A Randomized Controlled Trial of Intensive Neurophysiology Education in Chronic Low Back Pain

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Objectives: Cognitive-behavioral pain management programs typically achieve improvements in pain cognitions, disability, and physical performance. However, it is not known whether the neurophysiology education component of such programs contributes to these outcomes. In chronic low back pain patients, we investigated the effect of neurophysiology education on cognitions, disability, and physical performance.

Methods: This study was a blinded randomized controlled trial. Individual education sessions on neurophysiology of pain (experimental group) and back anatomy and physiology (control group) were conducted by trained physical therapist educators. Cognitions were evaluated using the Survey of Pain Attitudes (revised) (SOPA(R)), and the Pain Catastrophizing Scale (PCS). Behavioral measures included the Roland Morris Disability Questionnaire (RMDQ), and 3 physical performance tasks; (1) straight leg raise (SLR), (2) forward bending range, and (3) an abdominal "drawing-in" task, which provides a measure of voluntary activation of the deep abdominal muscles. Methodological checks evaluated non-specific effects of intervention.

Results: There was a significant treatment effect on the SOPA(R), PCS, SLR, and forward bending. There was a statistically significant effect on RMDQ; however, the size of this effect was small and probably not clinically meaningful.

Discussion: Education about pain neurophysiology changes pain cognitions and physical performance but is insufficient by itself to obtain a change in perceived disability. The results suggest that pain neurophysiology education, but not back school type education, should be included in a wider pain management approach.

Key Words: education, low back pain, multidisciplinary pain management

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Multidisciplinary cognitive-behavioral pain management (MPM) programs are typically effective in promoting normalization of pain cognitions, self-perceived disability, and physical performance of chronic pain patients.[1–3] Most MPM programs include education about the neurophysiology of pain and the physiology of the spine. Education is aimed at reconceptualization of the problem,[4] but acquiring information about a prob lem is a typical feature of all cognitive-behavioral treatments.[5]

With a few exceptions,[6–8] there has been little evaluation of the extent to which the education component of MPM programs contributes to outcomes. Imparting information alone is usually not sufficient to produce behavioral or physical performance change,[9–17] and only a few studies with chronic pain patients have reported positive results.[13–15] One systematic review concluded that there was no clinically important effect of group education programs for CLBP[18] and reviews on education-based back-schools make similar conclusions,[19,20] although some disagree.[21]

Frequently, the type of information presented in LBP education is based on a medical model or structural pathology model, which may not be conducive to the targeted psychologic change and may be iatrogenic in chronicity.[22] Certainly, information that is provided in many education programs is notable for largely ignoring the cognitive and behavioral aspects of pain.[20] Focus on a structural label for LBP may heighten attention on the pain[23,24] and emphasizing the vulnerability of the spine to damage has been shown to increase patients' health care consumption.[25] In light of these findings, it is not surprising that traditional education would fail to reduce the impact of psychosocial barriers to rehabilitation, which are now considered of primary importance in the development of chronicity.[26–32]

Two notable studies have evaluated education based on the biopsychosocial model, which acknowledges cognitive and behavioral factors.[33,34] One study compared 2 education booklets.[33] One booklet emphasized positive attitudes and an active response to LBP, the other traditional biomedical concepts. The authors reported large differences between groups in fear avoidance beliefs, and self-reported disability in those with high initial fear avoidance scores. Another study compared preventative pamphlets that focused on prevention of

disabling back pain.[34] That study reported a change in attitudes about back pain and a reduction in extended sick leave the following year. In both studies, the primary learning objective was to impart specific responses to LBP. Patients were not provided with the theoretical rationale underlying those responses.

It is not known whether providing a physiological rationale, via information about the neurophysiology of pain, contributes to normalization of pain cognitions, self-perceived disability, or physical performance. The aim of this study was to evaluate the effect of a formal intensive neurophysiology education program in chronic LBP patients. It was hypothesized that neurophysiology education would result in some normalization of pain cognitions, self-perceived disability, and physical performance. If the neurophysiology education is associated with such effects, then it is likely to be an active component of MPM programs.

