, 3) <i>2, 2</i> (0, 9-3, 5)	0, 04	3, 2 (2, 1-4, 3) <i>3, 2</i> (2, 2-4, 1)	1, 8 (0, 5-3, 1) <i>1, 8</i> (0, 5-3, 1)	0, 09

* Figures adjusted for age (years) and preoperative sick leave (weeks) presented in *italic*.
VAS = visual analogue scale.

tervention group compared with the control group, was accepted as clinically significant. With a statistical power of 0.80 and an α of 0.05, 25 patients in each group would be sufficient, depending on the variance in the groups.

Both the results from the intention-to-treat analysis and the analysis of the patients with complete follow-up are presented. Missing information on outcome in the intention-to-treat analysis was replaced with the proper preoperative assessment or questionnaire answers.

Differences between the groups were tested by *t* statistics for VAS and Roland. Otherwise, χ^2 statistics were used. Data were entered and analyzed using Epi Info ver. 6 (World Health Organization, Geneva, Switzerland).⁵ Analysis of covariance was performed with commercial software (SPSS for Windows; SPSS, Chicago, IL).

■ Results

Patient Characteristics Before Surgery

Patients in the training group were younger than those in the control group (Table 1). Most patients, 54 of 63, were in full-time employment at the beginning of the current episode of sciatica, and there were only minor differences between the two groups regarding preoperative workload, leisure time activity, and full-time employment (Table 1).

The preoperative registration of pain using the VAS indicated no significant differences between the two groups, but the Roland disability scale and the length of preoperative sick leave indicated a greater disability in the training group than in the control group (Table 2). The preoperative sick leave was, on average, 16.1 weeks for the training group and 7.6 weeks for the control

group (Table 2). The reporting of participation in daily activities, however, did not show a corresponding difference in disability between the groups. The duration of preoperative sciatic symptoms and reported overall health did not differ significantly between the two groups.

The preoperative clinical examination of neurologic signs, registration of atrophy, and results of a straight leg raising test and Schober's test showed only minor differences between the groups.

Follow-Up Results

The results of the intention-to-treat analysis of the absolute values of reported disability showed only minor differences in favor of the training group at the 6 and 12 month examination (Table 3). By using mean improvement of disability, however, there was a significantly larger improvement in the training group (Table 3). Both the mean improvement and the absolute value of pain were more favorable at 6 months after the operation in the training group. At the 12-month examination there were no differences between the groups. After adjusting for age and preoperative sick leave (Table 3), only minor and insignificant changes were found. If the preoperative results of Roland were introduced as a cofactor together with age and sick leave in the analysis of covariance, the differences between the groups in mean absolute scores increased and decreased correspondingly in mean improvement.

Table 4. Participation in Daily Activities, the Experience of Health Condition Postoperatively and the Duration of Postoperative Sick Leave in the Training and Control Group. Rana 1996.

	Training Group (N = 39)		Control Group (N = 24)		P-value
	n		n		
Participation in daily activities					
At 6 months					
-as usual or almost without difficulties	26	66,7%	10	41,7%	0,05
-with some or great difficulties	13	33,3%	14	58,3%	
At 12 months					
-as usual or almost without difficulties	25	64,1%	13	54,2%	0,4
-with some or great difficulties	14	35,9%	11	45,8%	
Overall health					
At 6 months					
-good to excellent	29	74,4%	14	58,3%	0,18
-fair to poor	10	25,6%	10	41,7%	
At 12 months					
-good to excellent	27	69,2%	15	62,5%	0,6
-fair to poor	12	30,8%	9	37,5%	
Sick-leave					
mean (weeks)	18,5			22,0	0,96
median	12,0			12,0	
SD	14,3			18,6	

Significantly more patients in the training group reported that they were able to participate in daily activities as usual or almost without difficulty at the 6-month follow-up. After 1 year, the difference between the groups had diminished (Table 4). The number of patients who changed their reporting of participation in daily activities from difficult before surgery to as usual after surgery was compared in the two groups, and a significant difference was found in favor of the training group at 6 months ($P = 0.01$), turning nonsignificant after 1 year ($P = 0.3$).

The frequency of patients considering their self-reported health condition to be good to excellent at 6 and 12 months, showed only minor differences between the groups (Table 4). However, of the 23 patients in the training group who reported fair to poor overall health before surgery (Table 2), 13 reported good to excellent health at 6 months ($P = 0.002$). In the training group, no patient's condition worsened. The corresponding numbers in the control group were 10 (Table 2), of whom 5 had their health improve from fair to poor before surgery to good to excellent at the 6-month examination ($P = 0.5$). Five of the control subjects began at good to excellent and worsened to fair to poor at 6 months. The differences in improvement in self-reported health from before to after surgery between the groups, were statistically significant at 6 months ($P = 0.02$) and at 12 months ($P = 0.05$). The length of the postoperative sick leave was approximately the same in both groups (Table 4).

