Clinical implications of a cervical myodural bridge

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Abstract

The existence of a previously unreported myodural bridge at the level of the atlanto-occipital junction suggests a direct and dynamic central-peripheral connection which may be directly related to some instances of idiopathic head and neck pain. Artificially functioning the muscular component of the bridge appears to influence the cerebrospinal fluid system by directly affecting dural tension. Because the myodural bridge has a direct influence upon the dura mater, a component of the reciprocal tension membrane system that is also a pain-sensitive structure, we propose that it offers a possible association between cervical musculature and headache pain.

Keywords

cranial manipulation, chronic pain, suboccipital muscles, spinal dura, cervical spine, cranial compliance

Background

The existence of a cervical anatomic relationship, termed the myodural bridge, is of significant importance to the osteopathic physician because it provides a direct physical link between the musculoskeletal system and the dura mater. The dura is intimately attached to the foramen magnum of the occiput, to the upper two or three cervical segments, and by fibrous slips to the posterior longitudinal ligament. It forms a tubular sheath around the spinal cord, terminating at the level of the second sacral vertebra with additional connections to the coccyx. While the cranial dura has been recognized to have extensive innervation, the extent of innervation of the spinal dura has been disputed. Recent work on rats has shown that the spinal dura is innervated and that there is a robust network of pain fibers in the dura at the level of the craniocervical junction. While the role of spinal dura as a source of pain at levels below the craniocervical junction is still not clear, there is no doubt that the dura mater at the level of the craniocervical junction has all of the necessary components of a pain-sensitive structure.

Gray’s Anatomy states that the posterior atlanto-occipital membrane is in relation with the rectus capitis posterior minor (RCPMI) muscle dorsally and with the spinal dura, to which it is “intimately adherent” ventrally. However, nowhere in this edition is any functional relationship described between the RCPMI muscle and the dura mater. Because of the continuity of dural attachment between cranium and sacrum, influences such as trauma and postural strain that affect one component of the reciprocal tension membrane (RTM) system have an affect upon the entire system. The discovery
of a cervical myodural bridge (See Figure 1) presents the possibility that the musculoskeletal system can have a direct influence upon central components. We speculate that this tissue bridge may offer a possible association between cervical musculature and headache pain.

**Methods and Materials**

A head and neck specimen obtained from a fresh unembalmed human adult male cadaver was procured from the Maryland State Board of anatomy. A midline sagittal section was performed. Specifically studied was the RCPMI muscle and its relationship to the dura mater. The RCPMI muscle was immediately visible arising from the posterior arch of the atlas and ascending to its insertion into the surface of the occipital bone from the inferior nuchal line to the foramen magnum (See Figure 2). A well-organized connective tissue bridge was observed passing from the RCPMI muscle through the atlanto-occipital joint and inserting onto the spinal dura via the posterior atlanto-occipital (PAO) membrane. The PAO membrane was securely fixed to the surface of the dural tube by multitudinous fine connective tissue fibers, and the two structures appeared to function as a single entity. These observations were also confirmed in ten fixed, sagittally hemisected head and neck specimens. The fixed specimens were from five females and five males, who ranged in age from 54-94 years. Review of medical histories of these individuals was unremarkable for head and neck trauma, autoimmune diseases, or medications associated with various forms of fibrosis.

The influence of the RCPMI muscle upon the dura mater was artificially produced in the hemisected specimen by manipulating the tissues in an attempt to simulate physiologic motion. The resultant motion produced
obvious movement of the spinal dura with fluid movement observed to the level of the pons and cerebellum (See Figures 3 and 4). Brain tissue shrinkage occurred rapidly upon dissection and with the passage of time the observable fluid movement was not as broad, but still evident. Once the brain tissue was removed, artificially functioning the muscle again produced observable changes in the position and tension of the dura mater, as well as the dura of the posterior cranial fossa, and would account for the observed fluid movement to the level of the pons and cerebellum. Head and neck extension of all fixed specimens produced infolding of the spinal dura complex accompanied by stretching of the connective tissue bridge.

**Discussion**

A growing body of literature relates head and neck pain to injury and/or pathology of the cervical spine. While etiology in some instances is certainly related to trauma affecting structures such as the zygapophyseal joints, the exact cause of tension headaches has been difficult to determine. One accepted hypothesis of tension headaches involves contraction of muscles in the head, neck, and/or face. Because the myodural bridge has a direct influence upon the dura mater, a pain sensitive structure, and a direct influence upon the reciprocal tension membrane system, we suggest that it may provide a link between cervical musculature and headache pain. Craniosacral techniques were added to the repertoire of the osteopathic physician around 1940 through the work of William G. Sutherland, DO. Sutherland reasoned that cranial sutures formed joints between bones of the skull and were intricately fashioned for the maintenance of motion. He theorized that these bones would show normal mobility during health, and that mobility would be restricted in response to trauma or systemic disease. The apparent rigidity of the skull has led
many traditionally trained physiologists and physicians to conclude that suture lines fuse when an individual becomes an adult. However, it has been demonstrated that a rapid injection of a bolus of fluid into the lateral cerebral ventricle of anesthetized cats results in both an increase in intracranial pressure and cranial bone movement at the midline sagittal suture where the bilateral parietal bones meet.