MATERIALS AND METHODS

Subjects

A note advertising the project was included in the material given patients as they presented at 3 private rehabilitation clinics. Volunteer subjects were included if the primary reason for presentation was LBP of greater than 6 months. Sixty-three subjects volunteered for the study. Subjects were excluded if they had unstable neural signs; an inability to understand, read, and speak English; or they had previously participated in a back school or MPM program. Five subjects were excluded. The recruitment and experimental schedule is shown in Figure 1.

Thirty-one and 27 subjects were allocated to the experimental group and control groups, respectively. Subject characteristics are shown in Table 1. There were no missing cases and the data sets were normally distributed. There were no significant differences in subject characteristics between the groups at pre-intervention ($P > 0.18$).

Experimental Design

The study was a blinded randomized controlled trial (RCT), with repeated measures comparison of means. Concealed randomization was performed after the initial assessment in accordance with recommendations made in the literature.[3,35] Subjects were informed that the purpose of the study was to assess the effect of an education program but were not informed that there would be 2 types of education programs. Thus, subjects were blinded to experimental group. All physical therapists were experienced in providing education as it was used in this study and did so as part of their normal practice. Therapists were also informed as to the purpose of the study but were told that the other type of education was the control intervention. The study was approved by the Institutional Medical Research Ethics committee. All procedures conformed to the Declaration of Helsinki.

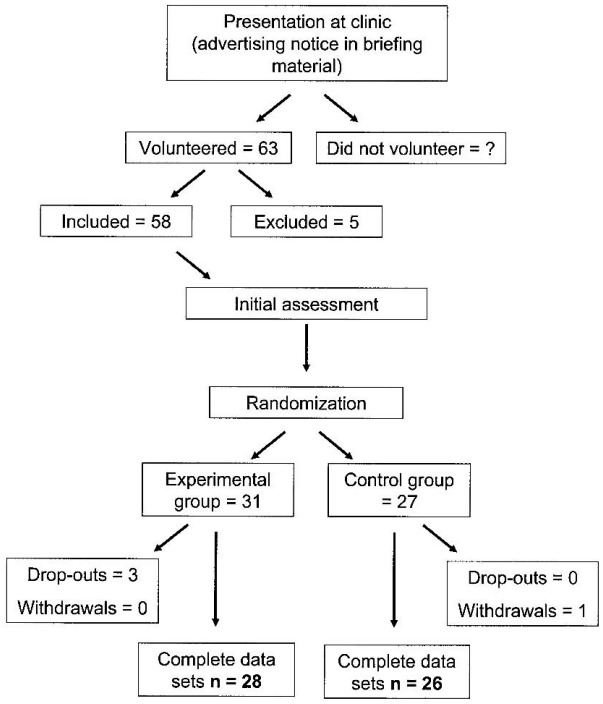

FIGURE 1. Recruitment schedule and experimental plan.

Methodology Checks

The treatment frequency, duration, and location were consistent between groups. The information was presented in the same way for each group, had the same format, appearance, and amount of content. Therapist expectation, client expectation, and therapist equivalence,[6] which included perceived enthusiasm, perceived knowledge level, and attentiveness, were assessed using Likert scales. Compliance was assessed through completion of a workbook. Educators were assessed

TABLE 1. Subject Details Pretreatment for the Experimental and Control Groups

	Experimental Group (n = 31) Mean ± SD	Control Group (n = 27) Mean ± SD
Age (yrs)	42 ± 10	45 ± 6
Sex	13M	12M
Duration of pain (mths)	29 ± 11	30 ± 13
Duration of therapy (mths)	18 ± 11	20 ± 11
Duration formal education (yrs)	11 ± 4	9 ± 2
Not working	n = 20	n = 18
Disability compensation	n = 18	n = 18
Previous spinal surgery	n = 7	n = 11

for knowledge of the material and presentation competency prior to data collection.

Intervention Procedure

Each subject took part in an education session, in 1-to-1 seminar format. Each session lasted for 3 hours, including a 20-minute break, during which time the subject was encouraged to leave the training room and have a refreshment. During the education session, subjects were free to sit, stand, or walk about. No problem solving, skills training, or role-playing exercises were conducted. Diagrams and hypothetical examples were used to convey concepts.

