Intensive Dynamic Back Exercises With or Without Hyperextension in Chronic Back Pain After Surgery for Lumbar Disc Protrusion

A Clinical Trial

Claus Manniche, Karsten Asmussen, Birgitte Lauritsen, Henrik Vinterberg, Henriette Karbo, Sonja Abildstrup, Karen Fischer-Nielsen, Rikke Krebs, and Kirsten Ibsen

Sixty-two patients with chronic low back pain occurring 14–60 months after undergoing discectomy for the first time were randomized to two physical treatment groups: 24 sessions of intensive dynamic back exercises with hyperextension or 24 sessions of intensive dynamic back exercises without hyperextension.

At the conclusion of therapy and at one-year follow-up, no difference was seen between the randomized groups, with regard to the combined assessments of pain, disability and objective measurements. A difference for back exercises without hyperextension to be superior to the other treatment regimen was statistically significant at the three-month follow-up. In the patient's qualitative assessment of treatment outcome there were seen no significant differences between back exercises with or without hyperextension. There was a similar and significant improvement of the isometric endurance of back muscles in both groups, but the flexibility of the spine was significantly improved only in the group using hyperextension exercises. The overall response rate of an earlier published investigation was reproduced.

It is concluded that chronic back patients after first time discectomy may benefit from an intensive rehabilitation protocol including intensive exercises. The added use of hyperextension exercises does not confer any independent benefit. Furthermore, the training had to continue for more than 2–3 months before a statistical significant decrease in back pain was reported in the patient pain diary. [Key words: chronic low back pain, discectomy, intensive back exercises, clinical trial]

From the Department of Rheumatology, Central Hospital Hillerød, Denmark.

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Epidemiologic research during the past decade has convincingly identified several risk factors for back trouble.[44] Low physical fitness and inadequate strength and endurance of the back muscles are some of the significant risk factors.[1,2,6,7,23,40]

Inspired by the epidemiologic results, back researchers and therapists in recent years have prescribed several different physical training programs aimed at helping the patient to understand the correct use of the musculoskeletal system, and including a goal-directed training of the body's muscles to prevent or treat back trouble.[4,8,9,12,14,15,17,19,20,25–27,29,31,33,36,38,41–43,45,46,48]

In a controlled investigation in 1988–1991,[31,33] Manniche et al showed that intensive back exercises, consisting of 30 sessions distributed during a period of three months, significantly reduced low back pain in chronic patients and that an intensive exercise protocol over a prolonged period is crucial for a satisfactory treatment outcome. The training program used in the study[33] contained not only intensive dynamic exercises, but also involved full range movements including hyperextension. However, it could not be concluded whether the addition of hyperextension exercises in the protocol is necessary for the beneficial effects.[33] Before making a recommendation for the ideal training program, the authors found it important to test whether the use of hyperextension exercises have independent benefit when the objective of the training is increased strength and endurance of the paraspinal muscles and when the goal is reduced low back pain.

From a controlled trial in 1993[36] it is concluded that a short-term high-dose exercise program beginning few weeks after discectomy and performed without regard to back pain or fear of activity, as well, can result in behavioral support for the patients, thus increasing their general functional levels. An objective of the current study was to test whether a long-term

high-dose exercise program could improve both the general functional levels in the patients as well as the physical dysfunctions found in these patient types.[24,38]

As in the first investigations,[27,31,33,36] the patient's global assessment, and Low Back Pain Rating Scale (RS)*[34] were used for qualitative and quantitative assessments, respectively.

■ Methods

All patients who underwent first time lumbar surgery for intervertebral disc protrusion, during the years 1983 through 1987 at Central Hospital Hillerød and without later reoperation (n = 305), were asked to complete and return a postal questionnaire enquiring about current back status (response rate: n = 261/305; 86%) between 14 and 60 months after surgery.[35] Among other questions, patients also were asked to complete a "global assessment" of the operation outcome with a choice of five possibilities: "very satisfactory" (excellent), "satisfactory, little discomfort" (good), "acceptable, some discomfort" (fair), "unchanged" (poor) or "aggravated" (poor). Patients who chose either "good," "fair," or "unchanged" were invited by letter to participate in a training study. Patients who had answered "excellent" (n = 81/261; 31%) were not contacted because they most often scored only 0–10 points of 130 possible in the RS, a score that is too low a starting value in a controlled study where the difference between RS-before and RS-after are used as an effect parameter. Patients who had answered "aggravated" (n = 14/261; 5%) were not contacted either, because it was concluded that some of these patients are in such a poor somatic condition that intensive back training was not feasible. Patients in the other three groups (261 - 81 - 14 = 166) were contacted consecutively, so those operated on most recently were offered participation first. A total of 132 invitations were sent out before the number of patients (n = 65), corresponding to the primary trial design, had agreed to participate in the investigation.

