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Clinical Study

Lumbar motion changes in chronic low back pain patients: a secondary analysis of data from a randomized clinical trial

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Abstract

BACKGROUND CONTEXT: Several therapies have been used in the treatment of chronic low back pain (LBP), including various exercise strategies and spinal manipulative therapy (SMT). A common belief is that spinal motion changes in particular ways in direct response to specific interventions, such as exercise or spinal manipulation.

PURPOSE: The purpose of this study was to assess changes in lumbar region motion for more than 12 weeks by evaluating four motion parameters in the sagittal plane and two in the horizontal plane in LBP patients treated with either exercise therapy or spinal manipulation.

STUDY DESIGN/SETTING: Secondary analysis of a subset of participants from a randomized clinical trial.

PATIENT SAMPLE: One hundred ninety-nine study participants with LBP of more than 6 weeks' duration who had spinal motion measures obtained before and after the period of intervention.

OUTCOME MEASURES: Lumbar region spinal kinematics sampled using a six-degree-of-freedom instrumented spatial linkage system.

METHODS: Trained therapists collected regional lumbar spinal motion data at baseline and 12 weeks of follow-up. The lumbar region spinal motion data were analyzed as a total cohort and relative to treatment modality (high dose, supervised low-tech trunk exercise, SMT, and a short course of home exercise and self-care advice). The study was supported by grants from Health Resources and Services Administration, Danish Agency for Science Technology and Innovation, Danish Chiropractors Research Foundation, and the University of Southern Denmark. No conflicts of interest reported.

RESULTS: For the cohort as a whole, lumbar region motion parameters were altered over the 12-week period, except for the jerk index parameter. The group receiving spinal manipulation changed significantly in all, and the exercise groups in half, the motion parameters included in the analysis. The spinal manipulation group changed to a smoother motion pattern (reduced jerk index), whereas the exercise groups did not.

FDA device/drug status: Not applicable.

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The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

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CONCLUSION: This study provides evidence that spinal motion changes can occur in chronic LBP patients over a 12-week period and that these changes are associated with the type of treatment.

Keywords: Low back pain; Spine; Measurement; Motion analysis; Biomechanics; Nonsurgical; Manipulation; Exercise

Introduction

For many years, researchers and clinicians have sought to measure back problems objectively, primarily to attempt to determine the origin of pain, and subsequently, to measure whether given types of treatment evoke a biologically or biomechanically measurable change [1,2]. There is a tradition of basing diagnoses on the results of imaging techniques, such as conventional X-ray, computed tomography, or magnetic resonance imaging. Ascribing a patient's low back pain (LBP) to a presumed injured or painful structure (ie, a pathoanatomical source) is often inaccurate even when based on advanced imaging techniques. In many cases, LBP patients may show no identifiable pathoanatomical source. Conversely, it is not a rare observation that asymptomatic individuals demonstrate spinal pathologies evident on imaging [3,4]. Consequently, it has been proposed that spinal physical impairment and disability are better evaluated by assessing measurements of the movement pattern in specific motor tasks and/or recording of maximal muscle strength/power to determine the patient's functional ability [5,6]. Functional capacity assessments addressing strength and endurance of trunk musculature can be performed to monitor the problem of LBP impairment. However, they are limited in that they measure extreme capacity, which often goes beyond normal trunk function needed for typical activities of daily living [6].

Traditionally in the clinic, spinal movement is quantified by measuring, for example, range of motion (ROM) or Schobers index [7]. Such low-tech measurements describe the full functional range of joint excursion but little about the quality of the motion. Research has indicated that simple ROM measurements have limited use as a measure of treatment outcomes or as a stand-alone measure of disability [8,9]. It has been proposed that a link between lumbar motion and lumbar pain may be found by addressing the *patterns* of the motion rather than the end *ranges* of motion [10]. More advanced motion parameters derived from high-tech three-dimensional (3D) motion devices may contribute to describing patient movement and movement changes.

Several motion parameters can be derived from real-time 3D spinal motion analysis, for example, angular velocity, acceleration, and smoothness of motion, respectively [11]. The development of advanced techniques to measure trunk motion characteristics during unloaded free dynamic activities represents an attempt to remedy existing deficiencies in the quantification of LBP impairment. However, the actual usefulness of regional lumbar motion measurements remains controversial. Lumbar motion measurements are probably influenced by several subjective factors, such as the patient's agenda, motivation, effort, fear and other psychosocial states, as well as actual physical capabilities.

Many hypotheses and theories exist about how different treatment modalities such as exercise or spinal manipulation affect biomechanical spine function [12,13]. Several specific therapies have demonstrated positive effect on patient-reported outcomes [14–17], but little is known about the change in spinal movement characteristics after treatment. When a therapist treats a patient, a common belief is that spinal motion changes in particular ways in direct response to specific interventions, such as exercises or manual therapy. However, there seems to be a lack of science-based knowledge on this important aspect of clinical rehabilitation.

The overall aim of the present study was to analyze changes in lumbar region motion for more than 12 weeks by describing pre-to-post treatment changes in the entire study population, as well as treatment group differences, by evaluating four motion parameters in the sagittal plane and two in the horizontal plane.

Specifically, we wanted to analyze the change in spinal ROM, maximum flexion velocity, phase-plot area, jerk index (smoothness of motion), and two circumduction area motion parameters in 199 chronic LBP patients over a 12-week intervention period and analyze the effect of 12 weeks of spinal manipulation therapy, supervised trunk exercise, or home exercise on spinal lumbar motion ability.

Materials and methods

Design

This spinal motion analysis study is a secondary analysis of a subset of study participants from an observer-blinded, parallel-group, randomized clinical trial [15]. Subjects were recruited over a period of 3 years at the Wolfe Harris Center for Clinical Studies at Northwestern Health Sciences University, Minneapolis, USA. The institutional review boards of the Northwestern Health Sciences University, the Minneapolis Medical Research Foundation, and the University of Minnesota approved the study, and written informed consent was obtained from all study participants. Spinal motion recordings were measured at two baseline (PRE) visits (separated by 7–14 days) and one follow-up visit after 12 weeks of intervention (POST). To illustrate the stability of pain intensity in the overall cohort, pain intensity levels