At the conclusion of the session, each subject was given a workbook consisting of 10 sections. Subjects were advised to read 1 section and then answer 3 questions about the material therein, each week-day for 2 weeks. Each subject returned for final assessment 15 weekdays after the initial session. Each subject was requested not to participate in any new treatment program, or change their activity level during the data collection period.

Neurophysiology Education (Experimental) Group

The information presented to subjects in the experimental group focused solely on the nervous system. No specific application was made to the lower back, or to emotional and behavioral patterns commonly associated with chronic pain such as catastrophic thought processes or fear avoidance. The material was based on current knowledge of the neurophysiology of pain according to Wall and Melzack.[36] The material was presented in several sections.

The Nervous System

Presentation of the basic structure of the nervous system, with a focus on the components of the nociception/pain pathways. This section included an outline of the functional significance of each component.

Synapses

Presentation of how nerves "talk to each other," including the concept of "chemicals" (neurotransmitters), postsynaptic receptors, and a conceptual "volume knob" (postsynaptic excitation and inhibition), with a special focus on the "danger messenger nerve" (second order nociceptive neuron).

Plasticity of the Nervous System

The adaptability of the nervous system including: afferent and efferent pathways; the variable state of neural structures including normal state, peripheral, and central sensitization; receptor synthesis; axonal sprouting; the neural response to inactivity; and movement control.

Back Education (Control) Group

The information presented to subjects in the control group included the anatomy and physiology of the bones and joints of the lumbar spine; the intervertebral disc; the trunk and back muscles; normal spinal curves; posture and movements, including analysis of postures and activities according to intradiscal pressures and joint forces; lifting techniques and lifting loads; lifting aids and ergonomics advice; principles of stretching; and strength, endurance, and fitness training. It did not include information about the nervous system, except for outlining the location and course of the spinal cord and the spinal nerve roots. It was similar to education material that has been researched elsewhere,[16,18,37] and the education components of back schools[38–40] and functional restoration programs.[41]

Measurement Procedures

Questionnaires

1. The Roland Morris Disability Questionnaire (RMDQ),[42] a reliable and valid measurement of self-perceived disability due to LBP.
2. The brief Survey of Pain Attitudes (revised) (SOPA(R)),[43] a sensitive and valid measure of attitudes and beliefs about pain. Total scores were calculated such that a higher total SOPA(R) score indicated a better result.
3. The Pain Catastrophizing Scale (PCS),[44] a self-report questionnaire that assesses inappropriate coping strategies and catastrophic thinking about pain and injury and has strong construct validity, reliability, and stability.[44]

Physical Performance Measures

1. Straight leg raise (SLR). An established clinical assessment tool, which has been used widely in the literature (eg, [45–48]) to provide a repeatable measure of physical performance. Performance may be limited by verbal feedback from the patient, or volitional motor activity. A standardized instruction and reporting protocol was followed.
2. Forward bending range. Forward bending has been used elsewhere and has been implicated in the evaluation of motor control in chronic pain patients.[49] The range of forward bending was assessed in bare-foot standing and full knee extension, using the distance from the longest finger to the floor.
3. Abdominal "drawing-in" task (ADIT). Widely used as an assessment and training strategy in the physiotherapy management of CLBP.[50] This task evaluates voluntary activation of the deep abdominal muscles and has been related to motor control of the trunk.[51] Training and performance of the ADIT followed the protocol set out by Richardson and colleagues.[52] Correct performance was monitored and recorded by a trained physiotherapist, who was blinded to treatment group.

Data Analysis

Pretreatment scores were compared between groups to ensure that they had no systematic effect on outcomes and that

randomization would equalize between groups any effect of regression to the mean. A 1-way MANCOVA was conducted with the posttreatment scores as dependent variables and the pretreatment scores entered simultaneously as covariates. Scheffé post-hoc tests compared posttreatment scores between groups for each of the dependent variables; statistical significance was set at < 0.05. Statistical analyses were performed using Statistica release 5.1 (Statsoft, Tulsa, Oklahoma).