Patients then submitted to an examination by a physician at the hospital where inclusion/exclusion criteria (Table 1) were controlled (three patients were excluded). They were informed that in the study, they would be randomized, by the drawing of envelopes, to one of two different training programs with the purpose of training back and abdominal muscles. After verbal consent for participation had been obtained (Helsinki II), RS[34] was completed, and a fitness test[51] was carried out on a bicycle ergometer.

Similar to several other clinical trials,[31,33,36,37] RS in this study consisted of low back pain at the moment (0–10 points), the worst low back pain within the past two weeks (0–10 points), and the average level of low back pain within the past two weeks, (0–10 points). The same questions were asked about leg pain, defined as in The Standardised Nordic Questionnaires.[28] Pain experience was registered on the 11-point box scale, which proved useful.[21]

Disability was registered by self-reporting on 15 everyday activities:

1. Can you *sleep* in the night without interfering low back pain?
2. Can you do your *daily work* without your low back pain reducing your activity?
3. Can you do *easy doings* at home, such as watering the flowers or cleaning the table?
4. Can you put on *shoes and stockings* yourself?
5. Will you be able to carry two full *shopping bags* (10 kilos in total)?
6. Can you get up from a low *armchair* without difficulties?
7. Can you bend over the wash basin in order to *brush your teeth?*
8. Can you *climb stairs* from one floor to another without resting because of low back pain?
9. Can you *walk* 400 meters without resting because of low back pain?
10. Can you *run* 100 meters without resting because of low back pain?
11. Can you *ride a bike* or drive a car without feeling any back pain?
12. Does the low back pain influence your *emotional relationship* to your nearest family?
13. Did you have to give up being together/having *contact* with other people within the last two weeks because of your low back pain?
14. If it was of present interest, do you think that there are *certain jobs* which you would not be able to manage because of your back trouble?
15. Do you think that the low back pain will influence your *future?*

Table 1. Patients Studied

Inclusion criteria:
- Surgery for lumbar disc protusion 1983–87, Central Hospital, Hillerod
- 18–74 years old
- Patient's global assessment: "good," "fair," or "unchanged"

Exclusion criteria:
- Evidence of recent root pressure (suggestive history +, positive straight leg test + sensory loss/motor paralysis in lower limb)
- Spondylolysis or osteomalacia
- Malignant disease in musculoskeletal system or in other organ with poor prognosis
- Inflammatory disease of the joints
- Present or previous somatic/psychiatric disease that might interfere with training

	-Ext.	+Ext.	Total.
Number included	31	31	62
Drop-outs because of aggravated back/leg pain	4	3	7
Drop-outs not because of side effect due to the back exercises	6	2	8
Completed the intervention	21 (68%)	26 (84%)	47 (76%)
Included in the worse case analysis	25 (81%)	29 (94%)	54 (67%)
Completed the fitness tests	15	19	34
Completed the pain diary	19	24	43
Completed the 3-months follow-up	21 (68%)	25 (81%)	46 (74%)

*A full version of Low Back Pain Rating Scale is available from C.M. on request.

The answers "yes," "can be a trouble," or "no" to each question were given 0–2 points, in total 0–30 points.

