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ORIGINAL REPORT

PAIN RESPONSES IN REPEATED END-RANGE SPINAL MOVEMENTS AND PSYCHOLOGICAL FACTORS IN SICK-LISTED PATIENTS WITH LOW BACK PAIN: IS THERE AN ASSOCIATION?

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Objective: **Repeated end-range spinal movements producing specific pain responses (i.e. centralization or non-centralization) may be used for diagnostic and prognostic purposes. However, possible associations between psychological factors and pain responses have been reported. The aim of this study was to investigate the associations between pain responses in repeated end-range spinal movement tests and psychological factors.**

Design: **Cross-sectional clinical study.**

Patients: **Data from 331 patients sick-listed for 4–12 weeks due to low back pain with or without sciatica.**

Methods: **Initially the patients completed a questionnaire including questions about psychological factors. Then they underwent a standardized physical test procedure and were classified according to centralized or non-centralized pain response.**

Results: **Statistically significant associations were found between non-centralization and mental distress ($p < 0.009$) as well as depressive symptoms ($p < 0.049$). These associations remained present after adjustment for potential confounders by logistic regression: mental distress odds ratio (OR) 1.16 (95% confidence interval (CI) 1.03–1.30) ($p = 0.013$), depressive symptoms OR 1.23 (95% CI 1.01–1.51) ($p = 0.044$).**

Conclusion: **The pain responses in repeated end-range spinal movements were not independent of psychological factors. Mental distress and depressive symptoms occurred more often among non-centralizers than among centralizers. It is recommended that the possible influence of psychological factors on the result of mechanical testing be accounted for in future studies.**

Key words: centralization, physical examination, psychological factors, low back pain, sciatica, sick-listing.

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INTRODUCTION

Most episodes of low back pain (LBP) are self-limiting and resolve within 6 weeks. However, approximately 2–7% of all patients develop chronic pain and persisting disability (1). The sub-acute stage (4–12 weeks) is considered a critical period in the transformation from acute to chronic pain, especially if patients are on sick leave (2). Assessment of risk factors and interventions at this stage are important to avoid chronicity and loss of contact with the work force (2). Psychological factors have consistently been shown to be important predictors in the development of chronic pain and disability in patients with LBP, whereas physical measures rarely predict outcomes (3, 4). Assessment with repeated end-range spinal movements resulting in specific pain responses (i.e. centralization (CEN) and non-centralization (non-CEN)) has been shown to yield good diagnostic and prognostic information about patients with LBP (5). This examination method is known as the McKenzie method or Mechanical Diagnosis and Therapy (MDT) (6). The pain response of CEN is described as a process whereby pain radiating from the spine is sequentially abolished from the most distal position towards the lumbar midline in response to repeated end-range therapeutic positions or movements. Non-CEN is defined as peripheralization – a distal spread of pain into the limb or no proximal change in pain location (6). The hypothesis behind these pain responses is that LBP may be caused by migration of nuclear material through radial fissures to the pain-sensitive annulus in the intervertebral disc. It is hypothesized that repeated end-range spinal movements guided by pain responses can be used to return the nucleus to its normal position (CEN) (6). Studies reporting association between CEN and positive discography have supported this hypothesis (7, 8).

The signs of CEN have been the focus of a considerable number of studies, and have been reviewed systematically (5). A CEN pain response has consistently been associated with good outcome in terms of pain, function and return to work, and decreased healthcare usage (7, 9–16). On the other hand, failure to achieve CEN has been associated with poor outcome (13). However, a possible association between psychological factors and the pain responses of non-CEN has been reported (8, 17). The diagnostic power of CEN in predicting positive discography has, to some extent, been shown to be reduced by psychological distress in patients with chronic LBP (8). In addition, a secondary analysis of a previously described cohort

of patients with acute LBP receiving workers' compensation has shown a strong association between psychological factors and the lack of CEN (17). Patients classified as non-centralizers had more non-organic signs (18), positive overt pain behaviour, somatization symptoms and increased fear avoidance of work activities than centralizers (17). A physical test will usually reflect some of the psychological elements of behaviour and the association of a test result with psychological factors may reduce its diagnostic and prognostic value. The aim of this study was to investigate the association between pain responses in repeated end-range spinal movement tests and psychological factors in patients sick-listed for 4–12 weeks due to LBP.