Reliability of Physical Measures

Five subjects were assessed on 3 occasions by 3 physiotherapists. Intraclass correlations delivered reliability measures for SLR, forward bending, and ADIT of 0.83, 0.93, and 0.70 (intra-rater) and 0.77, 0.89, and 0.62 (inter-rater), respectively.

RESULTS

Self-Report Data

Table 2 presents the pre- and posttreatment raw scores, including effect size for those variables in which a significant effect was observed. We used the SOPA(R) data as a single measure and also according to the factor structure outlined by Strong et al,[43] with the medication factor not included in the analysis because of the poor internal consistency of that factor.[43] In short, allowing for pretreatment scores, posttreatment SOPA(R) and PCS were higher and lower for the experimental group than the control group, respectively ($P < 0.001$ for both). According to the factor structure used, the experimental group were less likely than the control group to seek care from others when in pain ($P = 0.024$), more likely to believe that one can control one's pain ($P = 0.002$), more likely to believe that pain is influenced by emotional states ($P = 0.007$), and less likely to believe that pain is indicative of tissue harm ($P = 0.023$). The experimental group also perceived themselves as less disabled (RMDQ, $P = 0.022$). There was no effect on the perception that pain is necessarily associated with disability ($P = 0.31$).

Physical Performance Tasks

Allowing for pretreatment scores, SLR and forward bending range were greater in the experimental group than the control group ($P < 0.01$ for both).

Change in self-report data and physical performance tasks as a proportion of pretreatment scores are presented in Figure 2.

Pre-intervention data from the subjects that did not complete the study was removed, which did not cause a change in group mean pre-intervention scores ($P > 0.47$). There were no other missing values.

Methodological Checks

Statistical tests and observation of distribution curves confirmed normality and homogeneity of variance in the measures of therapeutic equivalence and expectation. An ANOVA on the methodological checks revealed no differences between

TABLE 2. Pre and Posttreatment Raw Scores for the Self-Report and Physical Performance Data

	Effect Size (95% Confidence Interval)	Experimental Group Mean ± SD		Control Group Mean ± SD	
		Pretreatment	Posttreatment	Pretreatment	Posttreatment
RMDQ* ↓	2.0 points (0.4–3.6 points)	15 ± 4	14 ± 3	15 ± 4	16 ± 3
SOPA (seeking care from others)* ↓	1.0 point (−1.2–3.2 points)	15 ± 4	15 ± 4	13 ± 5	14 ± 5
SOPA (emotions affect pain)* ↑	2.0 points (0.4–3.6 points)	8 ± 5	11 ± 2	7 ± 3	8 ± 4
SOPA (pain is controllable)* ↑	2.0 points (0.4–3.6 points)	7 ± 3	9 ± 3	8 ± 4	8 ± 3
SOPA (pain is indicative of harm)* ↓	4.0 points (2.1–5.9 points)	12 ± 3	9 ± 3	13 ± 4	14 ± 4
SOPA (pain causes disability) ↓	—	12 ± 3	11 ± 3	11 ± 3	11 ± 3
SOPA TOTAL* ↑	9.0 points (6.5–11.5 points)	6 ± 6	16 ± 7	6 ± 6	7 ± 8
PCS* ↓	6.0 points (3.8–8.2 points)	19 ± 6	14 ± 5	20 ± 6	21 ± 6
SLR (°)* ↑	5.0° (4.0°–6.0°)	37 ± 13	43 ± 13	35 ± 15	34 ± 15
Bending (cm from floor)* ↓	4 cm (0.0 cm–8.2 cm)	26 ± 13	22 ± 9	31 ± 12	31 ± 12
ADIT (mmHg) ↑	—	2.2 ± 1.8	4.2 ± 1.9	2.5 ± 1.7	3.8 ± 1.8

*Denotes significance ($P < 0.05$). Effect size and 95% confidence interval are shown for those dependent variables in which a significant between group effect was observed. Arrows indicate targeted direction of change for improvement.

RMDQ, Roland and Morris Disability Questionnaire; SOPA, Survey of Pain Survey; PCS, Pain Catastrophizing Scale; SLR, Straight Leg Raising; ADIT, Abdominal Drawing-in Task.

