Change in Low Back Movement Patterns After Neurosurgical Intervention for Lumbar Spondylosis

Aubrey P. Monie, PhD, MMT,[a] Roger I. Price, PhD,[b] Christopher R.P. Lind, MBChB,[c] and Kevin P. Singer, PhD[a]

Abstract

Objectives: The purpose of this study was to assess the use of computer-aided combined movement examination (CME) to measure change in low back movement after neurosurgical intervention for lumbar spondylosis and to use a CME normal reference range (NRR) to compare and contrast movement patterns identified from lumbar disk disease, disk protrusion, and nerve root compression cases.

Methods: A test-retest, cohort observational study was conducted. Computer-aided CME was used to record lumbar range of motion in 18 patients, along with pain, stiffness, disability, and health self-report questionnaires. A minimal clinically important difference of 30% was used to interpret meaningful change in self-reports. z Scores were used to compare CME. Post hoc observation included subgrouping cases into 3 discrete pathologic conditions—disk disease, disk protrusion, and nerve root compression—to report intergroup differences in CME.

Results: Self-report data indicated that 11, 7, and 10 patients improved by ≥30% in pain, stiffness, and function, respectively. Three patients experienced clinically significant improvement in health survey. A CME pattern reduced in all directions suggested disk disease. Unilaterally restricted movement in side-flexed or extended directions suggested posterolateral disk protrusion with or without ipsilateral nerve root compression. Bilateral restrictions in extension suggested posterior disk protrusion with or without nerve root compression. In 11 of the 18 cases, CME converged toward the NRR after surgery.

Conclusion: We described the use of CME to identify atypical lumbar movement relative to an NRR. Data from this short-term postoperative study provide preliminary evidence for CME movement patterns suggestive of disk disease, disk protrusion, and nerve root compression. (J Manipulative Physiol Ther 2018;41:111-122)

Key Indexing Terms: *Range of Motion, Articular; Spine; Intervertebral Disk; Nerve Compression Syndromes; Neurosurgery*

Introduction

Low back pain (LBP) is a major public health problem. 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 disk (IVD) and facet joints are the 2 most likely sources of pain, with prevalence 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 would enable pathology-specific interventions to be grouped for clinical research.

A key component of clinical examination 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

[a] The Centre for Musculoskeletal Studies, School of Surgery, The University of Western Australia, Perth, Western Australia, Australia.
[b] Department of Medical Technology and Physics, Sir Charles Gairdner Hospital, Perth, Western Australia, Australia.
[c] Department of Neurosurgery, Sir Charles Gairdner Hospital, Perth, Western Australia, Australia.
Corresponding author: Aubrey P. Monie, PhD, MMT, The Centre for Musculoskeletal Studies, School of Surgery M424, The University of Western Australia, Perth, Crawley, Western Australia 6009, Australia. Tel.: +61 421717932.
(e-mail: *aubrey.monie@research.uwa.edu.au*).
Paper submitted July 10, 2017; in revised form August 20, 2017; accepted August 23, 2017.
0161-4754

https://doi.org/10.1016/j.jmpt.2017.08.008

activities of daily living,[11] planar movements,[12-14] and combined movement examinations (CMEs).[15-17] A lumbar CME is considered more informative than a planar movement examination[15,18] because this approach matches functional movements to the patient's presenting complaint and may reproduce symptoms that could in future help with diagnosis.[19]

The purpose of the present study was to use a CME testing procedure[20] to determine if specific movement patterns exist in cases of chronic lumbar spine dysfunction. To examine this, CME and self-report data in 18 patients who underwent neurosurgical intervention for confirmed lumbar spondylosis were compared with a CME normal reference range (NRR). Normalizing of postintervention CME was attributed to the structure treated and provided insight into structure-specific CME movement patterns. For example, if a patient had reduced left-side flexion (LSF) because of LBP and treating a left L4-5 disk protrusion normalized LSF, we attributed the reduced LSF CME pattern to the left L4-5 disk protrusion.

The purpose of this study was to assess the use of computer-aided CME to measure change in low back movement after neurosurgical intervention for lumbar spondylosis and to use a CME NRR to compare and contrast movement patterns identified from lumbar disk disease, disk protrusion, and nerve root compression cases.

Methods

This observational 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, Shelburne, Vermont)[20] with custom software (LabVIEW V5.0, National Instruments, Austin, Texas) 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 have been reported elsewhere.[20]

Recruitment and CME Data Collection

Thirty-nine patients with LBP and/or leg pain diagnosed by neurosurgeons as originating from low back structures were recruited and attended a preintervention CME trial. Of these, 18 individuals received neurosurgical intervention and completed postintervention examination (Fig 2). Patients were recruited from a private physiotherapy practice (n = 2) and a neurosurgery department in a tertiary hospital (n = 16); the sample comprised 6 men (aged 49 ± 14 years) and 12 women (aged 50 ± 11 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.[20] 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), LSF, right-side flexion (RSF), extension, extension with added left-side flexion (EwLSF), and extension with added right-side flexion (EwRSF).

All 18 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 patients at each examination visit[21]: 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). A VASs was included because clinical measures often do not seek information regarding the effect of lumbar stiffness on function.[22,23] A minimal clinically important difference (MCID) of 30% was used for all self-report data.[24] Combined movement examination data were also collected and expressed using z scores (standard scores for normally distributed data). 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.[25] For the 8 CME directions the maximum values were displayed in a radial plot and z scores calculated for each direction and trial.

Each patient's CME was evaluated alongside the neurosurgeon's diagnosis, treatment response, lumbar computed tomography or magnetic resonance imaging 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.[20]

Statistical Analysis

A sample of convenience was derived from a tertiary hospital and private practice setting. z Scores were used to assess the clinical CME. This representation facilitates comparison with an NRR in each of the 8 CME movement directions, with reference to age and sex of each case.

Results

Change scores (%) were derived for: VASp and VASs in relation to their low back condition, SF-12 physical