MATERIALS AND METHODS

Patients

The present study was conducted as a cross-sectional clinical study nested in a randomized clinical trial. The patient sample included 331 of 500 patients referred from their general practitioner to the Research Unit at the Spine Centre, Regional Hospital of Silkeborg in Denmark from November 2004 to July 2007. Inclusion criteria were: partly or fully sick-listed for 4–12 weeks due to LBP with or without sciatica, age 16–60 years, and living in the municipalities of Silkeborg, Favrskov, Skanderborg or Randers in Denmark. Exclusion criteria were: sick-listed from unemployment, serious spinal pathology, progressive neural compression implicating plan of surgery, suspected progressive paresis or cauda equina syndrome, low back surgery the preceding year or previous lumbar fusion, pregnancy, dependency on drugs or alcohol, primary psychiatric disease, or not able to speak and understand Danish. A total of 149 patients did not meet the inclusion criteria upon referral because they were not sick-listed from work, had been sick-listed for more than 12 weeks or did not report LBP as their main complaint. A further 20 patients were excluded from this study: 5 had no pain at the time of examination, 4 declined repeated movements testing and 4 could not be classified due to lack of cooperation. Furthermore, 4 patients withdrew, one was 61 years old and 2 were diagnosed with metastatic malignancy of the spine, leaving 331 patients in the present study. The study was approved by the research ethics committee of Aarhus County, Denmark.

Procedures

Prior to the clinical examination, patients completed a comprehensive questionnaire including questions on pain, function, psychological factors, social demographics and work situation. The present study included the following variables: signs and symptoms of psychological disorders were assessed by a modified version of the validated Common Mental Disorders Questionnaire (CMDQ) (19). The questionnaire comprised 31 questions rated on a 5-point scale of distress ranging from "not at all" to "extremely" (0–4). Each item is then dichotomized between 1 "a little" and 2 "moderately" and added into sum scores in 4 different sub-scales (19). Two subscales assessed symptoms and signs commonly associated with somatoform disorders: bodily distress (SCL-SOM) (12 questions) and illness worries (Whiteley-7) (7 questions). One subscale with 8 questions included symptoms of general mental distress (SCL-8) and one with 6 questions covered specific depressive symptoms (SCL-DEP6). Two questions overlapped between the SCL-8 and the SCL-DEP6. The SCL-SOM only works as a symptom checklist and has one question regarding LBP, which was omitted in this study. Fear avoidance beliefs was assessed by the Orebro Musculoskeletal Pain Screening Questionnaire, which has been validated previously (20–22). Three questions on fear of physical and work activities, each with a 0–10-score box-scale, were added to a sum score (0–30). Back and leg pain were measured by the Low Back Pain Rating Scale (23). The scale includes questions about both pain and physical impairment; only the questions about pain were used in this study. Back and leg pain were measured by 3 questions: back and leg pain at the time of examination and worst and average pain in the previous 14 days scored on an 11-point box-scale (0–10). The 3 questions were added into a sum score (0–30) for back and leg pain. Disability was measured by the Roland-Morris Disability Questionnaire $_{\text{Patrick}}$ (RDQ) (24), which has been validated in Danish (25). The RDQ score is calculated by adding the number of positive answers into a sum score ranging from 0 (no disability) to 23 (maximum disability). Questions on multiple pain sites were measured by 3 questions about pain in the preceding 2 weeks: being much bothered by pain or discomfort in the neck, shoulders, arms, hands, back, buttocks, legs, knees and feet. Previous sick-listing due to LBP was dichotomized into simple yes or no. The duration of LBP was dichotomized into less and more than 3 months. All patients went through a clinical interview and low back examination was performed by a specialist in rheumatology and rehabilitation (OKJ). The back examination comprised evaluation of posture, curvature of the spine, measure of range of motion, neurological screening (i.e. muscle strength tests, sensibility to touch by fingers and deep-tendon reflex testing), Lasegue and femoral stretch test, springing test, tenderness by percussion and standardized manual examination of tenderness of muscles. Nerve root pain was defined as symptoms or signs of nerve root affection, e.g. radicular pain in one or both legs, positive Laseque $\leq 60^{o}$, missing or inhibited reflex, altered sensation in a dermatome or motor weakness.

Magnetic resonance imaging (MRI) of the lumbar spine was performed when nerve root pain was present, or if specific or serious back disease was suspected. In the last year of inclusion MRI was performed in all patients and was therefore performed in 75% of all patients. Other investigations were performed when clinically relevant.

