Structure-Specific Movement Patterns in Patients With Chronic Low Back Dysfunction Using Lumbar Combined Movement Examination

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Abstract

Objective: A test-retest cohort study was conducted to assess the use of a novel computer-aided, combined movement examination (CME) to measure change in low back movement after pain management intervention in 17 cases of lumbar spondylosis. Additionally we desired to use a CME normal reference range (NRR) to compare and contrast movement patterns identified from 3 specific structural pathologic conditions: intervertebral disc, facet joint, and nerve root compression.

Methods: Computer-aided CME was used before and after intervention, in a cohort study design, to record lumbar range of movement along with pain, disability, and health self-report questionnaires in 17 participants who received image-guided facet, epidural, and/or rhizotomy intervention. In the majority of cases, CME was reassessed after injection together with 2 serial self-reports after an average of 2 and 14 weeks. A minimal clinically important difference of 30% was used to interpret meaningful change in self-reports. A CME NRR (n = 159) was used for comparison with the 17 cases. Post hoc observation included subgrouping cases into 3 discrete pathologic conditions, intervertebral disc, facet dysfunction, and nerve root compression, in order to report intergroup differences in CME movement.

Results: Seven of the 17 participants stated that a "combined" movement was their most painful CME direction. Self-report outcome data indicated that 4 participants experienced significant improvement in health survey, 5 improved by ≥30% on low back function, and 8 reported that low back pain was more bothersome than stiffness, 6 of whom achieved the minimal clinically important difference for self-reported pain. Subgrouping of cases into structure-specific groups provided insight to different CME movement patterns.

Conclusion: The use of CME assists in identifying atypical lumbar movement relative to an age and sex NRR. Data from this study, exemplified by representative case studies, provide preliminary evidence for distinct intervertebral disc, facet joint, and nerve root compression CME movement patterns in cases of chronic lumbar spondylosis. (J Manipulative Physiol Ther 2017;40:340-349)

Key Indexing Terms: *Spine; Lumbar Vertebrae; Pain; Range of Motion; Articular*

Introduction

Low back pain (LBP) is a major public health problem in the Western world. The lifetime prevalence is as high as 85%, and the reported annual incidence in adults is 22% to 65%,[1] with 40% to 70% of those experiencing LBP seeking health care.[2] Despite increased efforts to understand LBP, knowledge of the underlying pathology and insights into optimizing clinical outcomes have advanced little in the last 2 decades.[3]

It is assumed that a large portion of LBP is caused or influenced by biomechanical factors.[4,5] Because all spinal structures are potentially a source of LBP,[6,7] an accurate diagnosis is often difficult to make.[8] Authors of a retrospective study of 170 patients undergoing diagnostic procedures for LBP suggested the intervertebral disc (IVD) and facet joints are the 2 most likely sources of pain, with prevalences of 42% and 31%, respectively.[9] Improved diagnostic accuracy would confer obvious cost advantages to the health system for enabling treatment to focus on particular sources of pain and, more than this, would enable

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pathology-specific interventions to be grouped for clinical research.

During a structured clinical examination of the lumbar spine, a key component includes assessing the range of motion (ROM),[10] indicating spinal function, painful movement directions, response to intervention, or even permanent impairment. The literature reports various movement assessments including functional activities of daily living,[11] planar movements,[12-14] and combined movement examinations (CME).[15-17] Sanchez-Zuriaga et al[18] reported subtle alterations in lumbopelvic motion in asymptomatic patients with recurrent LBP. However, their study only tested 2 planar movements (flexion and extension). A lumbar CME is considered more informative than a planar movement examination[15,19] because this approach matches functional movements to the patient's presenting complaint and may reproduce symptoms that could in future help with diagnosis.[20,21]

The purpose of the present study was to use a validated, reliable CME testing procedure[21] to determine if structure-specific movement patterns exist in cases of chronic lumbar spine dysfunction. To examine this, CME and self-report data in 17 patients who underwent pain management intervention for confirmed lumbar spondylosis were collected and compared with a relevant normal reference range (NRR). Normalizing of CME after intervention was attributed to the structure treated and provided insight into structure-specific CME movement patterns. For example, if a participant had reduced left-side flexion (LSF) caused by LBP, and treating the left L4-5 facet joint normalized LSF, we attributed the reduced LSF CME pattern to the left L4-5 facet joint.

