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Evaluation of the effect of postural perturbation on motoneuronal activity following various methods of lumbar spinal manipulation

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Abstract

BACKGROUND AND CONTEXT: One basic physiologic response to spinal manipulation (SM) is a transient decrease in motoneuronal activity, as assessed by the Hoffmann reflex (H-reflex) technique. However, questions of appropriate control procedures when using the H-reflex technique to study the basic physiologic mechanisms of SM still exist. The identification of appropriate control procedures may allow us to better differentiate among the specific and nonspecific aspects of SM.
PURPOSE: The purpose of the research was to determine the contributions of postural perturbations on the attenuation of motoneuronal activity following spinal manipulative thrusts and spinal joint preload procedures applied to the lumbar spine.
STUDY DESIGN/SETTING: H/M_{max} ratios, recorded from the gastrocnemius muscle, were measured before and after lumbar spinal procedures. The experimental designs for the laboratory data collection protocols were repeated measures and between-subjects.
PATIENT SAMPLE: The subjects were asymptomatic, young, healthy volunteers.
OUTCOME MEASURE: H/M_{max} ratios recorded from the gastrocnemius muscle.
METHODS: In Experiment 1, the administration of prone lumbar procedures involved either manual assist to more fully shear the lumbar zygapophyseal joints or no manual assist. One set of subjects (n=17) received assisted joint preload force and manipulation, whereas a second set of subjects (n=17) received unassisted joint preload force and manipulation. In a second laboratory experiment, one set of subjects (n=10) received a L5-S1 side-posture SM, whereas a second set of subjects (n=10) were just positioned into side-posture.
RESULTS: There was a H/M_{max} ratio attenuation of 18.2% after assisted spinal manipulation, whereas H/M_{max} ratio attenuation was only 9.5% after unassisted spinal manipulation. Decreases of H/M_{max} ratios by 8.5% and 7.5% were observed after assisted and unassisted joint preload forces, respectively. The amount of H/M_{max} ratio attenuation was significantly greater immediately after the L5-S1 SM procedure (28.4%) as compared with a side-posture positioning maneuver (15.3%).
CONCLUSION: SM may provide procedure-specific sensory input that appears to vary, based upon the various types of vertebral loading applied to the lumbar spine.

Keywords: Spinal manipulation; Lumbar spine; Tibial nerve H-reflex; Chiropractic

Introduction

Spinal manipulation (SM) is a commonly employed nonoperative treatment modality in the management of patients with neck, low back, or pelvic pain. One basic physiologic response to SM is a transient decrease in motoneuronal activity, as assessed by the Hoffmann reflex (H-reflex) technique [1–4]. However, questions of appropriate control procedures when using the H-reflex technique to study the basic physiologic mechanisms of SM still exist. SM of the lumbar spine typically involves changes in whole

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body orientation during side-posture procedures. A postural perturbation is one of many factors that may affect the amplitude of the H-reflex response [5,6]. The H/M_{max} ratio is a valid index of motoneuronal activity when the recording and stimulating environments are the same before and after an experimental perturbation [5]. Although the previous data on the effects of SM on the transient decrease in motoneuronal activity document the consistency of the recording and stimulating environments from pre to post SM [1–4], the inclusion of appropriate control procedures may allow us to better differentiate among the specific and nonspecific aspects of SM.

Other research indicates that a cervical SM does not lead to changes in the activity of the lumbar motoneuron pool as assessed by the tibial nerve H-reflex response [7]. SM delivered to the lumbar spine with the subject in side-posture leads to a short-term attenuation of tibial nerve H-reflex responses without a concomitant change after paraspinal massage therapy [2]. Motor evoked potentials in the gastrocnemius muscle from transcranial magnetic stimulation were significantly facilitated from 20 to 60 seconds after a L5-S1 SM, without a concomitant change after a side-posture positioning (control) maneuver [8]. These current data tend to support the hypothesis that SM imparts a specific effect on lumbar motoneuronal activity. Thus, the hypothesis that SM may produce the same result as a nonspecific perturbation, such as a ''startle'' maneuver, was not supported by these reports.

