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Telovelar approach to the fourth ventricle: microsurgical anatomy

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Object. In the past, access to the fourth ventricle was obtained by splitting the vermis or removing part of the cerebellum. The purpose of this study was to examine the access to the fourth ventricle achieved by opening the tela choroidea and inferior medullary velum, the two thin sheets of tissue that form the lower half of the roof of the fourth ventricle, without incising or removing part of the cerebellum.

Methods. Fifty formalin-fixed specimens, in which the arteries were perfused with red silicone and the veins with blue silicone, provided the material for this study. The dissections were performed in a stepwise manner to simulate the exposure that can be obtained by retracting the cerebellar tonsils and opening the tela choroidea and inferior medullary velum.

Conclusions. Gently displacing the tonsils laterally exposes both the tela choroidea and the inferior medullary velum. Opening the tela provides access to the floor and body of the ventricle from the aqueduct to the obex. The additional opening of the velum provides access to the superior half of the roof of the ventricle, the fastigium, and the superolateral recess. Elevating the tonsillar surface away from the posterolateral medulla exposes the tela, which covers the lateral recess, and opening this tela exposes the structure forming the walls of the lateral recess.

KEY WORDS • fourth ventricle • tela choroidea • inferior medullary velum • cerebellomedullary fissure • cerebellar tumor

LESIONS of the fourth ventricle have posed a special challenge to neurosurgeons because of severe deficits that may occur after injury to cranial nerve nuclei and pathways in the floor and because of disturbances following injury to the cerebellar peduncles and dentate nuclei in the ventricle roof. In the past, operative access to the fourth ventricle was obtained by splitting the cerebellar vermis or by removing part of a cerebellar hemisphere.[3,5,11] The purpose of this paper is to describe an approach directed through the cerebellomedullary fissure to the tela choroidea and inferior medullary velum, two thin sheets of tissue that, if opened, provide access to the fourth ventricle from the obex to the aqueduct and to the lateral recesses (Fig. 1).

Materials and Methods

Fifty formalin-fixed specimens, in which the arteries were perfused with red silicone and the veins with blue silicone, provided the material for this study. The dissections were performed in a stepwise manner to simulate the exposure that can be obtained by retracting the cerebellar tonsils and opening the tela choroidea and inferior medullary velum. Some of the dissections were performed by neurosurgeons attending microsurgery courses to whom we were demonstrating this anatomy.

Abbreviations used in this paper: CPA = cerebellopontine angle; PICA = posterior inferior cerebellar artery.

Results

Cerebellomedullary Fissure and Roof of the Fourth Ventricle

The tela choroidea and inferior medullary velum are located in the upper portion of the cerebellomedullary fissure, the complex cleft that extends superiorly between the cerebellum and the medulla, and is intimately related to the inferior half of the roof of the fourth ventricle (Figs. 1 and 2). The suboccipital surface of the cerebellum, the surface that borders the cerebellomedullary fissure and faces the occipital bone, has a deep vertical depression, the posterior cerebellar incisura, into which the vermis is folded between the hemispheres (Fig. 1A). The vermis surface, located behind the fourth ventricle and above the foramen of Magendie, has a diamond shape. The upper portion of the diamond-shaped area has a pyramidal configuration and, accordingly, is called the pyramid (Fig. 1B). The lower half projects downward between the cerebellar tonsils and is called the uvula, thus mimicking the situation in the oropharynx in which the uvula is located between the tonsils. The rostromedial margin of the tonsils borders the tapering edges of the uvula. The nodule of the vermis, which faces the lower half of the roof of the ventricle, is hidden deep with respect to the uvula.

The roof of the fourth ventricle is shaped like a tent (Figs. 2 and 3). The roof expands laterally and posteriorly

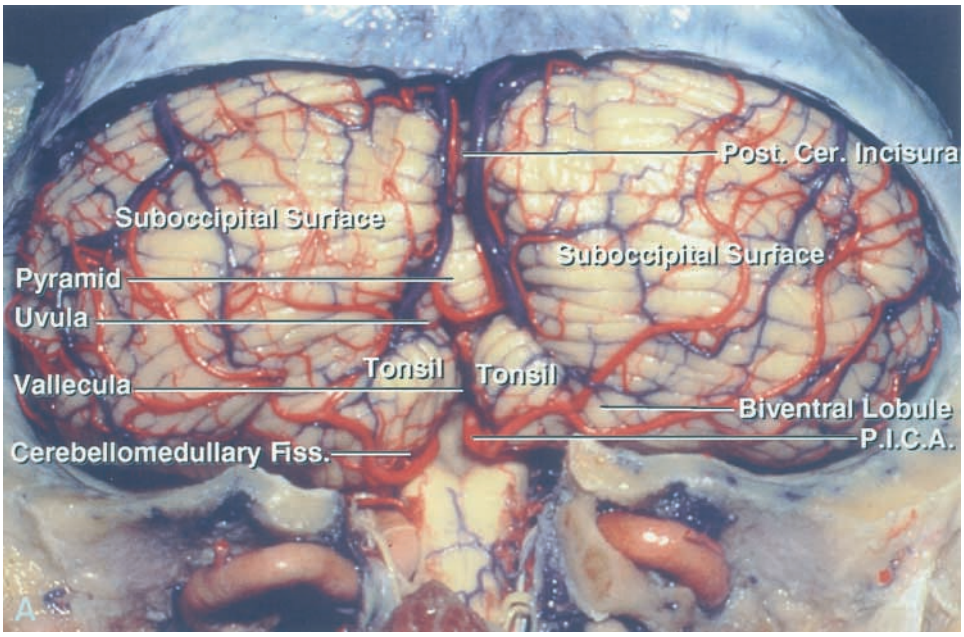


FIG. 1. Photographs demonstrating a stepwise dissection to show the relationship of the tela choroidea and inferior medullary velum to the fourth ventricle. A: The vermis on the suboccipital surface is situated in a deep cleft, the posterior cerebellar incisura, which is located between the hemispheres. The cerebellomedullary fissure is located between the cerebellum and medulla. The PICA passes around the medulla, through the cerebellomedullary fissure, and supplies the suboccipital surface. FIG. 1 *(continued)*→

