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CENTRALIZATION: ASSOCIATION BETWEEN REPEATED END-RANGE PAIN RESPONSES AND BEHAVIORAL SIGNS IN PATIENTS WITH ACUTE NON-SPECIFIC LOW BACK PAIN

Mark W. Werneke[1] and Dennis L. Hart[2]

From the [1]Rehabilitation and Spine Center at CentraState Medical Center, Freehold, NJ and [2]Consulting and Research for Focus On Therapeutic Outcomes Inc., White Stone, VA, USA

Objective: **Tests and measures, if confounded by behavioral signs, cloud interpretation of physical test results during clinical examination. The purpose of this study was to determine whether common behavioral signs and pain responses (i.e. centralization and non-centralization) were associated during initial examination.**

Design: **Observational and designed to cross-tabulate pain responses to behavioral signs.**

Patients: **Data from 177 consecutive patients with acute work-related low back syndromes referred to physical therapy were analysed.**

Methods: **Patients were screened for 8 baseline behavioral signs. Pain responses during initial evaluation were determined from repeated end-range trunk movement tests or loading strategies following McKenzie assessment methods. Association between centralization and non-centralization and baseline behavioral signs were assessed.**

Results: **The physical sign of non-centralization was associated with non-organic signs, overt pain behaviors, fear of work activities, and somatization. Although depression, fear of physical activities, disability and pain intensity were not associated with non-centralization ($p > 0.05$), upper bounds of odds ratios confidence intervals suggest that these behavioral signs may not be entirely independent of pain responses.**

Conclusion: **Presence of non-centralization is associated with many behavioral signs, and therefore when present, clinicians should consider additional psychosocial screening during the initial evaluation.**

Key words: centralization, physical examination, behavioral signs, non-specific low back pain.

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Correspondence address: Mark Werneke, CentraState Medical Center, Rehabilitation Department, 901 West Main Street, Freehold, NJ 07728, USA.
E-mail: mwerneke@centrastate.com

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INTRODUCTION

Precision and accuracy of clinical examination for patients with non-specific low back syndromes (LBS) are important for clinical diagnosis (1–2), classification (3–5), clinical treatment (3–4, 6), and outcome (6–9). For results of clinical assessments to be useful in patient management, the results must be based on objective measures of physical examination signs.

The physical sign centralization (CEN), observed during McKenzie assessment methods, has received increased medical interest over the past decade because peer review studies consistently report that CEN is a key physical finding in the evaluation and treatment of patients with LBS (8–14). CEN has been defined as a situation in which pain in response to therapeutic loading strategies is progressively abolished in a distal to proximal direction with each progressive abolition being retained over time until all symptoms are abolished (4). The physical sign non-centralization (non-CEN) occurs in the absence of CEN, i.e. distal migration of symptoms or no change in pain location in response to loading strategies.

Five fundamental requirements for an objective physical examination test or sign for patients with LBS have been reported (15–16). First, precise operational definitions for physical tests and signs must be clearly defined. Second, measures from each examination technique must be reliable between different examiners. Third, the data must differentiate patients with low back pain from healthy adults. Fourth, data from the physical test must provide valid and clinically useful information guiding treatment decisions related to prognosis. Finally, data from the physical test should be separable or independent of psychological distress including cognitive, emotional, and behavioral concerns of back pain illness. For this paper cognitive, emotional, and behavioral features of back pain illness will be collectively referred to as behavioral signs.

The last fundamental criterion, i.e. the relationship between physical and behavioral signs, is clinically important. Presence of behavioral signs during an examination procedure confounds interpretation of test results designed to assess an underlying physical or anatomical factor (15, 17). For example, Waddell et al. (15) performed analyses of 27 different physical examination tests for evaluating physical impairment for patients with non-specific LBS. Many of these physical tests, although clinically reliable, were not independent of behavioral signs. Waddell et al. (15–16) reported that physical tests not independent of behavioral signs are best interpreted as measures of back pain illness and are not suitable for objective assessment of physical impairment.

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One physical examination test, which was not investigated by Waddell et al. (15) for evaluation of patients with non-specific LBS, was repeated end-range trunk movements resulting in specific pain responses or physical signs of centralization (CEN) and non-centralization (non-CEN). CEN fulfills many of the fundamental principles required for an objective physical examination finding (4–6, 8–14). However, one fundamental criterion for CEN as an objective physical examination sign, which has not been investigated previously, is the relationship between behavioral signs and the physical signs CEN or non-CEN observed during repeated trunk movement testing. Because of the importance of documenting accurate and objective information from physical examination to assist clinical diagnostic classification and treatment of patients with LBS, the purpose of this study was to determine whether common behavioral signs are associated with the pain responses of CEN and non-CEN when assessed during physical examination of patients with acute work-related LBS. If pain responses from mechanical assessment are associated with behavioral signs, additional psychosocial screening during the initial evaluation may be warranted as recommended by clinical guidelines (18–20).