After the clinical examination, a physical therapy examination was performed. A total of 95% of the examinations were performed by one of the therapists (DC) holding a credentialed examination in MDT. The last 5% of the examinations were performed by a therapist holding a diploma in MDT. The therapists were unaware of the baseline scores of the questionnaire. The physical therapy examination included a standardized mechanical evaluation according to the MDT assessment method (6). Briefly, a series of repeated end-range spinal movements or static positions were used to assess pain responses. The patients completed pain drawings standing upright at a bench assuming the same position before the mechanical evaluation and after testing. The pain response of CEN was recorded if pain from the furthermost region (buttock, thigh, calf or foot) or pain in the midline of the lumbar spine was abolished. Peripheralization was recorded if pain moved into a region further towards the foot, or if pain in the foot substantially worsened and could not be centralized or reduced again. If no proximal change in pain location occurred in relation to testing, the patient was classified as a "non-responder". The patients were classified into 2 groups according to their pain response: the CEN group and the non-CEN group (peripheralization or no proximal change in pain location). After mechanical evaluation, tests for non-organic signs were performed, with the presence of more than 3–5 signs being considered positive (18).

Data analysis and statistics

A missing value procedure for the CMDQ subscales was performed according to a previous validation study of the CMDQ questionnaire (19), in which a missing value was coded as "not at all" (i.e. 0). Two additional restrictions were applied to this procedure: if missing values exceeded more than 25% of each subscale or 15% of each variable, they were recorded as missing. A similar procedure was used for the RDQ questionnaire; unanswered questions were automatically scored as no (24). Univariate analysis was performed with non-parametric methods. Differences between the groups were analysed with Wilcoxon rank-sum or χ^2 test. Statistically significant variables were included in further analysis. The possible correlation between mental distress (SCL-8) and depressive symptoms (SCL-DEP6) subscales were assessed with Spearman's rank correlation test. Because of co-variation,

multivariate logistic regressions were performed separately for mental distress and depressive symptoms. Multivariate logistic regression was conducted with mental distress and depressive symptoms as the primary explainable variable adjusted for gender, age, body mass index (BMI), nerve root pain, duration of pain, multiple pain sites, and previous sick-listing due to LBP. Post-estimation was calculated from logistic regression models. The statistical package STATA, version 10, was used, and a significance level of 5% was chosen.

RESULTS

A total 331 of 351 patients were classified according to pain response by mechanical testing at the initial examination (Table I). No statistically significant differences were found between patients classified and not classified by mechanical testing. In the CMDQ, 12% had one missing response and 4% had 2 or more missing responses. In the RDQ, 13% had 1 or 2 missing responses and 2% had 3 or more missing responses. No differences in missing values were found between the CEN and non-CEN groups. After the adjustment for missing value procedure, the percentage of missed responses was 4% for the CMDQ and 1% for the RDQ. The missing response rate did not exceed 3% in other variables. Multiple pain sites were reported by 15.7% of the patients and previous sick-listing due to LBP by 76.1%. A total of 50.8% of the patients had a pain duration exceeding 3 months, and nerve root pain was present in 36.9%. According to the physical therapy examination, CEN was achieved in 30.2% of the patients as a result of the mechanical assessment. In the non-CEN group, 8% peripheralized and 61.8% had no changes in their pain patterns. Positive non-organic signs were observed in 10.3% of the patients.

Table I. *Patient characteristics*

Characteristics	
Gender, female/male (% female)	169/162 (51.1)
Age, years, mean (SD)	41.8 (10.4)
Body mass index, mean (SD)	26.7 (5.0)
Pain duration, *n* (%)¤	
<3 months	161 (49.2)
>3 months	166 (50.8)
Nerve root pain, no/yes (% yes)	209/122 (36.9)
Multiple pain sites, no/yes (% yes)	279/52 (15.7)
Previous sick listing LBP, no/yes (% yes)¤	78/248 (76.1)
LBP, 0–30, median (IQR)*	19 (10)
Leg pain, 0–30, median (IQR)*	15 (12)
Disability, 0–23, median (IQR)†	16 (6)
Fear avoidance, 0–30, median (IQR)§	25 (9)
Bodily distress, 0–11, median (IQR)‡	3 (4)
Illness worries, 0–7, median (IQR)‡	2 (3)
Mental distress, 0–8, median (IQR)‡	1 (4)
Depressive symptoms, 0–6, median (IQR)‡	0 (1)
Pain response classification, *n* (%)	
Centralization	100 (30.2)
Non-centralization	231 (69.8)
Non-organic signs ≥3: no/yes (% yes)	297/34 (10.3)

*Low Back Pain Rating Scale.
†Roland-Morris Disability Questionnaire.
‡Common Mental Disorders Questionnaire (CMDQ).
§Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ).
¤Missing values for some patients.
IQR: interquartile range; LBP: low back pain; SD: standard deviation.