An efficacy analysis of disability measured by Roland's disability questionnaire and pain reporting by VAS (absolute values and mean improvement) showed mainly the same results as in the intention-to-treat analysis (Table 5): a nonsignificant difference in absolute dis-

ability measured by Roland; a statistically significant difference in reported disability presented as mean improvement; and, finally, a significant difference between the groups in pain assessed by VAS, both for absolute values and for mean improvement.

■ Discussion

The outcome of surgical treatment among patients with lumbar disc hernia depends on the postoperative regimens offered.¹³ Intensive, standardized medical exercise training that ignores fear of provoking pain and begins 4 weeks subsequent to surgery⁹ seemed to reduce postoperative disability at least in the first 6 months. The program reduced pain the first 6 months and increased the number of patients able to participate in daily activities. In contrast to the reported symptoms and physical performance, no differences were shown between the training group and the control group in clinical features such as neurologic signs, straight leg raising test result, and the mobility of the spinal column assessed by a modified Schober test.

Besides randomization, there were several positive features in the design of this trial. All patients, regardless of treatment, had regular contact with their personal physiotherapists, whereas all clinical end points were assessed by another physiotherapist blinded for the assigned treatment. In all intention-to-treat analyses, conservative estimates (preoperative results) are used for subjects who withdrew. An efficacy analyses of 58 and 53 patients at the 6- and 12-month follow-up, respectively, gave the same major results as the intention-to-treat analyses. Finally, because 63 of 65 eligible patients were included in the study, there was no selection bias.

There might be two objections to the presented results. One is the low statistical power for some of the end

Table 5. The Analysis of the Absolute Values and the Mean Improvement of Disability, Measured by Roland's Disability Questionnaire and Pain, Assessed by a 100mm VAS, at 6 and 12 Months After Surgery in the Training Group and the Control Group for Patients With Complete Follow-Up (95% Confidence Intervals in Brackets). Rana 1996.

	At 6 months			At 12 months		
	Training Group (N = 35)	Control Group (N = 23)	P-Value	Training Group (N = 31)	Control Group (N = 22)	P-Value
Roland						
Mean Absolute Values	3, 8 (2, 1-5, 6)	6, 1 (3, 9-8, 4)	0, 1	2, 5 (1, 2-3, 8)	5, 6 (3, 1-8, 1)	0, 1
Roland						
Mean Improvement	9, 9 (8, 1-11, 0)	5, 7 (3, 2-8, 2)	0, 007	10, 7 (8, 9-12, 5)	5, 7 (2, 8-8, 6)	0, 002
VAS						
Mean Absolute Values	2, 1 (1, 2-3, 0)	3, 6 (2, 5-4, 7)	0, 03	2, 1 (1, 2-3, 0)	3, 6 (2, 3-4, 9)	0, 05
VAS						
Mean Improvement	4, 1 (3, 0-5, 2)	2, 1 (0, 8-3, 4)	0, 02	3, 9 (2, 6-5, 2)	2, 0 (0, 6-3, 4)	0, 05

VAS = visual analogue scale.

points. Because of manpower problems at the hospital, the number of operations in the period was lower than expected, and there was a time limit, according to the protocol, for how long the study could run. The second objection is the choice of simple randomization, instead of block design, to assure a better balance between the groups. Controls were older and patients in the training group had been, on average, out of work for a longer period ahead of the operation than control subjects. Regardless of treatment group, however, reported postoperative pain and disability at 6 and 12 months did not differ in relation to age or preoperative time of sick leave. Adjustments for age and length of preoperative sick leave did not change the results.

At Rana Hospital the indications for operative treatment of lumbar disc prolapse have been unchanged during the past 12 years. In Norway, the average incidence of lumbar disc operation is 70/100,000 persons/year, whereas Rana Hospital performed 87/100,000.

The indications for lumbar disc surgery included lumbar disc prolapse verified by myelogram or computed tomography, neurologic loss, more than 3 months' duration of pain, and failure of conservative treatment. All patients in this study fulfilled the criteria for lumbar disc surgery.⁸

To our knowledge only one previous controlled trial regarding postoperative training after lumbar disc operation has been published.¹⁶ Manniche et al¹⁶ reported favorable effects on patients who performed high-intensity dynamic back extension and abdominal exercises starting 5 weeks after surgery on patient disability index and work capabilities. This study, supporting their findings, suggests that medical exercise training improves pain and disability during the first 6 months. At 12 months the differences between intervention and control groups will probably be clinically insignificant.