This reinforces the theories of Sutherland, leading many to believe that cranial bones in the human bend in harmony with the complex patterns of intracranial forces resulting from respiration and arterial, venous, and cerebrospinal fluid (CSF) pressures. In spite of the subtlety of these movements, they can convey important diagnostic information to a trained physician, and it has been shown that appropriate treatment protocols can yield therapeutic results.

In reviewing the literature, we found that the subject of functional relations between voluntary muscles and dural membranes has been addressed by Becker. He suggested that voluntary muscles might act upon dural membranes via fascial continuity, changing the tension placed upon them and influencing cerebral spinal fluid (CSF) flow. Our observation that simulated contraction of RCPMI muscles results in flexion of the PAO membrane-spinal dura complex CSF movement supports Becker’s hypothesis. Further, since the dural connection is in the immediate area of a major CSF reservoir, the cisterna magna, dural tension and movement in this region may influence CSF pressure. Becker also proposed that muscles attaching the skull to the spinal column might contribute to craniosacral motion. Since the dura links the cranium, spinal cord, and the sacrum, it is reasonable to expect that changes in dural tension at any one point of the central-peripheral membrane system should be transmitted through the cerebrospinal fluid to other parts of the system. Hypertrophy of muscles connected to the myodural bridge could result in excessive tension being placed upon the spinal dura, while atrophy of these same muscles could result in infolding of the spinal dura. We have observed atrophic changes in RCPMI muscles in chronic pain patients, and suggest that functionality of the myodural bridge may be compromised when atrophy occurs. While the RCPMI muscles are functionally classified as extensors, their small size, relative to more massive muscles traversing multi-segmental levels parallel to them, minimize their contribution to motion. Other authors have suggested that the primary function of the RCPMI muscle is to provide static and dynamic proprioceptive feedback to the CNS, monitoring movement of the head and influencing movement of the surrounding musculature.

We suggest that RCPMI muscles may act to monitor and control movement and tension of the spinal dura mater, thus protecting cerebrospinal fluid hydrodynamics (flow) during head extension. For either case (hypertrophy or atrophy), pathology in a muscle having direct influence on a pain sensitive structure suggests an alternative mechanism for generation of cervical headache. It has been demonstrated that massage and manipulation of the cervical spine are valuable for managing certain kinds of headache. A recent article describes the effect of placing a physician’s hands on the suboccipital region of the cervical spine and performing a circular kneading similar to the more involved occipito-atlantal technique of Sutherland. The study found that simply placing the physicians hands under the head caused vasodilation to occur in the subject’s finger. A larger increase in pulse amplitude was observed when manipulation was applied. Since variations in digital pulse amplitude can be used as a relatively direct and immediate index of vasomotor tone of the dermal arterioles, the authors suggested that this sympathetic response may occur as a result of a perturbation of the cerebrospinal fluid resulting from mechanical pressure. We suggest that significant movement of the atlanto-occipital articulation can occur when the head is treated by the cranial manipulator, and that perturbation of cerebrospinal fluid can result from direct activation of the myodural bridge. This dynamic relationship may effect cervical-frontal muscle tension, with corresponding effect on blood flow through emissary veins which flow directly into dural sinuses. The clinical implication is that a possible feedback loop, yet to be investigated, may exist which could help explain the etiology and duration of commonly reported symptoms of tension headache, namely suboccipital muscle tension which can progress to frontal involvement along the shared continuity of the gala aponeurotica.

Conclusions

We have described a previously unreported myodural bridge at the level of the atlanto-occipital junction that suggests a direct and dynamic central-peripheral connection which may be directly related to some instances of idiopathic head and neck pain. We propose that the suboccipital myodural bridge is in a position to dynamically affect tension within the dura mater, widely believed by some to be a point of origin for headache pain, and that it also represents a link between the periphery and the CNS which may be dynamically manipulated to treat headache. We suggest that there are at least two possible sources of idiopathic head and neck pain in some individuals that may be related to functional pathology of the myodural bridge:

- Abnormally increased tension in the RCPMI muscles that results in increased tension in the spinal dura, a structure that is known to be pain sensitive.
- Loss of functionality as a result of atrophic changes in the RCPMI muscles, resulting in abnormal infold-
An independent effort\textsuperscript{16} has confirmed our report of a PAO membrane.
spinal dura complex. These authors also suggest that the RCPMI muscles may monitor and/or control dural tension. They hypothesize that this mechanism may assist in resisting du-
ral infolding and may have possibly failed in patients experiencing chronic pain resulting from whiplash-type in-
juries when atrophy of RCPMI muscles has occurred. This is consistent with reports of RCPMI muscle atrophy that we have seen in chronic pain patients.\textsuperscript{4}

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