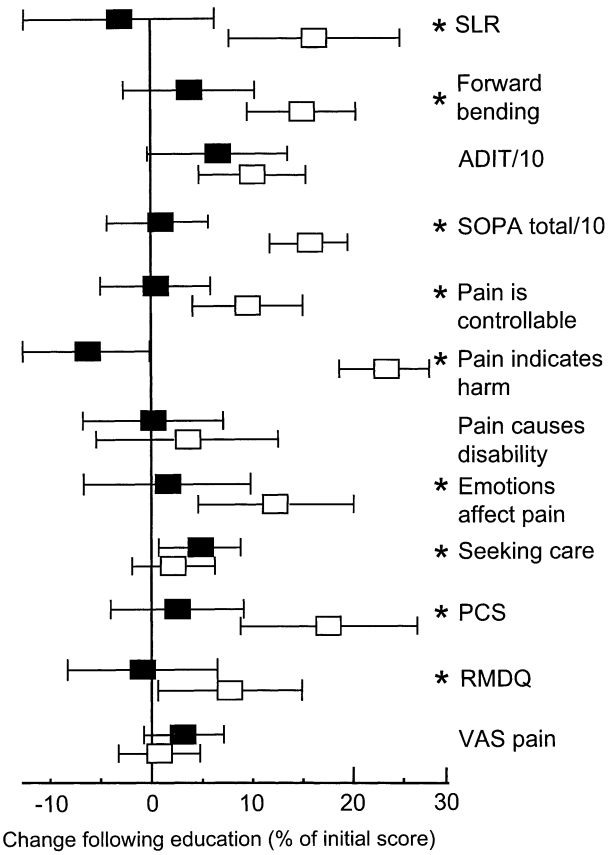

FIGURE 2. The mean (squares) and standard deviation change in each of the dependent variables, shown as a percentage of the pre-treatment score for each subject, for the neurophysiology education group (open squares) and back education group (filled squares). All scores have been converted such that the targeted direction of change is positive. VAS pain, self-reported disability (RMDQ), catastrophizing (PCS), total and sub-factors of the SOPA(R), the abdominal drawing-in task (ADIT), forward bending, and straight leg raise (SLR) are shown. *denotes a significant treatment effect ($P < 0.05$). Note that scores for ADIT and SOPA(R) total are 10 times that depicted in this figure.

the groups on client expectation, therapist expectation, or perceived enthusiasm, attention, or knowledge level of the therapist ($P > 0.17$).

Drop-Outs and Withdrawals

Three subjects from the experimental group failed to return to the final assessment and could not be contacted. One subject from the control group did not complete the study because of surgery unrelated to their CLBP.

DISCUSSION

The results indicated that neurophysiology education led to some normalization of attitudes and beliefs about pain, a reduction in catastrophizing, and an improvement in physical performance. The largest effect was on the SOPA(R) (effect size = 9 points). According to the factor structure used here, patients were less likely to seek care from others when in pain, more likely to believe one can control one's pain, that pain is influenced by emotional states, less likely to believe pain is indicative of tissue damage, and perceived themselves as less disabled. Extensive methodological checks exclude nonspecific treatment effects as causative of outcome. The findings provide the first evidence that education about the neurophysiology of pain improves pain cognitions and physical performance in the absence of a wider pain management program.

Our findings are consistent with an expansive body of literature that demonstrates that provision of information per se is insufficient to change behavior.[53] Despite the change in cognitive and physical performance measures, there was little effect on perceived disability. Although the difference in RMDQ between groups was statistically significant ($P = 0.02$), the size of the effect was small (<2 points on the RMDQ). The results may actually reflect a negative effect of the control (back education) group, and, regardless, are unlikely to be clinically significant. This finding is important because it demonstrates (1) that the provision of information about the neurophysiology of pain is effective at promoting reconceptualization of the problem, but (2) it is probably not sufficient to obtain behavioral advantage, at least in the population used in this study. This finding may suggest, particularly if perceived disability is the sole outcome of interest, that neither form of education has any clinically useful effect. Alternatively, the results may imply that neurophysiology education is a useful strategy that lays the groundwork for other active cognitive and behavioral pain management strategies. Further research would clarify this point.