from its narrow rostral end at the aqueduct to the level of the fastigium and lateral recess, the site of its greatest height and width. From there it tapers to a narrow caudal apex at the level of the foramen of Magendie. The apex of the roof, the fastigium, divides the roof into superior and inferior parts. The superior part of the roof is distinctly different from the inferior part: the inferior part is formed by two thin membranous layers, the tela choroidea and inferior medullary velum, and the superior portion is formed by thick neural structures. It is through the caudal portion of the roof, formed by the tela choroidea and inferior medullary velum, that the telovelar approach is directed.

The inferior portion of the roof slopes sharply ventral to and slightly caudal from the fastigium to its attachment to the inferolateral borders of the floor (Figs. 1–3). The ventricular and cisternal surfaces of the lower half of the roof are formed by the same structures, the tela choroidea and inferior medullary velum, except in the midline where the ventricular surface is formed by the nodule and the cisternal surface is formed by the uvula. The choroid plexus is attached to the ventricular surface of the tela choroidea. The ventricular surface of the lower half of the roof is divided into a cranial portion, formed by the nodule and inferior medullary velum, and a caudal portion, formed by the tela choroidea. The inferior medullary velum is a membranous layer connecting the nodule and the flocculus.[18] It is a thin bilateral semitranslucent butterfly-shaped sheet of neural tissue that blends into the ventricular surface of the nodule medially and stretches laterally across, but is separated from the superior pole of both tonsils by narrow rostral extensions of the cerebellomedullary fissure (Figs. 1E, 2C and D, and 4). The inferior medullary velum blends into the dorsal margin of each lateral recess and forms the peduncle to which the flocculi attach to the margins of the foramina of Luschka. The inferior medullary velum is continuous at the level of the fastigium with the superior medullary velum. Caudally it is attached to the tela choroidea.

The tela choroidea forms the lower portion of the inferior half of the roof and the caudal wall of each lateral recess (Figs. 1 and 2). It is a thin semitransparent arachnoid-like membrane, from which the choroid plexus projects into the ventricle and through which the choroidal arteries and veins course. The line of attachment of the inferior medullary velum to the tela choroidea, the telovelar junction, extends from the nodule into each lateral recess. The tela choroidea sweeps inferiorly from the telovelar junction around the superior pole of each tonsil to its attachment to the inferolateral edges of the floor along narrow white ridges, the taeniae, which meet at the obex. Cranially, the taeniae turn in a lateral direction over the inferior cerebellar peduncles and pass horizontally along the inferior borders of the lateral recesses. The tela choroidea does not completely enclose the inferior half of the fourth ventricle, but has three openings into the subarachnoid space: the paired foramina of Luschka, located at the outer margins of the lateral recesses, and the foramen of Magendie, located in the midline at the caudal tip of the fourth ventricle.

The cisternal (external) surface of the caudal half of the roof faces, and is intimately related to, the cerebellomedullary fissure. This fissure is one of the most complex fissures in the brain (Fig. 1). The anterior wall of the fissure is formed by the posterior surface of the medulla. The superior wall is formed by the inferior medullary velum and the tela choroidea. The posterior wall is formed by the

