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ANATOMY

Anatomical Connection Between the Rectus Capitis Posterior Major and the Dura Mater

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Study Design. Anatomic study performed on 13 cadaveric specimens focused on muscles of the suboccipital triangle, specifically, the rectus capitis posterior major (RCPma).

Objective. To investigate a connection between the RCPma and the cervical dura mater.

Summary of Background Data. In a study of the posterior intervertebral spaces, a connection between the RCPma and the dura mater was briefly described. To the best of our knowledge, no study has been conducted specifically on this communication.

Methods. Anatomic dissections were performed in the suboccipital regions of 13 embalmed, adult cadaveric specimens. Findings were recorded *via* photographic documentation.

Results. In 11 of the 13 specimens, the RCPma attached to the spinous process of the axis and then continued to establish a gross anatomical connection with the dura mater in the atlantoaxial interspace. Manual traction of the RCPma resulted in gross dural movement from the spinal root level of the axis to the spinal root level of the first thoracic vertebra.

Conclusion. A connection was found to exist between the RCPma and the cervical dura mater. Various clinical manifestations may be linked to this anatomical relationship.

Key words: cervical spine, posterior atlantoaxial interspace, rectus capitis posterior major, spinal dura. **Spine 2011;36:E1612–E1614**

The rectus capitis posterior major (RCPma), obliquus capitis superior, and the obliquus capitis inferior form the borders of the suboccipital triangle. The obliquus capitis inferior attaches the spinous process of the axis to the transverse process of the atlas. The RCPma, obliquus capitis superior, and the rectus capitis posterior minor (RCPmi) serve to attach the occipital bone to both the atlas and the axis.[1]

In 1995, Hack *et al*[2] reported an anatomical attachment between the RCPmi and cervical dura mater of the posterior atlantooccipital interspace.[3] The exact function of this connection is a matter of debate; however, it likely acts to resist dural movement toward the spinal cord during cervical extension[4] and forward translation of the occiput on the atlas.[5] The RCPmi may also monitor stress applied to the dura.[6]

Observations during neurosurgical procedures revealed that mechanical stress applied to the dura mater results in cephalgia.[7] Other studies have shown that chronic headaches in a significant amount of patients are of cervical origin[8] and that specifically the rectus capitis posterior muscles play a role in their development.[9] In addition, chronic tension type headaches have been linked to varying cross-sectional areas of both the RCPmi and the RCPma. Decreased muscle cross-sectional area due to atrophy has been shown to increase duration, frequency, and intensity of these headaches.[10] Pathological adhesions to the dura, commonly observed after excision of an acoustic neuroma, have been implicated in headache etiology, as well.[7] These studies suggest a direct correlation between dural tension and clinical head pain. Because of its connection to the dura mater,[2] hypertrophied RCPmi muscles can recreate this tension and therefore manifest similar symptoms.[4]

In 1992, Kahn *et al*[11] conducted a study on the posterior intervertebral spaces of the craniovertebral joint and briefly noted fascial communications between RCPmi, RCPma, obliquus capitis inferior muscles, and the dura mater. It was also noted in this study that no true membrane joins the posterior arch of the atlas to the laminae of the axis, but two fibrous planes run through this space.[11] In unrelated radiological and anatomical text, midsagittal views depict a posterior bulge of the dura mater at the level of the atlantoaxial interspace. This projection can be seen communicating with soft tissue that extends posteriorly through the atlantoaxial interspace, and upon crossing the spinolaminar line, begins an ascent toward the belly of the RCPma.[12–14]

To the best of our knowledge, anatomical relationships between the RCPma or the obliquus capitis inferior and cervical dura have neither been documented in other studies nor referenced in conventional anatomical literature. If the RCPma exhibits a connection similar to that of the RCPmi, the RCPma would conceivably exert an even greater mechanical traction on the dura because of its larger cross-sectional area.[15] Thus, any clinical manifestations arising from the RCPmi and its connection to the dura may be replicated and amplified by a connection between the dura and the larger RCPma.

