ORIGINAL ARTICLES

MAGNETIC RESONANCE IMAGING ZYGAPOPHYSEAL JOINT SPACE CHANGES (GAPPING) IN LOW BACK PAIN PATIENTS FOLLOWING SPINAL MANIPULATION AND SIDE-POSTURE POSITIONING: A RANDOMIZED CONTROLLED MECHANISMS TRIAL WITH BLINDING

Gregory D. Cramer, DC, PhD,[a] Jerrilyn Cambron, DC, MPH, PhD,[b] Joe A. Cantu, DC,[c] Jennifer M. Dexheimer, LMT, BS,[d] Judith D. Pocius, MS,[e] Douglas Gregerson, DC,[f] Michael Fergus, DC,[g] Ray McKinnis, PhD,[h] and Thomas J. Grieve, DC, MPH[i]

ABSTRACT

Objective: The purpose of this study was to quantify lumbar zygapophyseal (Z) joint space separation (gapping) in low back pain (LBP) subjects after spinal manipulative therapy (SMT) or side-posture positioning (SPP).
Methods: This was a controlled mechanisms trial with randomization and blinding. Acute LBP subjects (N = 112; four n = 28 magnetic resonance imaging [MRI] protocol groups) had 2 MRI appointments (initial enrollment and after 2 weeks of chiropractic treatment, receiving 2 MRI scans of the L4/L5 and L5/S1 Z joints at each MRI appointment. After the first MRI scan of each appointment, subjects were randomized (initial enrollment appointment) or assigned (after 2 weeks of chiropractic treatment appointment) into SPP (nonmanipulation), SMT (manipulation), or control MRI protocol groups. After SPP or SMT, a second MRI was taken. The central anterior-posterior joint space was measured. Difference between most painful side anterior-posterior measurements taken postintervention and preintervention was the Z joint "gapping difference." Gapping differences were compared (analysis of variance) among protocol groups. Secondary measures of pain (visual analog scale, verbal numeric pain rating scale) and function (Bournemouth questionnaire) were assessed.
Results: Gapping differences were significant at the first (adjusted, $P = .009$; SPP, 0.66 ± 0.48 mm; SMT, 0.23 ± 0.86; control, 0.18 ± 0.71) and second (adjusted, $P = .0005$; SPP, 0.65 ± 0.92 mm; SMT, 0.89 ± 0.71; control, 0.35 ± 0.32) MRI appointments. Verbal numeric pain rating scale differences were significant at first MRI appointment ($P = .04$) with SMT showing the greatest improvement. Visual analog scale and Bournemouth questionnaire improved after 2 weeks of care in all groups (both $P < .0001$).

[a] Professor and Dean of Research, Department of Research, National University of Health Sciences, Lombard, IL.
[b] Professor, Department of Research, National University of Health Sciences, Lombard, IL.
[c] Radiological Consultant, Charlottesville, VA.
[d] Clinical Research Coordinator, Department of Research, National University of Health Sciences, Lombard, IL.
[e] Morphometry Technician, Department of Research, National University of Health Sciences, Lombard, IL.
[f] Adjunct Professor, Department of Research, National University of Health Sciences, Lombard, IL.
[g] Assistant Professor, Department of Diagnostic Imaging, National University of Health Sciences, Lombard, IL.
[h] Statistical Consultant, Winfield, IL.
[i] Instructor, Department of Research, National University of Health Sciences, Lombard, IL.

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Submit requests for reprint to: Gregory D. Cramer, DC, PhD, National University of Health Sciences, Department of Research, 200 East Roosevelt Road, Lombard, IL 60148 (e-mail: *gcramer@nuhs.edu*).
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Conclusions: Side-posture positioning showed greatest gapping at baseline. After 2 weeks, SMT resulted in greatest gapping. Side-posture positioning appeared to have additive therapeutic benefit to SMT. (J Manipulative Physiol Ther 2013;36:203-217)
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A fundamental hypothesis of a beneficial effect of chiropractic spinal manipulative therapy (SMT) is that adhesions developing in hypomobile zygapophyseal (Z) joints are broken during SMT by gapping of the Z joint articular surfaces[1-3] (Fig 1).