To register physical impairment, four measurements were employed. Back endurance was tested with the patient placed on a table mat, with legs strapped and the trunk unsupported from iliac crest. The time for which the patient could remain horizontal, clear of the floor, was recorded. If the patient could remain in the position for 270 seconds, the test concluded (0–10 points).[3,18,22] Schober's modified test was used to assess back flexibility.[2,3,30] The flexibility was registered in millimeters and dichotomized into centimeters before the transformation to points scoring (0–10 points). The patient's mobility was registered based on the following movement pattern: from lying supine on a table mat 80 cm above the floor the patient stepped onto the floor next to the table, went to the foot of the bed, performed a deep knee-bending movement, and returned to the starting position (0–10 points). Use of analgesics was also scored 0–10 points, the maximum being given for centrally acting analgesics used five times a week or more. In total 0–40 points for the dimension "physical impairment." The total score in RS thus was from 0–130 points. After inclusion, the patient was entered into the group with hyperextension (+Ext) or without hyperextension (-Ext) (Table 2) at random by drawing lots. The training continued for 12 weeks. Data encoding (RS) was repeated at the conclusion of treatment and again by a postal questionnaire (PRS) at three months and at one-year follow-up. Included in PRS was "low back pain," "leg pain," and "disability," but from the "physical impairment" dimension only: "use of analgesics," 0–10 points was registered; thus, a total of 0–100 points. All data were collected by a single blinded observer.

Table 2. Treatment in the Two Groups

+ Extension:

1. Trunk Lifting:

   Prone on a table mat, hips at the edge, upper part of the body free but supported by the hands against the floor. Strap fixation over the calves and a pillow under the feet. With hands on the forehead, the trunk is lifted to the greatest possible extension in hips and spine. If necessary, starting with support from physical therapist. During pauses, the patient is supported by a chair in front of the table mat.

2. Leg Lifting:

   Standing by the end of the table mat, leaning over to a prone position with the hips against the edge in 90° flexion, knees at 45° and toes on the floor. Strap around wrists to keep legs together. Both legs are straightened and lifted to the greatest possible extension in hips and spine. Again, with support from physical therapist, if necessary.

3. Abdominal Exercise:

   Crook-lying lifting head and shoulders by hip flexion 0–30°.

4. Pull to the Neck.

   Sitting on a chair with the arms straight and abducted over the head and hands grasping a Weight lever (pulley device). Against submaximal resistance, the lever is pulled down behind neck.

Procedure:

Before starting the exercise program, the patient is offered a hot back packing for the lower back 20 minutes. Exercises 1, 2, and 3 are done in series of 10 with a 1-minute rest in between. Exercise 4 is repeated 50 times without rest. When finished the program, rest for 5 to 10 minutes. The program is repeated. Treatment times total 1–1½ hours with two training episodes a week and a total of 24 sessions for a 3-month period.

-Extension:

Exactly the same procedure as for the other group. In the 1st and 2nd exercise the movement range of the back and hip is only from 90° flexion to 0°. No hyperextension is allowed.

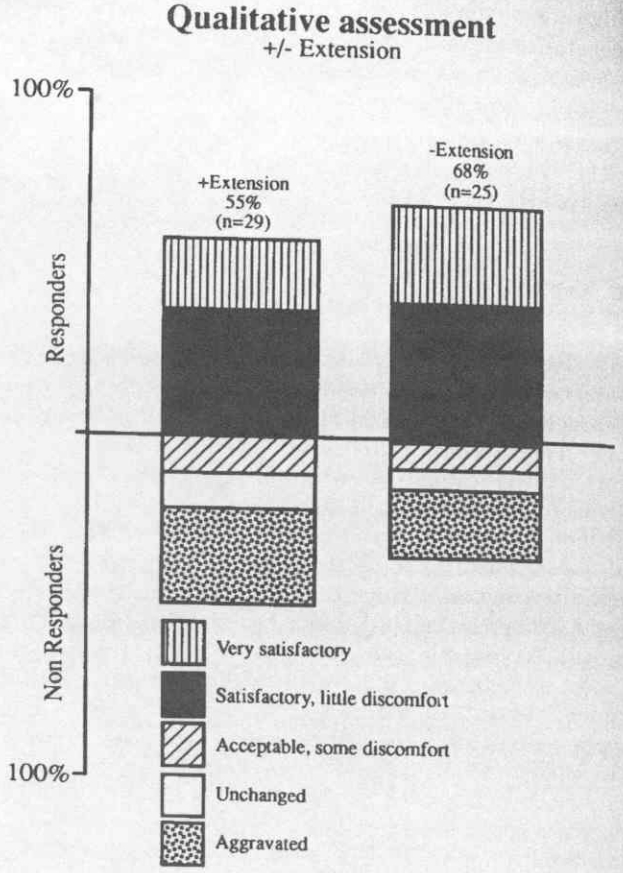

Figure 1. The patients' evaluation (global assessment) of treatment outcome. Response rate -Ext/+Ext = 68%/55%; P = 0.49, therapeutic gain, 13%–26%. According to the "intention-to-treat principle" seven patients who dropped out because of aggravated back/leg pain during the training period are included. The drop-outs are assigned as the poorest possible outcome.