MATERIAL AND METHODS

Subjects

This is a secondary analysis of a previously described cohort of patients (9). The project was approved by the Focus On Therapeutic Outcomes Inc. Institutional Review Board for the Protection of Human Subjects in compliance with federal law under HIPAA (Health Insurance Portability and Accountability Act). The original design was a prospective data collection of 351 consecutive patients between the ages of 18 and 65 years referred to physical therapy with acute onset of non-specific neck or low back pain of less than 6 weeks duration. Patients were excluded if they did not agree to sign a consent form, reported spinal pain or work loss within 6 months before this episode, were unable to complete intake questionnaires or had poor proficiency in English, prior spinal surgery, pregnancy, spinal stenosis, or serious spinal pathology. Fifty-one patients did not meet the admission criteria. For this study, we selected patients ($n = 177$) receiving workers' compensation benefits following a work-related low back pain incident and had data for pertinent independent variables (Table I).

Procedures

Data collection procedures have been described (8–9). Briefly, a "yellow-flag" (18) screen using reliable and valid tools for documenting cognitive (21), behavioral (22–23), emotional factors (24), pain intensity (25) and perceived disability (26–27) was completed prior to the initial physical therapy examination (Table I). The evaluating therapist scored the psychosocial questionnaires after the initial evaluation was completed. These measures are called "yellow-flags" because positive results do not imply medical urgency (i.e. "red-flags") (16) but do imply potential for poorer than expected outcomes (16, 18). After completing questionnaires at admission, patients received a physical evaluation following McKenzie's assessment methods by one of the 5 physical therapists (USA) who were credentialed or diplomats in McKenzie methods. The screening tool or physical procedure to determine pain response from clinical examination was repeated trunk movement tests (4). A detailed description of this examination procedure and measures has been published previously (4). Briefly, different pain responses (i.e. CEN or non-CEN) were evaluated during and after the patient completed a series of repeated end-range movement tests and positional techniques or loading strategies in standing, sitting and lying.

Body diagrams were completed before and after initial evaluation to quantify pain response following physical examination (9). Therapists applied a clear overlay template to the patient's body diagram to document the most distal pain location score, which was assigned a numerical pain location score between 1 and 6. The higher scores indicate a more distal pain location: 1 equals central low back pain, whereas 6 represents referred spinal symptoms into the foot. Changes in pain location recorded before and after physical examination were used to determine pain responses of CEN and non-CEN. Operational definition for centralization required a reduction in pain location score of at least 1 after the mechanical examination. If the pain location score increased or remained the same after initial evaluation, the pain response non-CEN was recorded. Data from documenting changes in pain location using this method for these patients have been shown to be reliable (9).

Table I. *Patient characteristics ($n = 177$) at admission and prevalence of behavioral and physical signs*

Characteristic	Value
Gender, men/women (%)	53/47
Age (years)	
Mean (SD)	37 (10)
Median (range)	37 (18–62)
Days off work	
Mean (SD)	4 (7)
Median (range)	0 (0–28)
Days between incident and initial evaluation	
Mean (SD)	12 (9)
Median (range)	9 (1–42)
History of prior spinal pain (%)	42
History of prior days lost from work (%)	12
History of prior worker-related complaint (%)	11
Not working full duty, full-time at admission (%)	96
Yellow Flag Screen for Behavioral Signs	Prevalence
Positive pain intensity ⩾6 of 10 (%) (30)	82
Positive non-organic signs (%) (22)†	11
Positive fear-avoidance of physical activities (%) (21, 29)*	50
Positive fear-avoidance of work activities (%) (21, 29)‡	30
Positive depressive symptoms (%) (24)*	46
Positive somatization of symptoms (%) (24)*	47
Positive disability rating (%) (26–27)§	64
Positive overt pain behavior (%) (17, 23)¶	15
Physical signs	
Physical sign: Non-centralization (%) (9)	54
Physical sign: Centralization (%) (9)	46

* Positive/negative score determined by median of scores.
† At least 3 of 5 non-organic signs (22).
‡ High score ⩾35 or more on a scale 0–42 (29).
§ High score ⩾ = 40 or more on a scale 0–100 (26–27).
¶ High score = ⩾2 or more overt pain behaviors (17, 23).