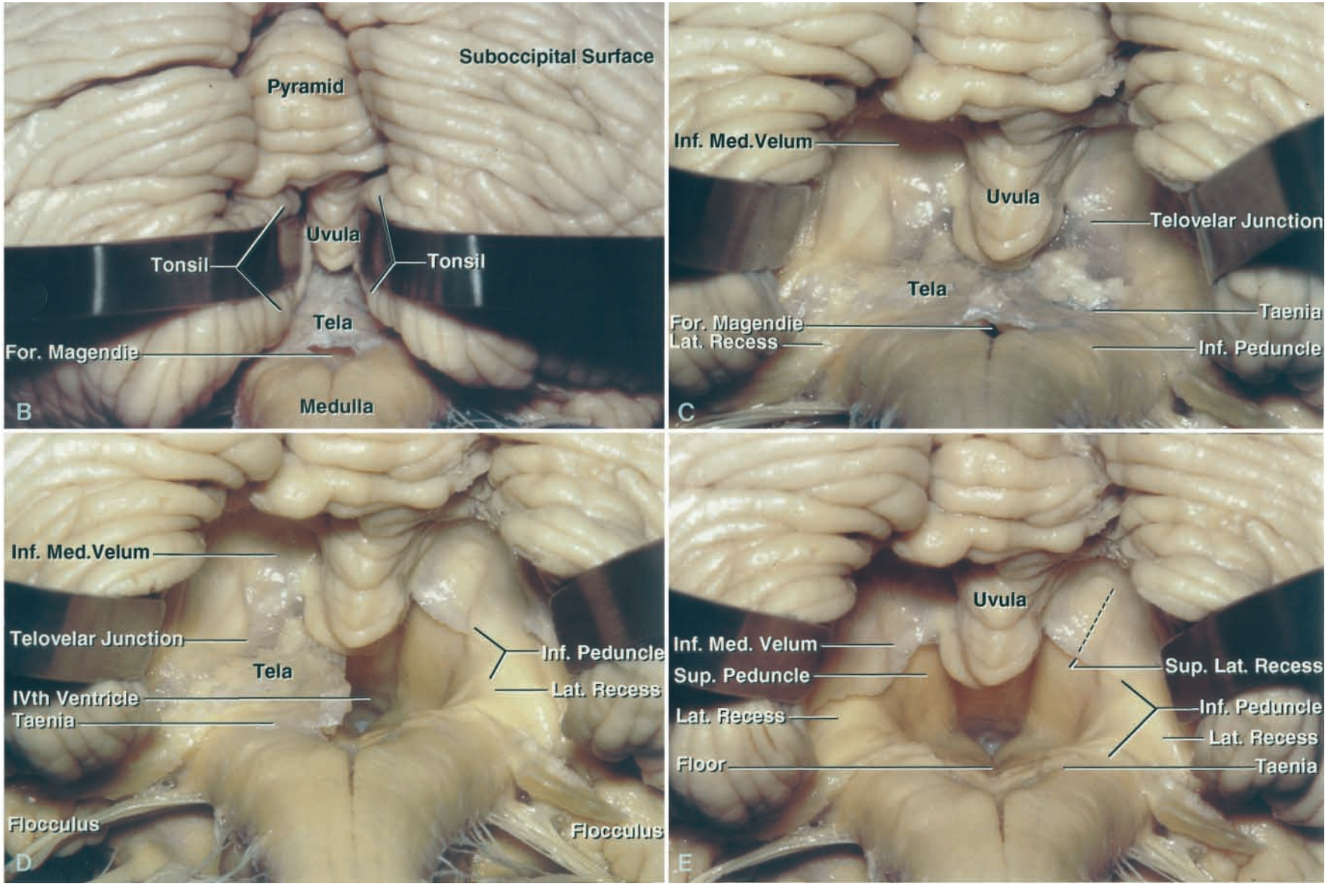


FIG. 1. B: The cerebellar tonsils have been gently retracted to expose the uvula, which is located behind and hides the nodule of the vermis. The uvula hangs downward between the cerebellar tonsils, thus mimicking the situation in the oropharynx. The tela choroidea, in which the choroid plexus arises, encloses the lower portion of the roof of the fourth ventricle and has an opening, the foramen of Magendie, located at the caudal end of the fourth ventricle. C: Enlarged view. Both cerebellar tonsils have been removed to expose the inferior medullary velum and the tela choroidea, which form the lower half of the roof of the fourth ventricle. The velum arises on the surface of the nodule, which is located deep with respect to the uvula. The telovelar junction is the line of FIG. 1 *(continued)*→

uvula in the midline and the tonsils and biventral lobules laterally. It extends superiorly to the level of the lateral recesses and communicates around the superior poles of the tonsils with the cisterna magna, through the foramen of Magendie with the fourth ventricle, and around the lateral recesses and foramina of Luschka with the CPAs. The upper pole of the tonsils faces the inferior medullary velum, tela choroidea, uvula, and biventral lobule in the superior part of the fissure. The portion of the fissure between the tonsil below and the tela choroidea and inferior medullary velum above is called the telovelotonsillar cleft. The rostral extension of the cerebellomedullary fissure around the superior pole of the tonsil through which the PICA courses has been called the supratonsillar cleft. Gently displacing the medial tonsillar surface laterally away from the side of the uvula exposes both the tela and velum. Opening the tela, beginning at the foramen of Magendie and extending upward to the telovelar junction, provides access to the floor of the fourth ventricle, from the aqueduct to the obex and to the medial portion of the lateral recesses (Fig. 5). The additional opening of the velum provides access to the ventricle roof including the fastigium, superolateral recesses, and the structures in the superior half of the roof. Elevating the anterior tonsillar surface away from the posterolateral medulla allows the tela to be opened from the foramen of Magendie to the foramen of Luschka, and provides access to the lateral recesses and the surface of the cerebellar peduncles forming the recess walls.

The ventricular surface of the superior half of the roof, which can be accessed from below through the cerebellomedullary fissure, is formed in the midline by the superior medullary velum and laterally by the ventricular surface of the cerebellar peduncles (Figs. 1E, 2A–C, and 4A and B). The rostral portion of the ventricular surface of each lateral wall is formed by the medial surface of the superior cerebellar peduncle and the caudal portion is formed by the inferior cerebellar peduncle (Fig. 4). The middle cerebellar peduncle, although it is the largest component of the peduncular bundle formed by the union of the three cerebellar peduncles, is separated from the ventricular surface by the fibers of the inferior and superior peduncles on its medial surface (Fig. 4C). The dentate nucleus produces a prominence, the dentate tubercle, in the posterolateral portion of the roof where, on cross section, the nuclei appear to wrap around the rostral pole of the tonsils (Figs. 3B and 4A). The cisternal (external) surface of the superior portion of the roof is formed by the lingula of the vermis, which adheres to the outer surface of the superior medullary velum, and is bordered on each side by the superior cerebellar peduncles, which form smooth longitudinal prominences on each side of the lingula before disappearing into the midbrain beneath the colliculi. The fibers forming the superior peduncle arise in the dentate nucleus that is located lateral to the fastigium at the level of the dentate tubercle. The rostral surface of the middle cerebellar peduncles wraps around the caudal margin of the superior cerebellar peduncles.

Floor of the Fourth Ventricle

The full length of the floor, which can be accessed by opening the tela choroidea, has a rhomboid shape (Figs. 1 and 5). The rostral two thirds of the floor is located posterior to the pons and the caudal one third is situated posterior to the medulla. Its cranial apex is located at the level of the cerebral aqueduct. Its caudal tip, the obex, is located at the rostral end of the remnant of the spinal canal anterior to the foramen of Magendie, and its lateral angles open through the lateral recesses and foramina of Luschka into the CPAs. A line connecting the orifices of the lateral recesses is located at the level of the junction of the caudal and middle one third of the length of the floor and also at the level of the junction of the pons and the medulla.