Non-parametric testing displayed statistically significant differences between CEN and non-CEN groups regarding mental distress ($p < 0.009$) and depression symptoms ($p < 0.049$), but not in terms of the other variables (Table II). Scores on mental distress and depression symptoms were statistically significantly correlated (Spearman's rank correlation coefficients of 0.79) ($p < 0.001$). Multivariate logistic regression with adjustment for possible confounders confirmed the positive associations between the non-CEN group and mental distress (OR 1.16 (95% confidence interval (CI) 1.03–1.30) ($p = 0.013$) as well as depression symptoms (OR 1.23 (95% CI, 1.01–1.51) ($p = 0.044$)) (Table III). The results can be interpreted as follows: for every step on the mental distress (0–8) or depressive symptom (0–6) scale, the OR for belonging to the non-centralizer group will be multiplied by 1.16 for mental distress and 1.23 for depressive symptoms.

DISCUSSION

According to the present study, the results of mechanical testing by the MDT method are influenced by psychological factors. The presence of mental distress and depressive symptoms were associated with increased probability of belonging to the non-CEN group. This may indicate that patients with mental distress and depressive symptoms have increased physiological arousal that may confound the interpretation of the pain responses. Pain responses in repeated end-range movement testing may result not only from the mechanical loading of the intervertebral discs structures; the degree of psychological distress and the patient's pain behaviour may also be involved. The good prognostic value of CEN found in previous studies may therefore be explained partly by the influence of psychological factors, as psychological distress and depressive symptoms were less prevalent in patients classified as centralizers than in non-centralizers. It is well known that psychological distress and depression are strong negative predictors of outcome in LBP patients (2).

Reported prevalences of CEN range from 17% to 87% (5, 14–16, 26) for patients with LBP. This prevalence seems to be affected by various factors, such as the duration of pain,

Table II. *Comparison of the centralization (CEN) and non-CEN groups by non-parametric methods*

Variable	CEN Median (IQR)	Non-CEN Median (IQR)	CEN vs non-CEN *p*-value
Low back pain	18 (9)	19 (9)	0.494
Leg pain	16 (12)	15 (12)	0.339
Disability	16 (5)	16 (6)	0.388
Fear avoidance	24 (8)	25 (10)	0.193
Bodily distress	3 (4)	3 (4)	0.109
Illness worries	2 (2.5)	3 (3)	0.117
Mental distress	0 (3)	1 (4)	0.009
Depressive symptoms	0 (1)	0 (2)	0.049
Non-organic signs >3 (%)	8.0	11.3	0.370*

All analysed with Wilcoxon rank-sum test, except *analysed by χ^2 test.
IQR: interquartile range.

Table III. *Results of multivariate logistic regression with non-centralization (CEN) group as outcome vs CEN group performed separately for mental distress and depressive symptoms*

	Non-CEN vs CEN			Non-CEN vs CEN	
Variable (n=322)	OR (95% CI)	p-value	Variable (n=315)	OR (95% CI)	p-value
Mental distress	1.16 (1.03–1.30)	0.013	Depressive symptoms	1.23 (1.01–1.51)	0.044
Gender	0.93 (0.57–1.55)	0.796	Gender	0.91 (0.54–1.52)	0.712
Age	0.98 (0.96–1.01)	0.150	Age	0.98 (0.96–1.01)	0.219
Body mass index	1.03 (0.98–1.08)	0.272	BMI	1.03 (0.98–1.09)	0.236
Nerve root pain	0.92 (0.55–1.56)	0.766	Nerve root pain	0.90 (0.53–1.52)	0.689
Duration of pain	1.24 (0.74–2.07)	0.408	Duration of pain	1.16 (0.69–1.95)	0.573
Multiple pain sites	0.62 (0.30–1.30)	0.190	Multiple pain sites	0.64 (0.32–1.31)	0.223
Previous sick-listing LBP	0.91 (0.51–1.63)	0.748	Previous sick-listing LBP	0.92 (0.51–1.64)	0.769

OR: odds ratio; 95% CI: 95% confidence interval; LBP: low back pain.