Data analysis

Association of the 8 baseline behavioral signs and 2 pain responses to repeated trunk movements (CEN or non-CEN) observed during initial examination was assessed using odds ratio statistics and prevalence of CEN and non-CEN per behavioral sign. To test the significance of OR, 95% confidence intervals (28) were used (null hypothesis OR = 1) and differences between prevalence values across repeated trunk responses ($\alpha = 0.05$).

The 8 baseline behavioral signs studied were non-organic signs (22), overt pain behaviors (23), depression (24), somatization (24), fear of physical activity (21), fear of work activity (21), perceived disability (26) and maximal pain intensity over the past 24 hours (25). To allow direct comparisons of variables, measures of continuous behavioral signs were dichotomized into a positive or negative score. A positive score indicated that the behavioral sign was present during examination. Re-coding behavioral signs into dichotomous variables was based on previous research suggesting best cut scores for clinical interpretation

Table II. *Relation of the prevalence of centralization and non-centralization and behavioral signs*

	Behavioral tests							
	Non-organic signs	Overt pain behaviors	Somatization	Depression	Fear (physical)	Fear (work)	Disability	Pain intensity
Patients with non-CEN								
Prevalence	0.18	0.25	0.57	0.49	0.52	0.41	0.71	0.86
(CI)	(0.10, 0.26)	(0.17, 0.34)	(0.47, 0.67)	(0.39, 0.60)	(0.42, 0.62)	(0.31, 0.51)	(0.61, 0.80)	(0.79, 0.93)
Patients with CEN								
Prevalence	0.02	0.02	0.35	0.41	0.48	0.17	0.56	0.77
(CI)	(0.00, 0.06)	(0.00, 0.06)	(0.25, 0.46)	(0.31, 0.52)	(0.37, 0.58)	(0.09, 0.25)	(0.45, 0.67)	(0.68, 0.86)
Odds ratio	8.7	13.5	2.4	1.4	1.2	3.4	1.9	1.9
(CI)	(2.0, 39.0)	(3.1, 59.3)	(1.3, 4.4)	(0.8, 2.5)	(0.7, 2.1)	(1.7, 6.9)	(1.0, 3.5)	(0.9, 4.1)

CI = 95% confidence interval; non-CEN = non-centralization of symptoms; CEN = centralization of symptoms.
Interpretation of odds ratio example: if non-CEN was found during initial examination, the patient was at least 8-times more likely to have positive non-organic signs, etc.

(22, 23, 26, 27, 29, 30). We were unable to find specific clinical cut points recommended for interpreting SCL-90-R depression and somatization subscales (24) or for the fear of physical activity scale (21, 29). As previously described (8), we defined the scores above the median as positive scores for SCL-90-R depression and somatization subscales and fear of physical activity scale.

RESULTS

Prevalence for the pain responses for centralization was 46% (82 out of 177) and 54% non-centralization (95 out of 177). We observed a high prevalence of positive behavioral signs for patients with acute work-related LBS referred to physical therapy (Table I). For example, half of the patients reported elevated fears of physical activities, 30% expressed high fear of work activities, more than 60% perceived their disability as severe to crippling, and almost half of the patients reported elevated symptoms of depression and or somatization.

According to OR and prevalence CIs, 4 of the behavioral signs were associated with (i.e. not independent of) the physical finding non-CEN (Table II). Prevalence of CEN and non-CEN was not different across levels of depression, fear of physical activities, disability, and pain intensity.

These findings can be interpreted as follows. If the physical sign non-CEN was found during initial examination, the patient was 8-times more likely to have positive non-organic signs, 13-times more likely to have positive overt pain behaviors, 3-times more likely to have fear of work activities, and 2-times more likely to have somatization. However, the converse is not as clear, i.e. the presence of non-CEN was independent of depression, fear of physical activities, disability, or pain intensity because, although OR and prevalence confidence intervals were supportive of independence, the upper 95% CIs were suggestive of the possibility of some association with pain responses.

DISCUSSION

This is the first study to investigate the relationship between physical signs CEN and non-CEN observed following repeated end-range trunk movement testing and psychosocial features of back pain illness. The results suggest that the physical examination sign CEN was not associated and possibly independent of many of the cognitive, emotional, and behavioral features of back pain illness investigated, but the clinical examination finding of non-CEN was associated (i.e. not independent) of the psychosocial measures studied. The latter finding was not unexpected (15). Previous studies have reported the relationship between physical and psychosocial signs should be examined, and if possible, the effect of behavioral signs should be separated from physical signs (15, 17). Enhancing the clinician's understanding of the relationship between pain response and psychological distress may improve the interpretation of that test as either an objective measure of a physical factor or as a measure of back pain illness to direct clinical care.