The floor is divided into three parts: 1) a superior or pontine part; 2) an intermediate or junctional part; and 3) an inferior or medullary part. The superior part has a triangular shape: its apex is located at the cerebral aqueduct; its base is represented by an imaginary line connecting the lower margin of the cerebellar peduncles; and its lateral limits are formed by the ventricular surface of the cerebral peduncles. The intermediate part is the strip between the lower margin of the cerebellar peduncles and the site of attachment of the tela choroidea to the taeniae just below the lateral recess. The intermediate part extends into the lateral recesses. The inferior part has a triangular shape and is limited laterally by the taeniae that mark the inferolateral margin of the floor. Its caudal tip, the obex, is anterior to the foramen of Magendie.

The floor is divided longitudinally from the rostral apex to the caudal tip into symmetrical halves by the median sulcus (Fig. 4C). The sulcus limitans, another longitudinal sulcus, divides each half of the floor into a raised median strip, called the median eminence, that borders the midline and a lateral region called the vestibular area. Each median eminence, when viewed from above to below, contains the facial colliculus and three triangular areas overlying the hypoglossal and vagus nuclei and the area postrema. The three triangular areas are paired, and are stacked along the median sulcus in such a manner that the caudal

attachment connecting the tela choroidea to the inferior medullary velum. The taeniae are small ridges along the lateral edge of the floor of the fourth ventricle to which the tela choroidea is attached. The tela choroidea forms the lower wall of the lateral recess. The inferior medullary velum, at the level of the lateral recess, narrows to a small band, the peduncle of the flocculus, to which the flocculus attaches. The choroid plexus attaches to the inner surface of the tela choroidea and protrudes through the foramen of Magendie in the midline and through the foramina of Luschka into the CPAs behind the glossopharyngeal and vagus nerves. D: The tela choroidea in the right half of the roof has been removed to expose the interior of the fourth ventricle. The inferior cerebellar peduncle forms the upper and anterior walls of the lateral recess. E: Removal of the tela choroidea on both sides exposes the whole lower half and almost all of the upper half of the fourth ventricle. Removal of the lateral portion of the tela choroidea exposes the anterior and upper walls of the lateral recess, both of which are formed by the inferior cerebellar peduncle. The inferior medullary velum, which is paper thin, has been preserved. The superolateral recess *(dashed line)* is located immediately above the lateral portion of the inferior medullary velum. For. Magendie = foramen of Magendie; Inf. Med. Velum = inferior medullary velum; Inf. Peduncle = inferior cerebellar peduncle; Lat. Recess = lateral recess; Post. Cer. Incisura = posterior cerebellar incisura; Sup. Lat. Recess = superolateral recess; Sup. Peduncle = superior cerebellar peduncle.

