REVIEW

Comprehensive Review of the Posterior Atlanto-Occipital Membrane

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ABSTRACT

The posterior atlanto-occipital membrane is part of the complex network of ligaments that support and protect the neck. Nuanced in its anatomical structure, the posterior atlanto-occipital membrane is often overlooked for its small role in the protection of the craniovertebral junction. However, in this paper we will review the anatomy, imaging, pathology, surgical considerations, and clinical issues of the posterior atlanto-occipital. Spine Scholar 1:6-8, 2018

INTRODUCTION

The posterior atlanto-occipital membrane is a wide, thin segment of connective tissue that loosely sheaths the gap between the atlas and the occiput. It forms the “floor” of the suboccipital triangle. Studies have found that the posterior atlanto-occipital membrane has relevance with regards to whiplash, cervicogenic headache, craniectomies, and vertebrobasilar artery deficiency. In this paper, we will review the detailed anatomy, comparative anatomy, imaging, pathology, surgical consideration, and clinical issues involved with the posterior atlanto-occipital membrane.

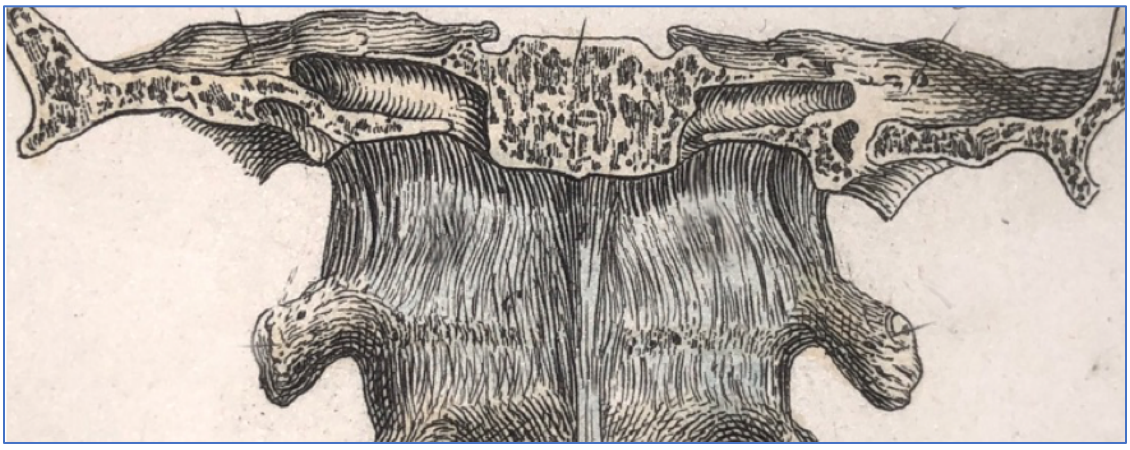

Fig. 1: Drawing of the posterior atlanto-occipital membrane

Anatomy

The posterior atlanto-occipital membrane is a wide but thin segment of connective tissue that joins the posterior margin of the foramen magnum with the upper border of the posterior arch of the atlas, merging laterally

with the atlanto-occipital joint capsules (Fig. 1) (Standring, 2016). The posterior portion of the atlanto-occipital membrane is much broader than, but not as strong as the anterior portion, and is slightly thickened in the medial fibers which attach the posterior tubercle of the atlas to the lower end of the occipital crest. Confocal microscopy has suggested that the posterior atlanto-occipital membrane might be part of the rectus capitis posterior minor fascia, tendon, and perivascular sheath (Nash et al., 2005). It corresponds situationally with the ligamentum flavum, but they differ in that the ligamentum flavum is composed of elastic tissue, while the posterior atlanto-occipital membrane is not (Morris, 1879).

The posterior atlanto-occipital membrane vertically circumvents the grooves for the vertebral arteries, venous plexuses, and first cervical nerve (Standring, 2016). The posterior atlanto-occipital membrane's lack of tension between the atlas and occiput means that the protection it provides might not be substantial (Morris, 1879).

Additionally, the posterior atlanto-occipital membrane is characterized by its firm attachment, and even continuity, with the dura mater (VanGilder, 1987). The observability that the posterior atlanto-occipital membrane is unique from the dura mater is not universal, as anatomical and histological studies have found the absence of such a membrane in certain cadaveric dissections. In such cases, the posterior atlanto-occipital is completely merged with the dura mater, and a "myodural bridge" might be found in the atlanto-occipital space (Pimenta et al., 2014). This fusion of the posterior atlanto-occipital membrane with the dura mater has been called the "posterior atlanto-occipital membrane-spinal dura complex" (PAOM-SDC). The myodural bridge that appears in this case is speculated to stabilize the dura mater and has been associated with neck pain and headache (Kahkeshani and Ward, 2011).