Whether conservative or operative treatment should be chosen for lumbar disc herniation is still disputed. If,

however, surgical treatment is offered, vigorous medical exercise training would reduce the time needed for recovery through reducing pain and disability. There is hardly any danger associated with such training after operation for disc herniation.

■ Key Points

- Patients who underwent surgery for lumbar disc herniation were included in a randomized blinded clinical trial comparing postoperative vigorous medical exercise therapy with an ordinary care program.
- The training group achieved reduced disability and pain after surgery compared with the control group, but no differences in clinical end points were observed.

Acknowledgments

The authors thank physiotherapists Kristin Sjøvoll and Ørjar Evensen for performing the clinical assessment.

References

1. Abramovitz J, Neff S. Lumbar disc surgery: Results of the Prospective Lumbar Discectomy Study of the Joint Section on Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons. *Neurosurgery* 1991;29:301-8.
2. Alaranta H, Hurme M, Einola S, Kallio V, Knuts LR, Törmä T. Rehabilitation after surgery for lumbar disc herniation: Results of a randomized clinical trial. *Int J Rehabil Res* 1986;9:247-57.
3. Carragee EJ, Helms E, O'Sullivan GS. Are postoperative activity restrictions necessary after posterior lumbar discectomy? A prospective study of outcomes in 50 consecutive cases. *Spine* 1996;21(Suppl 16):S1893-7.
4. Dvorak J, Gauchat M-H, Valach L. The outcome of surgery for lumbar disc herniation. I: A 4-17 years follow-up with emphasis on somatic aspects. *Spine* 1988;13:1418-22.
5. Epi Info 6. A word processing, database and statistics system for epidemiology on micro-computers. WHO shareware. Geneva: WHO; 1995.
6. Frymoyer J, Matteri R, Hanley E, Kuhlmann D, Howe J. Failed lumbar disc surgery requiring second operation. *Spine* 1978;3:7-11.
7. Greenwood J, MCGuire T, Fariss K. A study of the causes of the failure in the

herniated intervertebral disc operation: An analysis of 67 reoperated cases. *J Neurosurg* 1952;9:15–20.

8. The Norwegian Board of Health. Back pain, what is that? What are we doing? IK-2508 1995;7:62–3.

9. Gustavsen R. Training therapy. New York: Georg Thieme Verlag; 1985; chap 1;33.

10. Hansen JW. Postoperative management in lumbar disc protrusions. II: Follow-up on a trained and an untrained group of patients. *Acta Orthop Scand Suppl* 1964;71:32–46.

11. Herron L, Pheasant H. Bilateral laminectomy and discectomy for segmental lumbar disc disease: Decompression with stability. *Spine* 1983;8:86–97.

12. Hoffmann R, Wheeler K, Deyo R. Surgery for herniated lumbar discs: A literature synthesis. *J Gen Intern Med* 1993;8:487–96.

13. Howe J, Frymoyer JW. The effects of questionnaire design on the determination of end results in lumbar spinal surgery. *Spine* 1985;10:804–5.

14. Junge A, Frohlich M, Ahrens S, et al. Predictors of bad and good outcome of lumbar spine surgery: A prospective clinical study with 2 years' follow up. *Spine* 1996;21(Suppl 9):S1056–64.

15. Lewis P, Weight B, Broad R, Grace M. Long-term prospective study of lumbosacral discectomy. *J Neurosurg* 1987;67:49–53.

16. Manniche C, Skall HF, Braenholt L, et al. Clinical trial of postoperative dynamic back exercises after first lumbar discectomy. *Spine* 1993;18:92–7.

17. Manniche C, Asmussen K, Lauritsen B, et al. Intensive dynamic back exercises with or without hyperextension in chronic back pain after surgery for lumbar disc protrusion: A clinical trial. *Spine* 1993;18:560–7.

18. Nelson E C, Wasson J, Kirk J, et al. Assessment of function in routine clinical practice: Description of the COOP chart method and preliminary findings. *J Chronic Dis* 1987;40:555–635.

19. Roland M, Morris R. A study of the natural history of back pain. I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine* 1983;8(Suppl 2):S141–4.

20. Spengler DM, Quelette EA, Battie M, Zeh J. Elective discectomy for herniation of a lumbar disc. *J Bone Joint Surg [Am]* 1990;2:230–7.

21. Waddell G, Kummel E, Lotto W, Graham J, Hall H, Mc-Gulloch, J. Failed lumbar disc surgery and repeat surgery following industrial injuries. *J Bone Joint Surg [Am]* 1979;61:201–7.

22. Weber H. Lumbar disc herniation. A controlled, prospective study with ten years of observation. *Spine* 1983;8:131–40.

23. Wonca Classification Committee; Functional status measures in general practice. *Aust Fam Physician* 1991;20(Suppl 6):846,848,850–1.

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