The inferior medullary velum: anatomical study and neurosurgical relevance

Laboratory investigation

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Object. Although it is often visualized surgically, details regarding the inferior medullary velum are lacking in
the literature. The present study is intended to better elucidate this neuroanatomical structure using microsurgical and
immunohistochemical analyses.

Methods. To study the inferior medullary velum, the authors performed microdissection in 15 adult cadavers.
Following gross study, specimens were examined histologically.

Results. The inferior medullary velum extended from the flocculus to the middle cerebellar peduncle and
stretched between the inferior cerebellar peduncle and the nodule and pyramid. The average thickness of the velum
was found to be 0.5 mm (range 0.35–0.8 mm) and the average length was found to be 6 mm (range 5.5–7.2 mm). Ar-
terial branches were identified in all specimens that arose from medullary branches of the posterior inferior cerebel-
lar artery and supplied the inferior medullary velum. Histologically and from internal to external, a choroid plexus
epithelium as a single cell layer was adjacent to a cuboidal layer of ependymal cells with no visible cilia. The next
layer contained scattered glia in single cells or small clusters. The most external layer was composed of flat spindle
cells resembling fibroblasts. No neurons of any type were identified. Only rare axons traversed the thin hypocellular
zone that disappeared toward the midline.

Conclusions. Based on this cadaveric study, the authors conclude that division of the inferior medullary velum
should be relatively harmless as no neuronal cells were identified in this structure, which appears to be a vestigial
bridge of tissue between the left and right sides of the cerebellum.

(http://thejns.org/doi/abs/10.3171/2012.10.JNS12794)

Key Words • inferior medullary velum • fourth ventricle • medulloblastoma • anatomy

At

Anatomically, the fourth ventricle can be described as a gable-roofed chamber with a diamond-shaped floor. The gables are directed laterward and are prolonged in tunnel-like extensions around the inferior cerebellar peduncle. On either side, the roof is pushed out over the restiform body, thus forming the lateral recesses. The choroid plexus of the fourth ventricle invaginates into the epithelium of the roof and is suspended from the inferior medullary velum (Fig. 1 left). The inferior medullary velum forms the lateral part of the floor of the fastigial recess of the fourth ventricle and the roof of the tonsillar fossa.

Unfortunately, most standard textbooks of neuroanatomy do nothing more than mention the inferior medul-

lary velum. Mussi and Rhoton have described the inferior medullary velum as a butterfly-shaped structure that blends into the ventricular surface of the nodule medially and laterally and is separated from the superior tonsillar pole by an extension of the cerebellomedullary fissure. These authors also mentioned that the velum blends with the dorsal margin of the lateral recesses to form the peduncle of each flocculus.

Embryologically, the rhombencephalon gives rise to the pons, medulla oblongata, and the cerebellum; the lat-\nter is connected to the brainstem, not only by its three pairs of peduncles, but also by vestigial portions of the primitive middorsal wall of the neural tube adjacent to the developing cerebellum. In the anterior cerebellar notch,
the medullary body splits into two laminae: a superior lamina, which forms the superior medullary velum and three pairs of connecting bands (peduncles), and an inferior lamina, which is the inferior medullary velum. These laminae arise from the medullary body.

The medullary vela are thin, relatively undeveloped laminae that have been reported to be composed of mostly white substance. The junction between the inferior medullary velum and the tela choroidea is termed the telovelar junction, which extends from the nodule into each lateral recess. Some have reported the presence of neurons within this structure and suggested that it may attach to the cochlear nuclear complex.

Maneuvers such as telovelar approaches to the fourth ventricle avoid the complications of vermian splitting. In addition, placement of electrodes for central auditory stimulation traverses the inferior medullary velum. Therefore, the present study was performed to better evaluate the anatomical and histological nature of this structure.

Methods

Fifteen human adult formalin-fixed cadaver heads placed in the prone position underwent removal of the calvaria with an oscillating bone saw. Next, a wedge of occipital bone overlying the posterior cranial fossa was removed and the dura mater was opened with dissecting scissors. Once the cerebellum was isolated, the tentorium cerebelli was incised and the midbrain and spinal cord transected. The cerebellum was removed and a surgical operating microscope (Zeiss) was used to remove overlying cerebellum from the underlying inferior medullary velum. Gross observations and measurements were made using microcalipers.

After gross observations and measurements were made, the entire inferior medullary velum was removed and submitted for immunohistochemical analyses. Statistical analysis of measurements comparing sex and age was performed using Statistica (StatSoft) for Windows with significance set at $p < 0.05$.