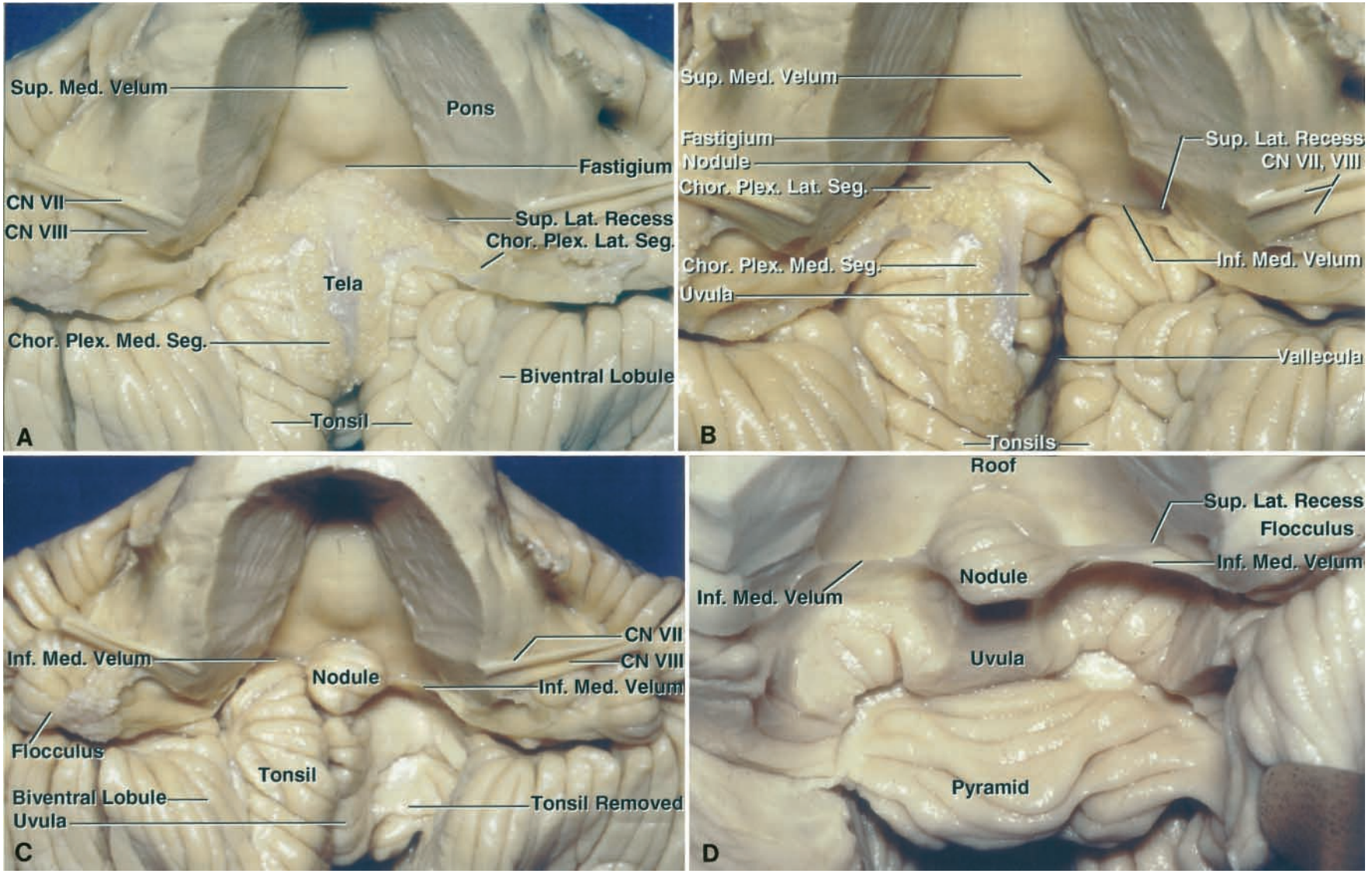


FIG. 2. Anterior views of the roof of the fourth ventricle. A: A portion of the pons and the whole medulla have been removed to provide this view into the roof of the fourth ventricle. The medial portion of the upper half of the roof is formed by the superior medullary velum. The lateral portions of the upper half of the roof, which are formed by the superior cerebellar peduncles, are hidden by the remaining pons. The fastigium is located at the junction of the upper and lower parts of the roof. The tela choroidea is the site of attachment of paired L-shaped fringes of choroid plexus, which contain the medial and lateral segments. The paired medial segments are oriented longitudinally and project from the foramen of Magendie. The lateral segments are oriented transversely and project from the foramina of Luschka. The inferior medullary velum is hidden deep with respect to the choroid plexus in this view. B: The right half of the tela choroidea has been removed to expose the nodule and the right half of the inferior medullary velum, which sweeps laterally from the surface of the nodule FIG. 2. *(continued)*→

portion of the floor displays a feather- or pen-nib configuration; thus, the area is called the "calamus scriptorius." The sulcus limitans is discontinuous; it is most prominent in the pontine and medullary portions of the floor, where it deepens at two points to form dimples called foveae, and is least distinct in the junctional part of the floor. The superior fovea is located lateral to the facial colliculus and the inferior fovea is located lateral to the hypoglossal triangle. The locus ceruleus is located at the upper end of the sulcus limitans. The vestibular area, the portion of the floor lateral to the median eminence and sulcus limitans, is widest in the intermediate part of the floor, where it forms a rounded elevation that extends into the lateral recess, is crossed by the striae medullares, and overlies the vestibular nuclei. The auditory tubercle, a prominence in the lateral portion of the vestibular area, overlies the dorsal cochlear nucleus and the cochlear part of the vestibulocochlear nerve.

Lateral Recesses

The lateral recesses are narrow curved pouches extending laterally below the cerebellar peduncles, which open through the foramina of Luschka into the CPA (Figs. 1D and E, 3B, and 5G and H). The ventral wall of each lateral recess is formed by the junctional part of the floor and the rhomboid lip, which is a sheetlike layer of neural tissue that extends laterally from the floor and unites with the tela choroidea to form a pouch at the outer extremity of the lateral recess (Fig. 4B and C). The rostral wall of each lateral recess is formed by the caudal margin of the cerebellar peduncles. The inferior cerebellar peduncle courses upward in the floor, forming the ventral wall of the lateral recess, and turns posteriorly at the lower portion of the pons to form the ventricular surface of the rostral wall of the recess (Figs. 1D and E, and 4C). The peduncle of the flocculus, which interconnects the inferior medullary velum and the flocculus, crosses in the dorsal margin of the lateral recess. The caudal wall is formed by the tela choroidea, which stretches from the taenia and attaches to the edge of the peduncle of the flocculus. The biventral lobule is dorsal to the lateral recess. The flocculus extends laterally from the superior edge of the outer extremity of the lateral recess. The rootlets of the glossopharyngeal and vagus nerves arise ventral, and the facial nerve rostral, to the choroid plexus, which extends through the lateral recess and the foramen of Luschka into the CPA. The fibers of the vestibulocochlear nerve cross the floor of the recess. Elevating the tonsil away from the posterolateral surface of the medulla and opening the tela and extending the view laterally from the foramen of Magendie toward the foramen of Luschka provides access to both the recess and the bordering peduncular surfaces.

Choroid Plexus

The choroid plexus of the posterior fossa is composed of paired inverted L-shaped fringes that arise on the ventricular surface of the tela choroidea[6] (Fig. 2A and B). Each of the paired fringes of the plexus has a longitudinal limb, the medial segment, which stretches from the level of the nodule to the foramen of Magendie, and a transverse limb, the lateral segment, which originates from the rostral end of the medial segment and extends parallel to the telovelar junction through the lateral recesses and the foramen of Luschka into the CPA.

