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Basic Science

Electromyographic activity of rectus capitis posterior minor muscles associated with voluntary retraction of the head

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Abstract

BACKGROUND CONTEXT: The functional role of rectus capitis posterior minor (RCPm) muscles is not well defined. To the best of our knowledge, electromyographic (EMG) data from RCPm muscles in humans have never been collected and analyzed.

PURPOSE: To test the null hypothesis that there will be no difference in normalized levels of EMG activity measured from RCPm muscles with the head in a neutral position and with the head in a retracted position.

STUDY DESIGN: A repeated measures design intended to quantify normalized levels of EMG activity measured from RCPm muscles.

METHODS: Disposable 25-gauge, bipolar fine wire hooked electrodes were used to collect EMG data from both right and left RCPm muscles from 17 asymptomatic subjects. Data were collected while subjects performed five trials with the head maintained in a neutral position; performed three maximal voluntary isometric contraction efforts; performed four trials with the head maintained in a retracted position. Mixed effects beta regression models were used to analyze the data.

RESULTS: Normalized EMG activity of RCPm muscles collected with the subject's head held in a retracted position was significantly higher ($p<.0001$) than normalized EMG activity collected with the subject's head held in a self-selected, neutral position.

CONCLUSIONS: Rectus capitis posterior minor muscles are active when the head is held in a neutral position and show a significant increase in activity when the head is held in a retracted position. © 2014 Elsevier Inc. All rights reserved.

Keywords: Rectus capitis posterior; Electromyography; Neck muscles; Functional role; Head retraction

Introduction

Rectus capitis posterior minor (RCPm) muscles arise from the posterior tubercle on the posterior arch of the atlas and insert on the occipital bone inferior to the inferior nuchal line and lateral to the midline [1]. The orientation of the RCPm muscles is such that there is no significant wrapping around bony or muscular structures. Rectus capitis posterior minor muscles are the only muscles that attach to the posterior arch of the atlas. Based on their anatomical location, rectus capitis anterior muscles would appear to be antagonistic to RCPm muscles.

The functional significance of RCPm muscles has not been clearly defined. Bilateral contraction of RCPm muscles

FDA device/drug status: Not applicable.

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is purported to result in extension of the head [2]. However, their small size, relative to larger posterior muscles acting in parallel, would seem to minimize their contribution to gross extension of the head and neck [3,4]. The high density of muscle spindles found in RCPm muscles in both the cat and humans would suggest that they provide significant proprioceptive feedback to the central nervous system, related to position and motion of the head [5–8]. It has also been suggested that a fibrous connection to the spinal dura enables RCPm muscles to monitor/control dural tension during flexion and extension of the head and neck [9,10].

Voluntary retraction of the head is a physiologic motion involving posterior translation of the head within a sagittal plane without rotation (Fig. 1). This motion increases posterior loading of the superior articular facets of the atlas, resulting in flexion of the occipitoatlantal (OA) joint and elongation of the RCPm muscles [11,12]. Comparison of RCPm muscle activity when the head is held in a neutral position with muscle activity when the head is held in a retracted position would help to clarify the functional role of these muscles. Increased understanding of the functional role of RCPm muscles should provide insight into head and neck pain that may be related to pathology resulting from fatty infiltration of these muscles.

To the best of our knowledge, electromyographic (EMG) data from RCPm muscles in humans have never been collected and analyzed. The goal of this project was to test the null hypothesis that there will be no difference in normalized activation levels of RCPm muscles with the head in a neutral position and with the head in a retracted position.

Materials and methods

Subject enrollment

Potential subjects were recruited from within the second year student population of the College of Osteopathic Medicine at Michigan State University. We sent an e-mail describing the project to 200 students. Forty-three individuals responded, of which 20 were eligible to enroll in the study. Our inclusion criteria required subjects to be free of head and neck pain and have no significant motion restrictions in the region of the upper cervical spine. We also required subjects to be between the ages of 20 to 40 years because muscle atrophy due to aging results in a 30% to 50% decrease in muscle mass between the ages of 45 to 80 years [13]. The study was approved by Michigan State University's Institutional Review Board.

The project leader (RCH) explained the research protocol to each potential subject and addressed their questions. Subjects willing to proceed with the study signed an institutional review board–approved informed consent form. We paid consenting subjects $150 for participation in the study, regardless of whether they completed the protocol or not. The study cohort consisted of 13 males and seven females. The means and standard deviations for demographic variables were as follows: weight, 74±15 kg; height, 177±12 cm; age, 25±2 years; and body mass index (BMI), 24±4.

Subject instrumentation

The study was conducted at the MSU Center for Orthopedic Research. On arrival at the center, the research protocol was reviewed with the subject and physical data were collected (eg, sex, height, weight). The subject was then seated in a PRseries EWC-40, cervical flexion/extension device (Atlantis Engineering, Dallas, TX, USA). The height and anterior/posterior position of the seat were adjusted so that the articular pillars of C3 were in approximate alignment with the axis of rotation of the device's movement arm (Fig. 2).

The subject then exited the cervical flexion/extension device and assumed a prone position on a standard examination table. A towel was placed between the subject's chest and the examination table so that the head and neck were slightly flexed. This facilitated insertion of the fine wire, EMG electrodes by increasing access to the suboccipital region. A color Doppler ultrasound unit was used by the physicians (LLP and JJR) to confirm that the subject

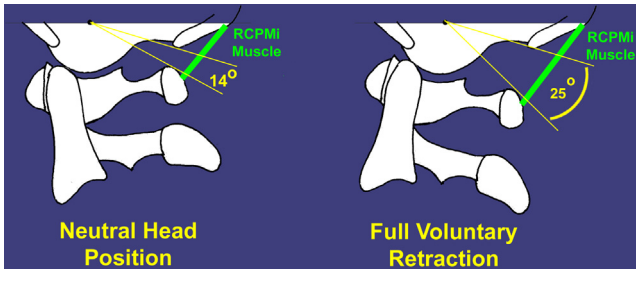

Fig. 1. Orientation of the occiput, the atlas, and the axis with the head in a self-defined, neutral head position and full voluntary retraction of the head [11]. RCPMi, rectus capitis posterior minor.

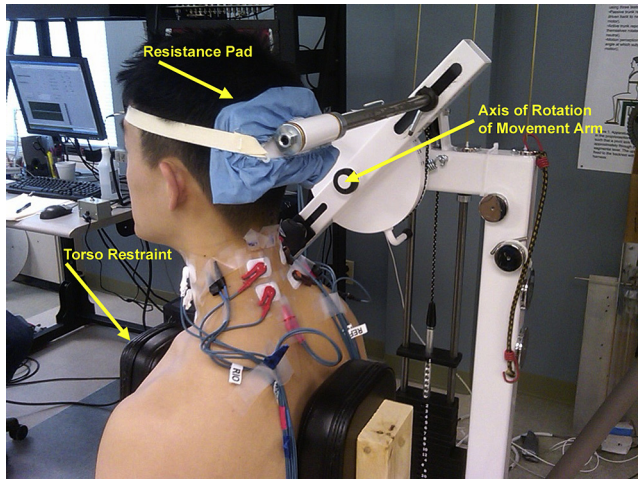

Fig. 2. Subject position for maximum voluntary isometric contraction efforts from the neutral head position.

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