Results

The lateral boundaries of the inferior medullary velum extended to the flocculus and blended with the middle cerebellar peduncle; anterosuperiorly, the velum covered the nodulus of the cerebellar vermis. The inferior medullary velum stretched between the inferior cerebellar peduncle laterally, and the node and pyramid medially. The average thickness was found to be 0.5 mm (range 0.35–0.8 mm) and the average length was found to be 6 mm (range 5.5–7.2 mm) (Fig. 1 right). Arterial branches were identified in all specimens arising from the posterior inferior cerebellar artery (Fig. 1 right). These branches all terminated on the surface of the inferior medullary velum and associated choroid plexus. No direct connections to the cochlear nuclear complex were observed.

Histologically, the inferior medullary velum ends in a free crescentic edge. The free anterior margin of the inferior medullary velum was continuous with the double layer of pia mater of the tela choroidea of the fourth ventricle. The inferior medullary velum consisted of a thin membranous tissue with the following characteristics (from innermost to outermost) identified in all specimens (Fig. 2): 1) intermittent choroid plexus epithelium in papillae and in a single cell layer; 2) intermittent/denuded, thin nearly squamous flattened cuboidal layer of ependymal cells with no visible cilia; 3) intermittent thin layer of hypocellular fibrillary zone (typically termed subependymal plate in the wall of the ventricles) containing scattered glia, in single cells or small clusters; 4) outermost very thin layer of flat spindle cells resembling fibroblasts. The central-most portion of the inferior medullary velum contained significantly fewer axons than the peripheral areas. In the central portion of the inferior medullary velum, the subependymal zone essentially disappeared. No neurons of any type (such as granulocytes, Purkinje cells, or pyramidal cells) were identified. No germinative cells were identified. Only rare axons traversed the thin hypocellular zone that disappeared toward the midline. No statistically significant differences in measurements were noted between sexes or ages.

Discussion

Histology

Santee described the inferior medullary velum as a short plate of white matter not more than a quarter of an inch long. This layer has been simply described as “an exceedingly thin sheet, entirely devoid of nervous tissue and formed by the ventricular ependyma” or as “a thin sheet of white matter.”

Arora believed that some characteristics of the velum were typical features of the stratum granulosum of the cerebellar cortex. Our findings are in agreement with these observations, and lend credence to the notion that this membrane consists of vestigial cerebellar tissue. In 1988, Terr and House analyzed the edges of the inferior medullary velum (tenia) and found groups of neurons...
The inferior medullary velum

(scattered multipolar and pyramidal cells) immediately under the pia mater and covering the tenia. In our larger study, we did not identify a single neuron within the inferior medullary velum.

Surgically, the so-called telovelar approach to the fourth ventricle has been employed to gain access to the fourth ventricle and avoid splitting the vermis or removing parts of the cerebellum. Intuitively, using the cerebellomedullary fissure as a corridor to the fourth ventricle is preferred to traversing brain tissue. Moreover, this maneuver may provide greater access to the upper portions of the fourth ventricle, the fastigium and superolateral recess. For this procedure, the cerebellar tonsils are displaced laterally. Once this is achieved, the inferior medullary velum and tela choroidea can be seen. Once the tela is opened, the fourth ventricle can be visualized from the cerebral aqueduct to the inferiorly positioned obex. Additionally, some have placed electrodes through the inferior medullary velum for cochlear nuclei stimulation. Based on our findings, such procedures, which involve manipulation of the inferior medullary velum should carry a low risk of neurological injury.

Potential Role of the Inferior Medullary Velum and Neoplasia

Medulloblastomas usually arise in the inferior medullary velum and tela choroidea.
ullary velum from germinative cells originating in the neuroepithelial roof of the fourth ventricle and grow anteriorly into the fourth ventricle. In fact the “medullo” in medulloblastoma is derived from the fact that early pathologists believed that this tumor always arose from the inferior “medullary” velum. Medulloblastoma is the most common malignant brain tumor and the most common tumor of the posterior fossa in children; it represents 20% of all intracranial tumors and 40% of all posterior fossa tumors in this age group. However, with such variation in cell type and based on our findings, it is unlikely that these tumors arise from the inferior medullary velum in most individuals as no specimen exhibited cell bodies that appeared atypical. However, these findings do not rule out the possibility that rare individuals might have precursor cells for this tumor within the inferior medullary velum. Larger studies would be necessary to shed light on this notion.

Conclusions

Based on our findings, the inferior medullary velum contains no neurons, and no specimens had findings suggesting neoplastic cell nests. This structure most likely represents all that remains of the cortical continuity between the flocculus and nodule of the cerebellum.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following: Conception and design: Cohen-Gadol, Tubbs. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Cohen-Gadol. Study supervision: Tubbs.

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Accepted October 18, 2012.
Please include this information when citing this paper: published online November 16, 2012; DOI: 10.3171/2012.10.JNS12794.
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