Vascular Relationships

The PICA is intimately related to the inferior half of the roof[13,14] (Figs. 1A and 3–5). The PICA passes around the medulla, between the fila of the glossopharyngeal, vagus, and accessory nerves, and across the posterior aspect of the medulla near the caudal one half of the tonsil, where it turns upward along the medial surface of the tonsil, at first passing in the cleft between the tonsil and tela choroidea and, later, between the tonsil and inferior medullary velum. The PICA segment coursing in the cleft between the tonsil on one side and the tela and velum on the opposite side is referred to as the "telovelotonsillar segment" (Figs. 3–5). This PICA loop, which forms a convex rostral curve in its course around the rostral pole of the tonsil, is also referred to as either the "cranial" or "supratonsillar loop." The apex of the cranial loop faces the inferior medullary velum. It is from this PICA segment that the choroidal branches to the tela and choroid plexus arise.[6] The segment, which passes across the posterior medulla, often forms a caudally convex loop that coincides with the caudal pole of the tonsil, but it may also course superior or inferior to the caudal pole of the tonsil without forming a loop. Most PICAs bifurcate into a medial and a lateral trunk in their passage around the tonsil. The medial trunk ascends to supply the vermis and the adjacent portion of the hemisphere, and the lateral trunk passes laterally over the tonsil to supply most of the hemispheric and tonsillar surfaces. The main trunks of the anterior inferior cerebellar artery, which are only infrequently exposed during an operation directed through the cerebellomedullary fissure, course near the foramen of Luschka, where they extend small choroidal branches to the tela and choroid plexus in the lateral recess.[15]

The largest vein crossing the inferior portion of the fourth ventricle, the vein of the cerebellomedullary fissure, originates on the lateral edge of the nodule and uvula, courses laterally near the junction of the inferior medullary velum and tela choroidea, and passes caudal to the cerebellar peduncles and dorsal or ventral to the flocculus to reach the CPA where it drains into the veins emptying into the superior petrosal sinus[17] (Fig. 5C and G). The tributaries of the vein of the cerebellomedullary fissure drain the superior and ventral surfaces of the tonsil, the inferior vermis, the inferior medullary velum, the tela choroidea and attached choroid plexus, the periventricular white

and blends into the flocculus at the level of the lateral recess. The superolateral recess is situated above the lateral portion of the inferior medullary velum. C: The tela choroidea on both sides and the right tonsil have been removed. The rostral pole of the tonsil bulges upward into the inferior medullary velum, but is separated from it by a narrow extension of the cerebellopontine fissure in which the PICA courses. D: Both tonsils and the uvula have been removed while preserving the inferior medullary velum. The uvula was removed to demonstrate that the inferior medullary velum connects the nodule and flocculus. Chor. Plex. Lat. Seg. = choroid plexus lateral segment; Chor. Plex. Med. Seg. = choroid plexus medial segment; CN = cranial nerve; Sup. Med. Velum = superior medullary velum.

