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Novel Electromyographic Protocols Using Axial Rotation and Cervical Flexion-Relaxation for the Assessment of Subjects With Neck Pain: A Feasibility Study

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Abstract

Objective: The purpose of this study is to examine the feasibility of novel variations to the way cervical flexion-relaxation phenomenon (FRP) studies are conducted and the feasibility of using cervical axial rotation as an alternative objective measure of cervical pain/dysfunction.

Methods: Electromyographic data were collected from cervical paraspinal muscles of 5 participants with neck pain and 5 asymptomatic controls. Cervical FRP was conducted as reported in the literature with the participants seated, except that they started with the head fully flexed instead of being erect. Data were also collected with participants laying prone, starting with their head hanging over the edge of the table. Additional data were collected from cervical paraspinal and sternocleidomastoid (SCM) muscles while the seated participants rotated their head fully to the right and left. Ratios were obtained for each type of test by dividing the electromyographic amplitude when muscles were most active by that when they were relaxed or in contralateral rotation.

Results: In each case, the ratio was higher for the controls than for those with neck pain, suggesting that any of the 4 methods could be used to distinguish between 2 groups. The ratios were most pronounced from SCMs during axial rotation. There appeared to be a negative relationship between pain level and the ratios obtained from each method.

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Conclusion: The findings from this small study are encouraging for all methods used, with axial rotation using SCMs appearing to be the most promising. These results indicate that larger, powered studies are warranted.

Introduction

Depending on the case definitions used, the 12-month prevalence of neck pain ranges from 12.1% to 71.5% in the general population, and each year, 11%-14.1% of workers are reported as being limited in their activities because of neck pain.[1] Although quite common, neck pain is difficult to quantify in an objective manner. Subjective measures are commonly used, such as the visual analog scale[2] or the numerical rating scale for pain,[3] or questionnaires aimed at the ease/difficulty of performing physical tasks.[4] Because there is no way to objectively quantify pain directly, efforts have been made to develop objective methods that rate alternative indicators of pain such as pressure pain threshold and electromyographic (EMG) amplitude of specific muscles.[5–7] The flexion-relaxation phenomenon (FRP) is a type of neuromuscular response in which the back muscles of healthy individuals become essentially inactive when one flexes the trunk forward to the end range of motion. A review of the literature has indicated that lumbar FRP has been used for many years[8] and has been shown to be a valuable objective tool to aid in the evaluation of patients with low back pain.[9] For example, the FRP has been shown to be able to objectively distinguish those with low back pain from those without as well as between subgroups of low back pain.[10]

In 1997, Watson et al[11] developed the concept of the flexion-relaxation ratio (FRR) to quantify the degree to which the FRP is present. Since then, multiple methods of computing a lumbar FRR have been reported in the literature.[12,13] To measure lumbar FRR, surface EMG electrodes are placed over the lumbar paraspinal muscles. Muscle activity is recorded while a person begins by standing erect, then bends forward, stays in the fully flexed position for a few seconds, and ends by returning to the erect posture. The FRR is calculated by dividing the maximum value of the EMG amplitude during the raising up of the trunk by the average EMG amplitude recorded while the participant is fully flexed. In healthy individuals, the EMG amplitude is greatly reduced when the person is fully flexed, resulting in a relatively large FRR. However, in persons with low back pain, the EMG amplitude may not be similarly reduced when that person is fully flexed, thus resulting in a smaller FRR.

There are also several fairly recent studies examining FRP in the region of the cervical spine in the same manner as has been done in the lumbar spine. Three articles were found in the literature examining FRP in persons without cervical pain. In 1993, Meyer et al[14] applied the FRP to the cervical spine in 10 asymptomatic participants. While sitting erect in a straight backed chair, the participants were instructed to lower their heads with the goal of approximating their chin to their upper chest and then raising them up again. The FRP was demonstrated in all 10 cases as noted by visual inspection of the plots of the EMG data. In 2008, Burnett et al[15] sought to determine whether the FRP exists in cervicothoracic muscles in asymptomatic participants while seated in a standardized neutral spine posture. They did not see the FRP in upper trapezius or thoracic erector spinae (at T4) but did see evidence of it in the cervical paraspinals. In 2009, Pialasse et al[16] found the cervical FRP to be more pronounced (greater values of FRR) in asymptomatic participants if the participant is seated, leaning forward, and supported with the trunk in 45° of flexion.

Four articles were found in the literature examining FRP in persons with neck pain. Although primarily evaluating a wireless EMG system, Airaksinen et al[17] showed a visual difference in the plots of EMG data taken during cervical flexion-relaxation of one person with neck pain and one without. Murphy et al[18] calculated FRRs from EMG recordings taken from 14 persons with chronic neck pain and 14 asymptomatic controls. They found a significant difference in the FRR between the 2 groups, as did Maroufi et al[19] using groups of 21 with neck pain and 20 without. Zabihhosseinian et al[20] found a difference between the FRR of 13 healthy participants and that of 12 with neck pain. They also found that after fatigue was elicited by repetition of an isometric neck extension task, the FRR decreased for the controls but increased for those with neck pain.

Although not working with neck pain participants, Nimbarte et al[21] also documented changes in FFR when the cervical muscles were significantly fatigued.