Statistics. For use as measurement of the improvement of intervention, the relative differences Total-before minus Total-after were calculated. This difference (delta total) is regarded as the most important effect parameter. We used nonparametric methods (Mann-Whitney test, Wilcoxon's signed rank test) in the program Medstat.[51] Statistical significance was registered at 5% level, and if qualitative indices "the intention-to-treat principle" was used (Figure 1), so the drop-outs because of aggravated back/leg pain were included and assigned as the poorest possible outcome.

In the calculation of correlation coefficients Spearman's R(S) was used.

In Figure 2 the mean pain scoring was calculated and the two-sample *t* test used.

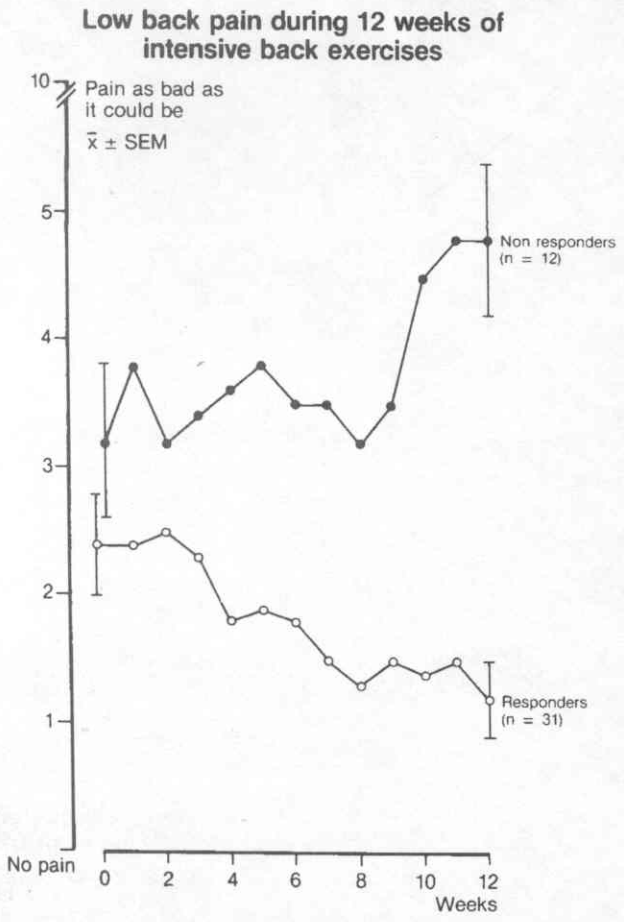

Figure 2. Mean pain scoring ($\bar{x}$) for all 43 patients who completed the pain diary in the two randomized groups during 12 weeks of intensive dynamic back exercises. The pain scoring was done once a week (Monday 6:00 PM) throughout the training period. Pain scoring before intervention: responders/nonresponders, two-sample t test; NS. Pain scoring after the intevention: responders/nonresponders; two-sample t test; P < 0.00001. Delta-responders (before/after): Wilcoxon's signed rank test; P = 0.0001. Delta-nonresponders (before/after): Wilcoxon's signed rank test; P = 0.08.

■ Results

Table 3 summarizes the characteristics of 62 patients (32 women) entered into the study. There were no differences between the characteristic profiles of the two randomized groups. Forty-seven patients (76%) completed the intervention. Of these, 46 were followed up at three months and 42 were followed up at one year (Table 1).

Figure 1 indicates patients' qualitative assessments by choice of one of the five possible answers at conclusion of the treatment. Only "very satisfactory" and "satisfactory, little discomfort" were regarded as acceptable outcomes after protracted and intensive treatment. Seven patients who dropped out during the intervention period because of aggravated back or leg pain were included as the poorest possible outcome.