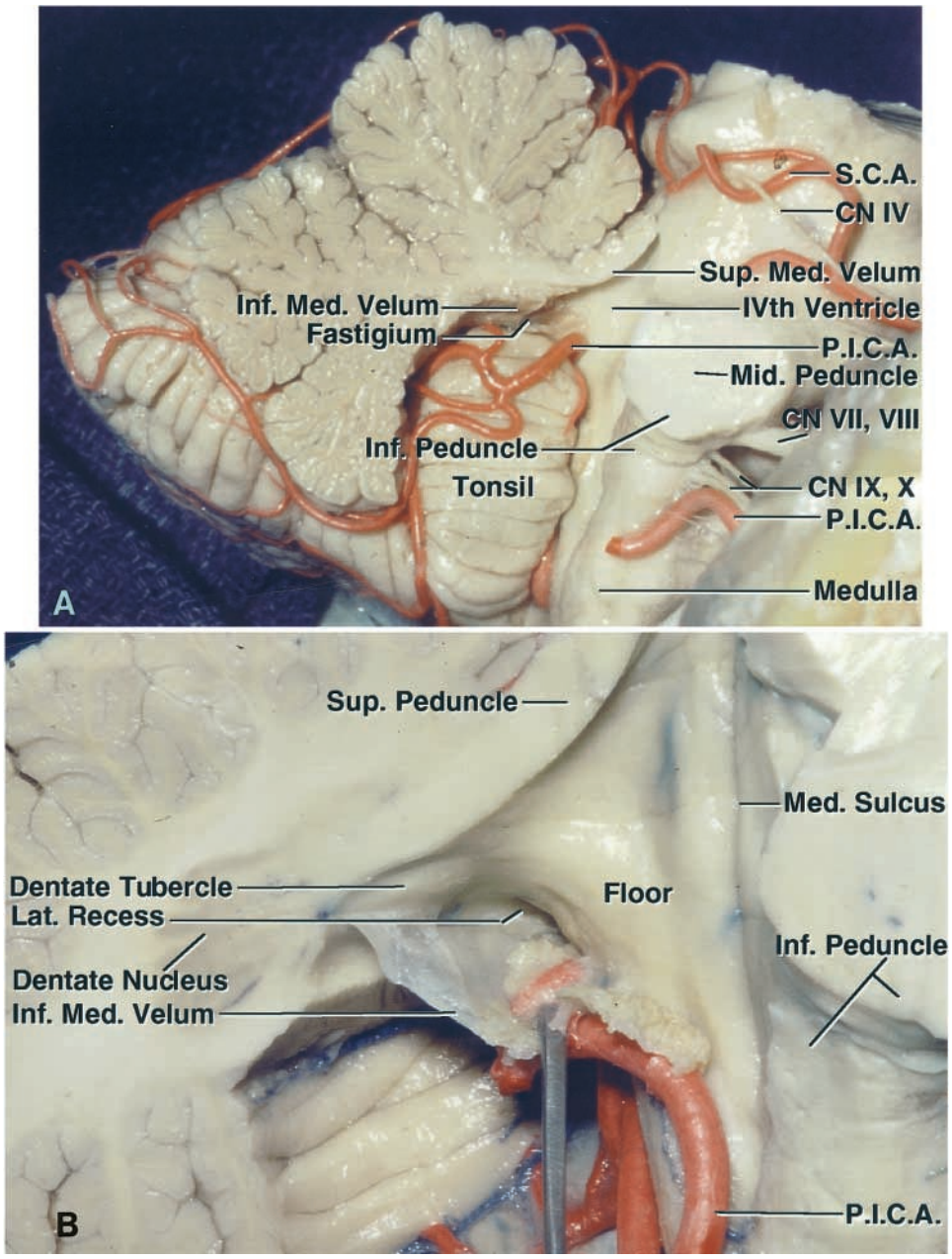


FIG. 3. A: The right half of the cerebellum was removed by dividing the vermis sagittally and the cerebellar peduncles transversely. The PICA courses around the rostral pole of the tonsil in the cleft between the tonsil on one side and the tela choroidea and inferior medullary velum on the other side. B: The tonsil has been removed and the inferior medullary velum has been displaced downward to expose the opening into the lateral recess. The dentate nucleus forms a prominence, the dentate tubercle, in the superolateral recess of the roof of the fourth ventricle near the site of attachment of the inferior medullary velum. Med. Sulcus = median sulcus; Mid. Peduncle = middle cerebellar peduncle; S.C.A. = superior cerebellar artery.

matter, and the dentate nuclei. The veins draining the posterior surface of the tonsil empty into vermian veins, which empty into the sinuses in the tentorium anterior to the torcula (Fig. 1A).

Discussion

A common approach to the fourth ventricle and lateral recess has consisted of splitting the vermis on the suboccipital surface or removing a portion of one cerebellar hemisphere.[3,5,11] Dandy[3] stated that the vermis could be opened without causing a disturbance in function, provided the surgeon carefully avoided the dentate nuclei. However, vermian lesions may cause equilibratory disturbances with truncal ataxia, staggering gait, oscillation of the head and trunk, and nystagmus on assuming the erect position, without ataxia on voluntary movement of the