Methods

This study was approved by the human research ethics committees at the University of Western Australia and Sir Charles Gairdner Hospital (Perth, Western Australia, Australia). Patient information was provided, and consent was obtained in all cases.

A 3-D motion tracking system (MotionStar Ascension Technology, VT)[21] with custom software (LabVIEW V5.0, National Instruments, Austin, TX) was used to measure a standardized 8-direction CME (Fig 1). Proof of concept for the use of computer-aided CME and acceptable intrasession and intersession reliability has been reported elsewhere.[21]

Recruitment and CME Data Collection

A total of 33 patients with LBP and/or leg pain diagnosed by pain specialists as originating from low back structures were recruited and attended a preintervention CME trial. Of these, 17 individuals received pain management intervention and completed postintervention examination (Fig 2). Patients were recruited from a private physiotherapy practice (n = 8) and a pain management clinic in a tertiary hospital (n = 9); the sample comprised 8 men (aged 53 ± 12 years) and 9 women (aged 60 ± 13 years).

After familiarization with test protocol, 2 skin-mounted MotionStar sensors (Ascension Technology) were placed over the volunteer's S1 and L1 spinous process. Data acquisition and postprocessing are described in detail elsewhere.[21] Patients were asked to remember their most painful and most stiff CME movement direction, followed by instruction and guidance into each of the 8 CME movement directions (Fig 1). Maximal data values for ROM were recorded according to a predefined sequence: flexion (Flex), flexion with added left-side flexion (FwLSF), flexion with added right-side flexion (FwRSF), left-side flexion (LSF), right-side flexion (RSF), extension (Ext), extension with added left-side flexion (EwLSF), and extension with added right-side flexion (EwRSF).

All 17 patients were tested before intervention and retested at approximately 14 weeks after intervention.

Outcome Measures

A battery of self-report outcome measures were used to assess cases at each examination visit[22]: visual analog scale for pain (VASp) and low back stiffness (denoted as VASs), Roland-Morris Low Back Pain and Disability Questionnaire (RMDQ), and a short-form health survey (SF-12). Stiffness measured by VASs was included as an outcome measure because clinical measures often do not seek information regarding the effect of lumbar stiffness on function.[23,24] A minimal clinically important difference (MCID) of 30% was used for all self-report data.[25] Combined movement examination data was also collected and expressed using z scores (standard scores for normally distributed data). A variable can be converted to a z score if the distribution of normal range for that variable is Gaussian. In this study, z scores expressed each individual's ROM relative to their age and sex-matched NRR, indicating the magnitude of each movement direction in standard deviations (+ or −) from the NRR mean.[26] For the 8 CME directions the maximum values were displayed in a radial plot and z scores calculated for each direction and trial. For ease of comparison, it is noted that 68% of the distribution lies within 1 standard deviation (SD) of the mean ($-1 \le z \le +1$), and 95% lies within 2 SD of the mean ($-2 \le z \le +2$).

Total change scores and z scores are reported. Each participant's CME was evaluated alongside the pain specialist's diagnosis, treatment response, lumbar computed tomographic imaging (CT) or magnetic resonance imaging (MRI), and matched NRR, in an effort to compare CME with identified pathologic conditions. A normal NRR (n = 159) was used to aid in comparing and contrasting each case's movement patterns.[21]

Statistical Analysis

A sample of convenience was derived from a tertiary hospital and private practice setting, and z scores were used to assess the clinical CME. This representation facilitates

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