Table 3. Characteristics of Initial 62 Patients

	-Ext.	+Ext.
Personal Data		
Median/(10th and 90th percentile)		
Men/Women	12/19	18/13
Age (yrs)	49 (36,67)	51 (40,69)
Height (cm)	170 (161,184)	176 (164,189)
Weight (kg)	73 (55,90)	75 (57,92)
Low back pain duration (yrs)	17 (4,32)	16 (2,39)
Postoperative period (yrs)	2.8 (1,5)	2.7 (1,5)
Employed full-time	18	11
Employed part-time	5	5
Back-straining work	14	5
Clinical Findings Before Inclusion:		
Positive straight leg raising test	3	3
Motor deficits	6	4
Sensibility loss	15	11
Operation Findings:		
Sequestration	8	12
Extrusion	15	14
Protrusion	4	3
Other abnormal findings or nothing abnormal	4	2

Results of surgery	Excellent	Good	Fair	Poor
Patient's global assessment*	2	24	31	5
Doctor's global assessment†	10	29	11	8

*Two patients from the group "excellent" (1 +ext; 1 -ext) were included by mistake.
†No information on four patients.

There was no statistical difference between group -Ext and group +Ext (response rate -Ext/+Ext: 68%/55%; *P = 0.49; "therapeutic gain"* 13% ± 26%). At the one-year follow-up, 61% and 38% of the patients in group -Ext and group +Ext, respectively, answered "very satisfactory" or "satisfactory, little discomfort" ($P = 0.19$); "therapeutic gain" 23% ± 26%.

Table 4 shows median and 10–90 percentiles for RS-scoring in the two groups. There is no significant differences between the randomized groups ($P = 0.15$) at conclusion. After the three-month follow-up the difference between the treatment groups is statistically significant ($P = 0.046$), but not after the one-year follow-up ($P = 0.08$). Point scoring improved significantly in both groups (Table 5). Only the statistical analysis of points scoring in the total RS is presented in the current article. An alternative statistical analysis of points scoring of the separate items (back/leg pain, disability, physical impairment) demonstrated no differences in outcome from one item to another.

Figure 3 shows that the endurance of the patients' back muscles increased during the course of the treat-

Table 4. Low Back Pain Rating Scale, Quantitative Indices Median; (10th/90th percentile)

Before Treatment	-Ext (n=21)			+Ext (n=26)		
Pain	(3)	12	(28)	(4)	18	(39)
Disability	(4)	10	(16)	(6)	10	(16)
Physical impairment	(7)	11	(20)	(6)	12	(22)
Total before	(15)	31	(58)	(23)	40	(75)
After Treatment						
Pain	(0)	5	(16)	(2)	12	(36)
Disability	(0)	6	(12)	(3)	9	(16)
Physical impairment	(2)	7	(16)	(1)	11	(16)
Total after	(5)	20	(34)	(10)	31	(64)
Delta Total 1 (Total before minus Total after)	(0)	10 (n=21)	(31)	(-13)	7 (n=25)	(22)
Delta Total 2 (Total before (pain + disability + use of analgesics) minus Total follow-up 3 months)	(-15)	8 (n=19)	(28)	(-14)	1 (n=23)	(9)
Delta Total 3 (Total before (pain + disability + use of analgesics) minus Total follow-up 1 year)	(-11)	3	(23)	(-26)	0	(9)
Mann-Whitney;-Ext; (+Ext)						
Delta Total 1			NS; (P = 0.15)			
Delta Total 2 (3 months)			P = 0.046			
Delta Total 3 (1 year)			NS; (P = 0.08)			

ment in both groups. However, flexibility (Schober's modified test) only increased significantly in +Ext (Table 5).

Figure 3 shows mean pain scoring for all the patients in the two randomized groups during the intervention period. The pain scoring has been done once a week (Monday at 6:00 PM) throughout the entire training period. The figure illustrates the groups: responders/nonresponders (n = 31/12; 2/2 patients did not complete a pain diary). Group assignment depended on the patient's global assessment after the intervention period.