In addition, magnetic resonance imaging has revealed fluid accumulations occurring at the convergence point of

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the RCPma and the obliquus capitis inferior. Retrospinal fluid collections in the atlantoaxial interspace are commonly associated with spontaneous intracranial hypotension and postlumbar puncture cephalgia.[16] This area of concern corresponds directly with the proposed dural attachment of the RCPma.

MATERIALS AND METHODS

Thirteen (nine male and four female) embalmed, human cadavers were examined during this study. The specimens were fixed with formalin-alcohol-phenol solution. None of the selected cadavers for this study showed any signs of history of cervical surgery or trauma. The specimens were obtained from the Department of Anatomical Sciences at St. George's University, and all guidelines were followed for use of cadaveric material in research.

In all the 13 specimens, an anatomical dissection of the suboccipital region and posterior cervical spine was performed. Photographic documentation was recorded with a Nikon D-40 camera, using two different lenses (Nikon DX Af-S Nikkor 18–55 mm 1:35–5.6 GII and a Lester A. Dine 105 mm f/2.8 Macro 1:1).

Each cadaveric specimen was denuded of all soft tissue superficial to the suboccipital muscles. A laminectomy was performed caudal to and including the third cervical vertebrae. The lamina of the axis and the posterior arch of the atlas were preserved initially to examine attachment sites of the suboccipital musculature. Two saws were used to perform the laminectomy. Gross cuts were performed using an oscillating Stryker Autopsy 810 (Stryker, Kalamazoo, MI) saw and excision of partial bone was performed using a Dremel 200-1/15 two-way rotary (Robert Bosch Tool Corporation, Mt. Prospect, IL) with a 426 1-1/4 in fiberglass-reinforced cutoff wheel attachment.

The obliquuis capitis inferior was removed from its origin and insertion points to better visualize the tendonous and fascial components of the RCPma as well as the floor of the atlantoaxial interspace. The RCPma was separated from its attachment sites at the inferior nuchal line and the spinous process of the axis. The deeper fascial connection to the dura mater was preserved and documented in 11 of the 13 specimens (Figure 1).

A midsaggital cut was performed along the bifurcation of the spinous process of the axis and along the right lamina just medial to the zygapophyseal joint. This process was then repeated on the contralateral side, at the same vertebral level, to completely expose any potential attachment of the RCPma to the dura mater in the atlantoaxial interspace. The RCPmi was then detached from the posterior arch of the atlas and its insertion point on the inferior nuchal line. The deeper attachment to the dura at the atlantooccipital interspace was preserved. To remove the posterior arch of the atlas, sagittal cuts were performed, bisecting the groove of the vertebral artery bilaterally.

In the initial cadaveric specimen, six pins were inserted approximately 4 mm deep into the dorsal aspect of the dura mater. The pins approximated the level of each spinal root from the sixth cervical vertebra to the third thoracic vertebra. The RCPma was tractioned posteriorly with forceps and movement of the pins was observed. The attachment was tested in the initial specimen *via* posterior, inferior, and superior traction of the RCPma.

RESULTS

In all the 13 specimens, the RCPma was firmly attached to the spinous process of the axis. In 11 of the 13 cadaveric specimens, the RCPma attached to the laminae of the axis but mainly sent dense conjunctive tracts through the atlantoaxial interspace, into the vertebral canal, to the posterior surface of the dura mater. These fibers provided a firm attachment between the RCPma and the cervical dura.

After the removal of the RCPma from its attachment sites and a subsequent cervical laminectomy, the RCPma continued to exhibit a clear attachment to the dura mater (Figure 2). In the two specimens that did not exhibit this connection, the muscle was completely separated from the specimen upon removal from its attachment sites.

In addition, the RCPmi attachment to the dura was validated in all the 13 specimens. It was also noted that in the specimens that exhibited a connection between the dura mater and the RCPma, the obliquus capitis inferior seemed to send similar conjunctive fibers toward the dura mater as well. In all the 13 specimens the obliquus capitis superior did not seem to demonstrate fibrous extensions.

Applied traction of the RCPma resulted in movement from the spinal root level of the axis to the spinal root level of the first thoracic vertebra. Movement below this level was not noted. In the two specimens that did not posses this anatomical connection, manual traction of the RCPma did not result in any dural movement.