Comparative Anatomy

An imaging study of dogs of various breeds distinguished the anatomical similarities and differences in the atlanto-occipital membrane between dogs and humans. In dogs, the ventral atlanto-occipital membrane ran from the atlas to the occipital bone between the occipital condyles. A fat pad laid ventral to the membrane, aiding in its ability to be imaged. The dorsal aspect of the atlanto-occipital membrane was similar to what has been studied in humans and was easily visualized (Middleton et al., 2012).

In horses studied, the dorsal atlanto-occipital membrane was completely visible in the sagittal and transverse planes, but the dorsal plane could not be followed in its entirety in any of the dissected specimens. The atlanto-occipital membrane in horses ran from the dorsal border of the foramen magnum and dorsal margins of the occipital condyles to the cranial border of the dorsal arch of the atlas. The dorsal aspect of the membrane was reinforced with ligamentous bands that formed an X or V-shape to surround it, even forming a homogenous appearance with the atlanto-occipital membrane when viewed from the sagittal and transverse planes. On the dorsal plane, the atlanto-occipital membrane was homogenous in appearance, whereas the reinforcing bands were heterogeneously striped (Gutiérrez-Crespo et al., 2014).

While highly visible in dogs and horses, the dorsal atlanto-occipital membrane was not found in studies regarding marine mammals (e.g., *Nephocaena phocaenoides*), instead merging with the spinal dura mater in a case similar to that found by Pimenta et al. (Liu et al., 2017, Pimenta et al., 2014). Similar to humans, a myodural bridge was found in such cases (Liu et al., 2017).

Imaging

Imaging of the posterior atlanto-occipital membrane is largely performed through magnetic resonance imaging (MRI). Sagittal MRI of the posterior atlanto-occipital membrane depicts it as a dark band, sometimes fused with the dura mater and in others, separated by a thin connective tissue layer (Krakenes et al., 2003). Imaging studies have found that it can only be evaluated via sagittal MRI (Krakenes et al., 2001).

Pathology

An imaging study found lesions in the atlanto-occipital membrane of 17% of whiplash patients in the sample, but more specific studies regarding the type of whiplash injury and methods of therapy are required before determining the atlanto-occipital membrane's specific role in whiplash injury (Krakenes et al., 2003, Kwan and Friel, 2004). However, a statistically significant relationship has been found between abnormalities of the posterior atlanto-occipital membrane and severity of whiplash symptoms (p=0.035), suggesting an independent effect of abnormalities of the atlanto-occipital membrane on the degree of disability due to whiplash injury (Kaale et al., 2005). Additionally, there is speculation that the ligaments of the posterior atlanto-occipital interspace might transmit forcees from the craniocervical junction to the dura mater, resulting in some cervicogenic headaches. However, evidence attributing this hypothesis to the posterior atlanto-occipital membrane specifically, has yet to be reported (Nash et al., 2005).

Ossification of the posterior atlanto-occipital membrane can lead to the formation of a bony bridge, referred to as posterior ponticle, posticus ponticus, ponticulus posticus, Kimmerle anomaly, or arcuate foramen (Afsharpour et al., 2016). The presence of an arcuate foramen has been associated with vertebrobasilar arterial insufficiency

(Afsharpour et al., 2016). Cases of such ossification have also been associated with chronic tension-type headaches and neurosensory hearing loss, which has been speculated to be due to the arcuate foramen's stenosis of the vertebral artery (Koutsouraki et al., 2010). Cervical spine radiography has found that there is no significant difference of occurrence of ossification between sex or sides (Cakmak et al., 2005).

Tubbs et al. (2003) reported a pediatric posterior cranial fossa decompression for a Chiari malformation with syringomyelia had led to months of unresolved symptoms, and it was later found that the posterior atlanto-occipital membrane had reformed. A second surgery to transect the posterior atlanto-occipital membrane led to improvement in patient symptoms.

CONCLUSION

While often overlooked, the posterior atlanto-occipital membrane has a complicated anatomy and enigmatic role in clinical issues and procedures.

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