For practical reasons, the fitness test[51] was performed by only 34 participating patients before and after the course of training. The result was: delta-Median -0.9 mL oxygen/kg/min; *P* = NS; 10/90 percentile -7.5—9.5 mL oxygen/kg/min.

■ Drop-Outs

Fifteen of the 62 patients dropped out before conclusion of treatment (10 from -Ext, 5 from +Ext). In most cases, drop-out was for occupational or personal reasons, or because of an unacceptably long transportation time to the hospital. One patient could not complete the training program because of exertional dyspnea (right pneumonectomy two years earlier), and one gave up because of dizziness elicited by the training. Two patients dropped out because of aggravated low back pain (1 from -Ext, 1 from +Ext) during the training, and an additional five (3 from -Ext, 2 from +Ext) as training worsened the leg pain. The back/leg pain caused by the training decreased again in the course of hours to weeks after cessation of the training. In no case were changed or aggravated sensory loss/motor deficits found in the lower limb which unequivocally gave suspicion of reprotrusion appeared during the training period. Five patients had computed tomographic scanning of the low back carried out after leg pain elicited by training. In four cases there was no evidence of reprotrusion. In one patient, the scanning indicated a small reprotrusion, but whether it had occurred before or after inclusion into the study was uncertain. The patient was not reoperated and at the conclusion of the study was still working as a full-time artisan.

■ Discussion

The assessment method—Low Back Pain Rating Scale—has been used in several clinical trials by the author.[31,33,35–37] The former trial demonstrated that rating scores were strongly correlated to the patients' overall assessments [R(S) = 0.75] and a short-time repeatability-test resulted in a correlation coefficient of R(S) = 0.99.[31] A validity study[34] including 58 chronic back pain patients shows interobserver variation of the rating scale resulting in a reliability coefficient (k)

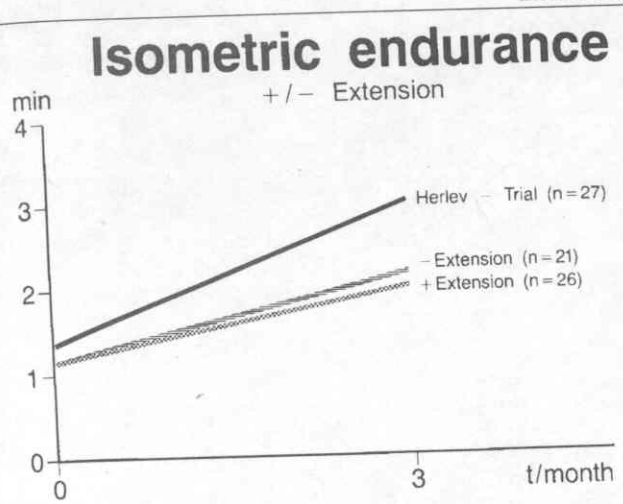

Figure 3. The increase in isometric endurance of the back muscles in patients in the randomized groups. Herlev Trial (33).

= 0.90 and rating scale correlated to the patients' overall assessments (k = 0.49). The correlation in 58 back pain patients between RS and Oswestry-scale[16] was R(S) = 0.66.

The authors believe it is important that a representative subgroup of the defined group of patients is included in a clinical trial. Only by doing this it is possible to interpret the result of the trial in the general population.[49] In this trial approximately 50% of a cohort undergoing surgery for disc protrusion 14–60 months before inclusion participated. From the rating scale it was seen that only two included patients did not report back or leg pain within the last two weeks.

The representative inclusion criteria are not without cost. Patient motivation to continue three months of back excercises varies from patient to patient, resulting in a disappointing drop-out rate. However, the consistency of the presented data indices that the conclusion would not change if a more favorable drop-out rate was seen.