The results showing that the physical sign non-CEN was associated but CEN was probably not associated with the behavioral signs investigated provides further evidence that CEN is a useful and objective measure for evaluating patients with LBS. Clinical classification of, and treatment decisions about, patients with acute work-related LBP depend on objective physical examination signs and measures. Precision and accuracy of clinical assessment mandates that the physical sign is precisely defined, reliable, valid and independent of behavioral signs during physical examination. Although the design of this study and the statistical techniques used to analyse the data cannot confirm that CEN is entirely independent of the behavioral signs investigated, these results suggest the physical sign CEN meets the fundamental requirements for an objective measure (15) and therefore, testing for pain responses is recommended for routine clinical assessment of patients with acute, non-specific low back pain. In contrast, the non-CEN physical sign was not independent of many behavioral signs investigated in this study. Presence of non-CEN was associated with non-organic signs, overt pain behaviors, fear of work activity, and somatization, and although the CIs of the ORs and prevalences of the other behavioral signs suggested presence of

non-CEN was independent of these behavioral signs, the upper 95% CIs suggested these behavioral signs might not be entirely independent of non-CEN. The results suggest that perhaps the finding of non-CEN may be regarded as an indicator of illness behavior, not a physical finding.

The International Forums on Primary Care Research for LBP reported that screening and identifying subgroups of patients who may benefit from a cognitive behavioral treatment approach is an important research priority (20). In addition, recent guidelines encourage clinicians to be aware of the multi-factorial nature of LBP and that simple unidimensional treatment for LBP may not be sufficient (19). The clinical guidelines however do not provide details identifying which subgroup of patients would benefit from multi-factorial treatment. These results suggest that the presence of positive behavioral signs and the finding of non-CEN are associated, so patients demonstrating non-CEN from repeated trunk movement tests may benefit from a multi-factorial treatment approach combining clinical management of behavioral signs in conjunction with physical signs.

Lastly, practice guidelines also recommend a yellow flag screen using validated questionnaires to identify psychosocial factors for patients with acute, non-specific low back pain syndromes (18, 31). This recommendation is of particular importance for all primary healthcare clinicians evaluating and managing patients with LBS because a high prevalence of psychosocial factors has been consistently reported for these patients (32–34) including the current findings. Exploring ways to facilitate the clinician's confidence for screening patients for psychosocial issues is important. Utilizing a standard and common physical examination procedure (4, 35) that assists clinicians to identify the presence of psychosocial factors may facilitate use of psychosocial questionnaires in primary care.

A limited number of behavioral signs were investigated, so these findings should not be generalized to other behavioral signs. However, we selected reliable and valid tools commonly recommended for clinical psychosocial or yellow flag screening of patients with low back pain for behavioral, cognitive, and emotional factors (21–26). Furthermore, we investigated CEN and non-CEN classification categories using a prospective cohort design. Such a design allows for examination of diagnostic testing (i.e. pain response from repeated trunk movements) and its relationship to behavioral signs (target disorder). However, randomized control trials are required to elucidate whether results of classifying patients based on pain response lead to more effective treatment.

Larger sample sizes are necessary to evaluate the relationships between depression, fear of physical activity, disability, and pain intensity and the physical signs CEN and non-CEN. Although these results suggest no relationships for these psychosocial issues ($p > 0.05$), the upper 95% CI may suggest that future studies should examine further any relation between depression, fear of physical activity, disability, and pain intensity and pain responses.

Because the possibility that gender and age might affect the odds ratios and therefore imply a multivariate analysis might be favored statistically, univariate analyses were used to test whether the presence of CEN or non-CEN was affected by age or gender. Neither age (two-sample t-test: $t = -0.35$, df = 166.7, $p = 0.7$) nor gender ($\chi^2 = 0.55$, df = 1, $p = 0.46$) affected the presence of CEN or non-CEN, so it was concluded that multivariate analyses controlling for age and gender were not necessary.

The generalizability of these findings for patients with chronic LBS has not been investigated. Future research is needed to investigate pain responses from repeated trunk movement testing and behavioral signs for geriatric patients and for patients with either chronic low back pain or neurological deficits. We are presently evaluating the association between physical and behavioral signs for a wide range of patients with low back pain syndromes regardless of age, symptom acuity, occupational nature of symptoms, or neurological status.

In conclusion, the results of this study demonstrate that CEN may and non-CEN may not be independent of many behavioral signs in patients with non-specific, acute low back pain syndromes. Results contribute to existing literature by showing (i) the repeated end-range pain response of centralization is a useful and objective clinical measure for evaluating patients with acute work-related LBS and (ii) how data collected for the examination of centralization or non-centralization in the presence or absence of behavioral signs could be interpreted, and these may assist clinical treatment and management decisions.

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