age, the experience of the examiner in MDT and the strictness of the definition (5, 16). In our study, the classification of pain responses was governed by strict operational definitions and carried out by physiotherapist trained in MDT. CEN was observed in 30.2% compared with 42% by Skytte et al. (14) and 46% by Werneke & Hart (17), who all adopted similar criteria for CEN. These differences may be well be rooted in differences in patient samples and sample size. In our patient sample, 50.8% had pain duration for more than 3 months, whereas in the studies by Werneke & Hart (17) and Skytte et al. (14), the patient's symptom lasted less than 6 weeks and 14 weeks, respectively. All patients in this study were partly or fully sick-listed for 4–12 weeks. In comparison, 60% were on sick leave in the study by Skytte et al. (14) and work loss due to LBP ranged from 0 to 28 days in the study by Werneke & Hart (17). The prevalence of CEN in patients with LBP with longer pain duration has been shown to be lower (8, 16, 26). Laslett et al. (8) reported a prevalence of 32% for CEN in chronic patients referred to discography, and in a Danish cohort study of 793 patients with a pain duration of 4–26 weeks, only 18% were centralizers (26).

The present study indicated that pain responses (i.e. CEN and non-CEN) at the initial mechanical testing were associated with mental distress and depressive symptoms. These associations remained after adjustment for potential confounders. Interestingly, we found no significant associations for measures of somatization symptoms, fear avoidance beliefs or positive tests for non-organic signs as reported previously (17). We used validated questionnaires, but it is not known how these questionnaires perform in comparison with questionnaires used in other studies. However, we believe that the present study has several strengths. Our study was considerably larger than previous studies targeting this area (8, 17). Measurements of fear avoidance beliefs and somatization were analysed in sum scores, while Werneke & Hart dichotomized these variables into high and low values (17). The use of a dichotomized sum score may entail an overestimation of the association. In the study by Werneke & Hart only fear avoidance beliefs about work activities were associated with the pain response non-CEN (17). In the current study fear avoidance was first analysed as one variable including questions of both fear of physical and work activities. A secondary analysis, which included only the questions regarding fearing work activities, did not change the conclusion (figures not shown). Our findings are supported by George et al. (15), who also found no significant differences in baseline fear avoidance beliefs about psychical and work activities between CEN and non-CEN group, when reporting fear avoidance beliefs as a continuum.

A limitation of the present study was the lack of testing over time. It is possible that some of the patients could have changed classification group if assessed over time. To investigate this in detail would require repeated measurements of both pain responses and psychological factors; this was not done in our study. Only one study has previously included both pain responses and various psychological factors in multivariate analysis predicting long-term outcomes (13). The study found pain responses to be a more significant predictor of chronic pain than psychological factors. However, their results may have been affected by the fact that the study used a multiple visit definition of CEN over several treatment sessions, whereas psychological factors were only collected at baseline.

A recently published study by Werneke et al. (16) found the baseline pain response of non-CEN to be predictive of functional status and pain at discharge in patients with LBP, whereas fear avoidance did not predict outcome. Interestingly, only measures of fear avoidance of physical activity were included.

Another limitation of the present study design may be that the patient's behaviour at the examination could influence the therapist's attitude and thereby the classification process. To minimize potential differential information bias on the outcome variable (pain responses), all patient were tested thoroughly and the therapists conducting the examination were blinded to questionnaire scores. Only information on the presence of non-organic signs was collected after assessment of pain responses. We believe that if such bias were present, it would have entailed an overestimation of the association. Because differences between centralizers and non-centralizer could be identified for only 2 out of 6 psychological variables and not in non-organic signs, it is unlikely that such bias could explain our findings. To avoid loss of information in subscales in the CMDQ, this study used a procedure where missing values were replaced by neutral values (i.e. 0). Missing values in the CMDQ have been reported more frequently in patients in whom psychological factors are present than in patients where they are not (19), so it is possible that the associations observed actually could have

been underestimated. Finally, it should be remembered that the present results are only based on a study of sick-listed patients with LBP, although we do believe that similar associations may be found in other patients with LBP, even if this cannot be established with certainty at present. In conclusion, pain response classification is not independent of mental distress and depressive symptoms in patients sick-listed due to LBP. When assessing prognosis and deciding on treatment on the basis of repeated end-range spinal movement testing in clinical settings, supplementary psychological screening may be a useful adjunct. It is recommended that the possible association between psychological factors and pain responses (i.e. CEN and non-CEN) be accounted for in future studies.

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