Approximately 70% of patients who underwent first-time surgery for intervertebral disc protrusion several years previously still complain of low back pain at follow-up.[11] To improve the outcome requires increased scrutiny in patient selection and an increased emphasis on operative procedures.[13] The postoperative period has received less attention. Mayer et al[39] and Kahanovitz et al[24] have documented the obvious postoperative physical deficits found in these patient types. Many hospitals offer postoperative programs including general information of the spine as well as postural and physical fitness recommendations, but the lack of positive documentation in the literature is striking.[47]

The population group in this study consisted exclusively of patients operated on for lumbar disc protrusion, in contrast to the previous studies[31,33] where only 10 of 105 participating patients underwent back surgery before inclusion. However, the overall response frequency by qualitative assessments in the present study (61%), was at the same level as in previous studies (69%), when using "the intention-to-treat principle." If the drop-outs were not included in the non-responder group, the equivalent response frequencies were (70%) to (74%). The present results were also quantitatively comparable to the formerly obtained results,[33] and pain, disability, and physical impairment all were improved. The results demonstrate that also patients who have had first lumbar discectomy benefit from intensive back exercises and that only 7/62 (11%) gave up because of aggravated back and/or leg pain during the training period.

The results of the training with or without extension exercises were different, although the differences were not, in general, statistically significant. Several patients in the +Ext group did not achieve improvements in pain and disability assessments. Hyperextension exercises did result in transient (1–14 days) back pain in approximately one third of the patients. It must be emphasized, however, that many patients who have had back surgery can carry out hyperextension without problems, and even if this element is left out of the training program, this does not guarantee that all patients will able to undergo the exercise program (four patients in -Ext excluded because of side effects compared to three in +Ext). It appears that examination of the pain responses to sagittal end-range spinal motion before prescription of flexion–extension exercises may show improved results in individual patients.[10]

If the goal for the training is improved endurance of the back muscles, fulfilling the postoperative deficits found in these patients,[24,39] Figure 2 shows that the same good results occur with or without hyperextension, as long as the intensity of exercise is maintained. The progress in endurance registered in the treatment groups was only half that of the corresponding progress in the previous study's treatment

Table 5. Differences in Ratings Before and After Treatment Median (95% Confidence Limit)

	-Ext (n=21)	+Ext (n=26)
Delta Pain (points)	6 (1,10) *P* = 0.004	2 (-4,8) NS; P = 0.2
Delta Disability (points)	2 (0,3) *P* = 0.0004	2 (0,3) *P* = 0.02
Delta Endurance (seconds)	63 (30,90) *P* = 0.002	48 (0,90) *P* = 0.002
Delta Flexibility (cm) Schober's test	0 (0,1) NS	1 (0,2) *P* = 0.04

Wilcoxon's signed rank test.

group.[33] It has to be considered that the number of training sessions in the present study was only 24 in 12 weeks as opposed to 30 in 12 weeks in the former. Another explanation could be that patients who have had disc surgery need more training sessions in order to achieve the same increases in endurance capacity of the back muscles as patients without back surgery. Future investigations in this subject are therefore necessary.

Epidemiologic studies have demonstrated that spinal hypoflexibility as well as hyperflexibility may be back pain risk factors.[2,5] In contrast, the answer provided by the literature is not clear: Could it be possible to lower the risk of future back pain through back exercise that would improve flexibility? The present trial does not answer the question. But only the use of the full range of movements, including hyperextension exercises, demonstrated a significant improvement in spinal flexibility (median = 1 cm). The similar overall outcome results in the randomized groups indicate that this moderate improvement in flexibility has no independent benefit.

The training program included an abdominal exercise (Table 2), in contrast to the program in the previous study.[31] Nothing in the present results indicate that this exercise had any independent effect on outcome, either positive or negative, but on the basis of theoretical considerations,[32] we will continue to use abdominal muscle training in exercise programs.

The result of the fitness tests indicated that intensive training did not increase the general state of fitness, presumably because the performance of the exercises did not result in any sizable rise in pulse-rates. From a theoretical point of view,[3,32] we find that improved fitness is desirable, so we will include in future exercise programs the use of an exercise bike with six minutes of submaximal exercise twice daily.

Figure 3 shows that the responding patient will not experience reductions in pain until after one or more months of training. This fact is of crucial importance to recognize, for the therapist and the patient. The course of training ought to be carried out for at least three months, 2–3 times a week before the results—based on back pain—can be judged.

Finally, it must be emphasized that because patients who undergo surgery for disc protrusion represent only a small subgroup in the total back patient population,[47] very broad conclusions of the results of this study are not advisable.

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Address reprint requests to

Claus Manniche, MD
Department of Medicine
Division of Rheumatology
Hvidovre Hospital
University of Copenhagen
DK-2650 Hvidovre, Denmark