Figure 1. Postlaminectomy photograph from a left dorsolateral perspective of rectus capitis posterior major (RCPma) and its connection with the cervical dura mater. (**1**) Attachment between RCPma and cervical dura mater; (**2**) RCPma; (**3**) cervical dura mater; (**4**) axis; (**5**) atlas; and (**6**) occiput.

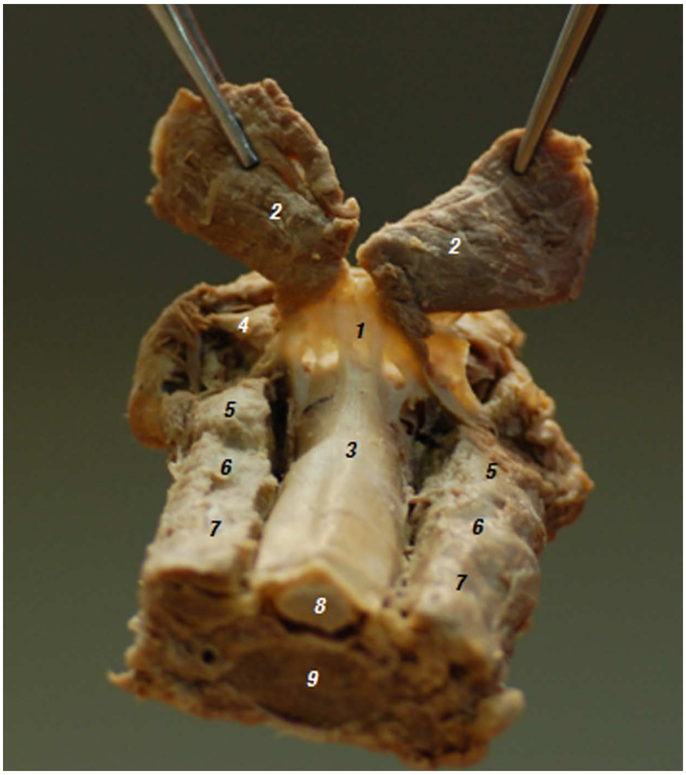

Figure 2. Photograph of dural attachment between rectus capitis posterior major (RCPma) and cervical dura mater. (1) Attachment between RCPma and cervical dura mater; (2) RCPma; (3) cervical dura mater; (4) lamina of axis; (5) transverse process of atlas; (6) third cervical vertebra; (7) fourth cervical vertebra; (8) spinal cord; and (9) body of fourth cervical vertebra.

DISCUSSION

Knowledge of the communication between the RCPma and cervical dura should supplement existing information in the diagnosis and treatment of clinical manifestations involving the dura mater. It has been suggested that the RCPmi serves to monitor dural tension during flexion/extension of the head *via* a similar fibrous connection to the dura.[2] This is plausible because the greatest amount of head and neck flexion/extension occurs at the atlantooccipital joint.[17]

However, the atlantoaxial articulation affords the greatest amount of head and neck rotation.[17] It could be speculated that muscles acting on this joint would then serve to monitor dural tension as a result of head and neck rotation.

The action of the obliquus capitis inferior is strictly ipsilateral rotation.[1] Further studies should be conducted on this muscle to check for dural attachments. The RCPma functions in head and neck extension and slight ipsilateral rotation, therefore sharing common actions with both the RCPmi and obliquus capitis inferior. In a spectrum of rotation *versus* extension, the RCPma may serve to monitor dural tension as a result of fine movements that combine both rotation and extension or flexion.

Because it has been shown that dural tension results in many clinical manifestations,[7–10] it would be plausible for a biomechanical monitor preventing excessive dural tension to exist.

➢ Key Points

- ❑ The rectus capitis posterior major communicates with the cervical dura mater.
- ❑ Aside from its attachment on the spinous process of the axis, this muscle also exhibited a fibrous connection to the dura mater.
- ❑ Manual traction of this muscle resulted in movement of the dura mater, thus validating a substantial connection between the two structures.

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