Either way, neurophysiology education imparts a change in pain cognitions and physical performance. The factor structure used in the present study suggests that the pain cognitions most affected relate to the ability to control pain and the link between pain and emotions. We suggest that this effect lies in the redefinition of pain that is conveyed by the neurophysiology education. According to neurophysiology education, pain is defined as being dependent on complex neural processing and adaptation rather than being a robust informer of spinal pathology. By reconceptualizing pain in this fashion, patients may be more responsive to strategies such as exposure to activities and movements of which they are fearful, graded increase in activity despite pain, and direct challenging of catastrophic thought processes about pain. In this sense, although the clinical utility of the effect sizes observed here may be limited when considered in isolation, they are probably more important if they enhance the effect of other strategies.

One finding of the current work that is particularly noteworthy is the increase in SLR and forward bending observed in the treatment group. The mechanism of this effect is not clear;

however, it is reasonable to suggest that the cognitive changes outlined in the paragraph above directly impact on pain threshold and tolerance during this task. Although SLR is used as a diagnostic test,[54] the small change in SLR observed here is unlikely to reflect alterations at a tissue level, particularly in light of the nature of treatment involved.

Our data also support the current evidence concerning the lack of efficacy of back-school type education as a pain management strategy. In a review of group education programs for LBP, Cohen et al[18] concluded that there was no clinically important effect of the intervention. The results of this study suggest that there may even be a negative effect of conventional education programs in this population, an effect that probably explains some of the treatment effect observed. Negative effect of conventional education is not surprising: such education programs conceptualize chronic LBP in terms of an underlying structural problem and imply that the underlying structures are vulnerable to injury. By ignoring nociceptive and pain mechanisms, conventional education programs logically impart an isomorphic understanding of the relationship between pain and tissue damage. In this sense, the current data are consistent with previous findings that these types of emphases increase attention to pain[25] and health care utilization.[23,24]

The intervention used in this study was more intensive than successful education strategies in the literature,[33,34] but did not impart more potent effects. Two possible explanations are differences in the type of information provided (physiological aspects were addressed rather than specific attitudes and behaviors), and differences in the study population. In this study, LBP was, on average 2½ years in duration, compared with acute LBP[33] or pre-injury,[34] and the patients were more disabled (mean RMDQ = 15) than those used in the acute LBP study (mean RMDQ = 10).[33]

In light of the evidence that demonstrates the efficacy of cognitive-behaviorally based MPM programs,[1,2] our findings raise 2 main clinical implications. First, formal neurophysiology education about pain is effective and there are grounds for its inclusion in MPM programs. Second, and in contrast, the inclusion of conventional back-school education (of the type outlined here) in MPM programs should be questioned.

There were 2 main limitations in this study. First, the external validity is limited to moderately to highly disabled CLBP patients. Second, the study may have suffered from too few subjects and/or too many dependent variables. As the work was largely explorative in nature, we considered that this was acceptable. However, our study needs to be replicated in a heterogeneous chronic pain population, as a true component analysis within a MPM program, and ideally with more patients and fewer dependent variables.

Finally, the current study used novel methodological checks to enhance the robustness of the experimental design. The impetus for their inclusion lay both in the wealth of literature that demonstrates that clinical pain and behavioral research is highly vulnerable to bias,[3,55,56] and in a short series of pilot studies conducted prior to the current work (L. Moseley unpublished data, February 1998). Pain research is particularly vulnerable to the confounding effect of non-specific factors,[57] and it is reasonable to suggest that any research involving therapist-subject interaction, particularly with pain populations, would be enhanced by the inclusion of such checks.

CONCLUSIONS

In summary, we found that neurophysiology education results in some normalization of pain cognitions and physical performance but not in self-perceived disability. The findings support the inclusion of neurophysiology education in a wider multidisciplinary pain management approach, and concordantly raise doubts about the suitability of conventional (structural-pathology based) back-school type education in these programs.

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