Vertebral segmental hypomobility has been identified clinically, and low back pain (LBP) patients with identified vertebral hypomobility have been found to respond more favorably to SMT than those without hypomobility.[4,5] Putative reasons for Z joint hypomobility include inactivity; injury; or repetitive, asymmetric motions (eg, assembly line work). Such repetitive motions would tend to result in normal or increased movement of some of the Z joints while chronically loading others. The joints receiving the long-term loading would likely become relatively hypomobile.

Fibrous adhesions are thought to develop in hypomobile Z joints, further preventing normal joint motions.[1-3] In fact, fibrous adhesions[6] and degenerative changes[7] have been quantified in hypomobile animal Z joints (Fig 1, step 2). Gapping of the Z joints is thought to break-up intra-articular adhesions that have developed during hypomobility and aid in re-establishing normal range of motion to the Z joints (Fig 1, steps 3-5).[1,3,8] In the past, SMT was hypothesized to separate, or gap, the Z joint articular surfaces,[3,8-14] and more recently, SMT and side-posture positioning (SPP) have been shown to gap the lumbar Z joints in healthy human volunteers, with SMT resulting in greater gapping than SPP alone.[15-17] However, no previous studies assessed Z joint gapping in clinical (LBP) patients.

The study reported here was designed to determine whether Z joints gap during lumbar side-posture SMT and SPP in acute LBP patients (Fig 1, step 3). Zygapophyseal joint gapping was assessed from magnetic resonance imaging (MRI) scans taken at initial presentation (M1) and after 2 weeks of chiropractic care (M2). Secondary outcomes assessing pain and functional impairment were also included.

Methods

Project Overview

This controlled mechanisms trial with randomization and blinding used 4 MRI protocol groups (SPP, SMT, and 2 control groups) to assess a component of one of the proposed mechanisms of SMT. Figure 2 shows the general overview of the study. The study was not designed to assess the effectiveness of spinal manipulation as a treatment; other investigators are conducting such effectiveness studies[19-25]; this study was designed to assess gapping of the Z joints with SPP and SMT in LBP subjects. All subjects in this study received the same modalities of care during the treatment phase of the project.

This study was approved by the Institutional Review Board of the National University of Health Sciences (IRB no. H-0107) and was registered with the US NIH Clinical Trial Registry (NCT00284063).

Screening Examination

Table 1 shows the inclusion and exclusion criteria used at the screening examination. The acute LBP subjects[26] included in this study closely matched the patients described as "Category 1" (more specifically, categories 1a and 1b) of the Quebec Task Force classification.[27] Each subject's most painful side (primary treatment side [PTS]) was determined at the examination. The treating clinician (DG) asked the patient to describe her/his pain and to identify the most painful side. The subject's reported most painful side became the PTS and did not change throughout the study. The PTS was the up-side during all SMT or SPP during M1 and M2 appointments.

MRI Scanning

Previously published methods were used for the MRI positioning and scanning.[15,16] Each of the 112 subjects received 2 MRI scans (Hitachi MRP 5000, 0.2-T MRI unit, Hitachi Medical Systems America, Inc, Twinsburg, OH) on 2 separate occasions, the M1 and M2 (Figs 3 and 4).

Figure 4 shows the protocols used for the 4 protocol groups of the study. The most painful side, the PTS, was always the up-side for SPP or SMT. The 4 protocol groups were as follows: protocol 1 (SPP group): neutral positioning, followed by SPP, remaining in SPP for second MRI scan; protocol 2 (SMT control): neutral positioning, followed by side-posture SMT, followed by neutral positioning for second MRI; protocol 3 (SMT group): neutral positioning, followed by side-posture SMT and remaining in side-posture for second MRI; and protocol 4 (SPP control, primary control): neutral positioning, followed by brief SPP, followed by neutral positioning for second MRI.

Magnetic resonance imaging scans were taken with the subjects in the original neutral position and in the final position. The first scan of each MRI appointment was taken in the neutral (supine) position. This allowed for a baseline Z joint space (gapping) measurement to be obtained for each subject. The initial (neutral position) MRI was followed by an intervention (side-posture SMT or SPP), which was immediately followed by a second scan. The second MRI scan was taken either back in the supine