The exact physiologic mechanism underlying SM-induced inhibition of motoneuronal activity is unknown. SM may produce an inhibitory reflex response that is segmental in origin [9,10]. Group Ia, Ib, II, and IV afferents respond in a graded fashion to the velocity, magnitude, and direction of vertebral loading applied to the lumbar spine [10]. Importantly, stimulations of Group Ib, III, and IV muscle afferents exert an inhibitory effect on alpha motoneurons [10,11]. The transient nature of SM inhibition of motoneuronal activity may involve decreased excitatory inputs from the muscle spindle afferents which is consistent with two well-defined physiologic mechanisms: muscle spindle aftereffects and post-activation depression of Ia afferents (cf. current discussion and Dishman and Bulbulian [1]). Thus, SM, and similar types of perturbation, may alter sensorimotor behavior of the lumbar spine [10,12].

Other manual therapies that do not employ high-velocity, low-amplitude (HVLA) manipulative thrusts are also commonly used as a conservative treatment technique in the management of patients with neck, low back, or pelvic pain. The independent contribution of manual joint preload application to the transient attenuation of lumbar motoneuronal activity after a side-posture L5-S1 SM procedure was previously addressed [1]. Healthy subjects, with no low back pain (n=7) were evaluated for baseline tibial nerve H-reflex responses, and then subjected to bilateral manual spinal joint preload procedures in side-posture. Then, after a 1-hour wash-out period, these same subjects were administered a bilateral L5-S1 SM (HVLA) procedure in side-posture. Other than the manipulative thrusts, the bilateral joint preload procedure did not differ from the bilateral SM procedure. Although there were no significant differences between SM and joint preload alone, the H/M_{max} ratios, collapsed across procedures, were significantly reduced with respect to baseline pre-values from 10 to 50 seconds post-procedures [1]. The same ordering of procedures, joint preload first then SM, for a small number of subjects, may have limited their ability to detect differences between the procedures or may have indicated that effects of joint preload and SM were additive. In addition, and perhaps more importantly, the nonspecific contribution of the side-posture body positioning perturbation on the SM-induced attenuation of motoneuronal activity was not addressed. What role might body positioning perturbation play in the observed effect of HVLA SM on motoneuron excitability?

The overall purpose of the current research was to determine the contributions of postural perturbations on the attenuation of motoneuronal activity after HVLA manipulative thrusts as compared with spinal joint preload procedures applied to the lumbar spine. The investigators developed experimental protocols that used a constant prone patient positioning for the administration of spinal procedures to the lumbar spine and the collection of tibial nerve H-reflex responses. The experimental protocols also altered the direction of applied force vectors by performing the prone lumbar procedures with or without the so-called ''pelvic assist''. The ''pelvic assist'' essentially entails the lifting of the pelvis via an anterior iliac crest contact, in an attempt to more fully shear the lumbar zygapophyseal joints. Comparisons of tibial nerve H-reflex responses before and after HVLA manipulative thrusts and low-velocity, spinal joint preload procedures in the prone position, assisted and unassisted, allowed us to address the effects of various aspects of different vertebral loading applied to the lumbar spine, independent of postural perturbations. In a second experiment, a comparison of tibial nerve H-reflex responses before and after a side-posture positioning maneuver and a side-posture HVLA SM was addressed in an attempt to better differentiate among the specific and nonspecific (ie, postural perturbation) aspects of the manipulative thrust on the lumbar spine.

Methods

Experiment 1

Participants. The subjects were 34 healthy, young volunteers recruited from a college student population. Inclusion criteria included no low back pain within the past 3 months and no history of radiculopathy or neuropathy of the lower limbs. One set of subjects (n=17, 11 males and 6 females) received mobilization and manipulation with assist (25.8±1.67 years; 170.7±10.48 cm; 78.2±17.78 kg),