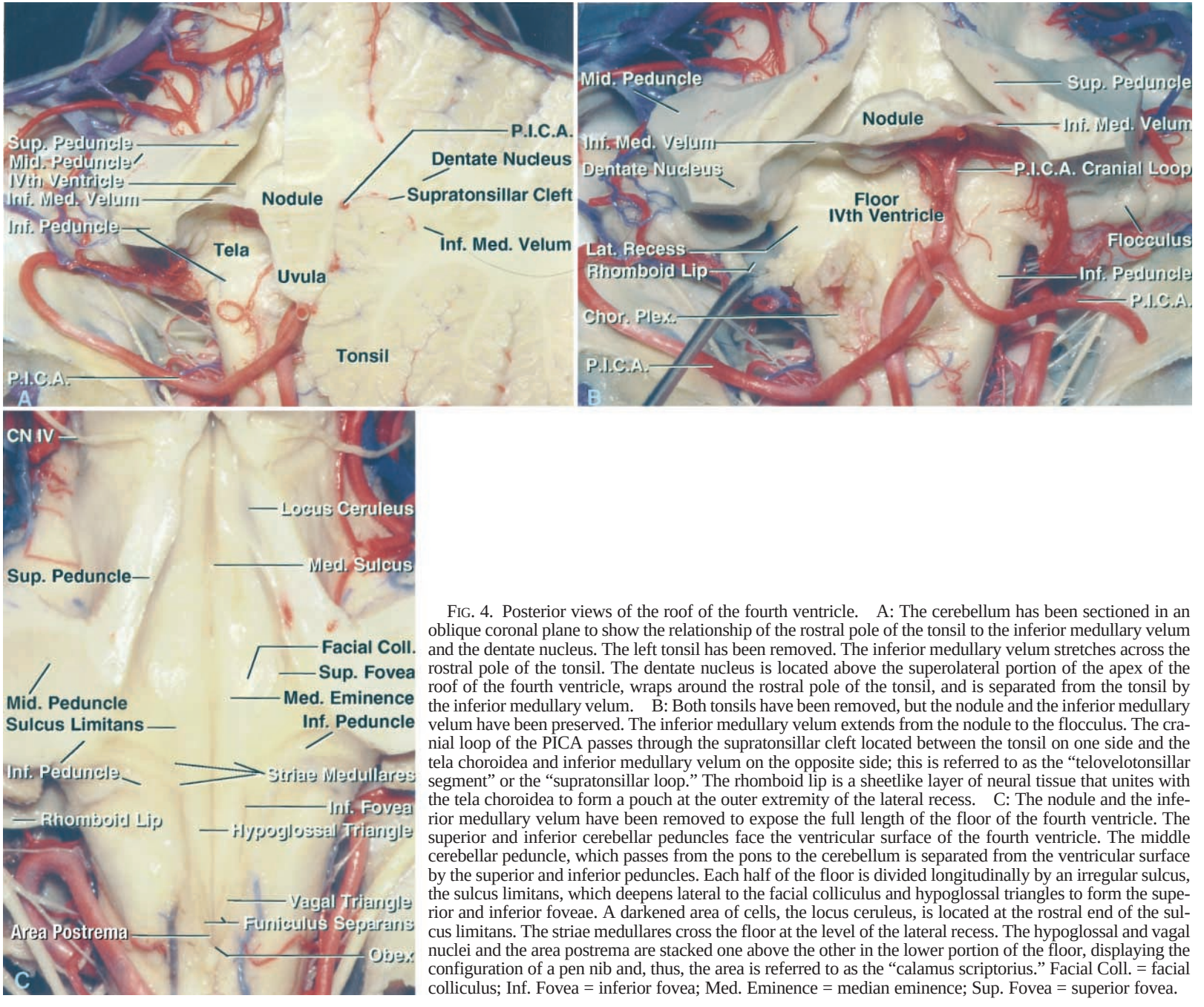


FIG. 4. Posterior views of the roof of the fourth ventricle. A: The cerebellum has been sectioned in an oblique coronal plane to show the relationship of the rostral pole of the tonsil to the inferior medullary velum and the dentate nucleus. The left tonsil has been removed. The inferior medullary velum stretches across the rostral pole of the tonsil. The dentate nucleus is located above the superolateral portion of the apex of the roof of the fourth ventricle, wraps around the rostral pole of the tonsil, and is separated from the tonsil by the inferior medullary velum. B: Both tonsils have been removed, but the nodule and the inferior medullary velum have been preserved. The inferior medullary velum extends from the nodule to the flocculus. The cranial loop of the PICA passes through the supratonsillar cleft located between the tonsil on one side and the tela choroidea and inferior medullary velum on the opposite side; this is referred to as the "telovelotonsillar segment" or the "supratonsillar loop." The rhomboid lip is a sheetlike layer of neural tissue that unites with the tela choroidea to form a pouch at the outer extremity of the lateral recess. C: The nodule and the inferior medullary velum have been removed to expose the full length of the floor of the fourth ventricle. The superior and inferior cerebellar peduncles face the ventricular surface of the fourth ventricle. The middle cerebellar peduncle, which passes from the pons to the cerebellum is separated from the ventricular surface by the superior and inferior peduncles. Each half of the floor is divided longitudinally by an irregular sulcus, the sulcus limitans, which deepens lateral to the facial colliculus and hypoglossal triangles to form the superior and inferior foveae. A darkened area of cells, the locus ceruleus, is located at the rostral end of the sulcus limitans. The striae medullares cross the floor at the level of the lateral recess. The hypoglossal and vagal nuclei and the area postrema are stacked one above the other in the lower portion of the floor, displaying the configuration of a pen nib and, thus, the area is referred to as the "calamus scriptorius." Facial Coll. = facial colliculus; Inf. Fovea = inferior fovea; Med. Eminence = median eminence; Sup. Fovea = superior fovea.

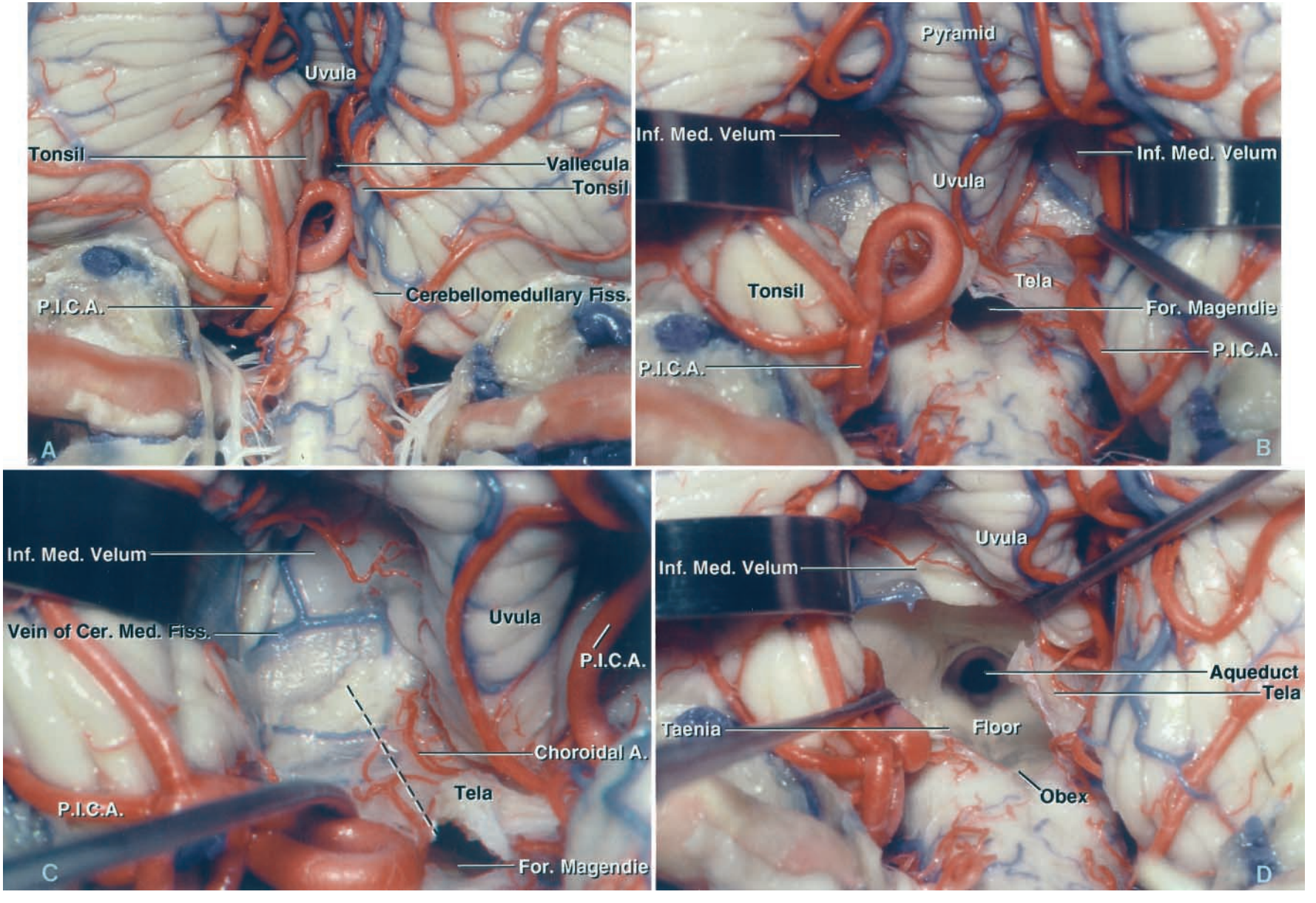
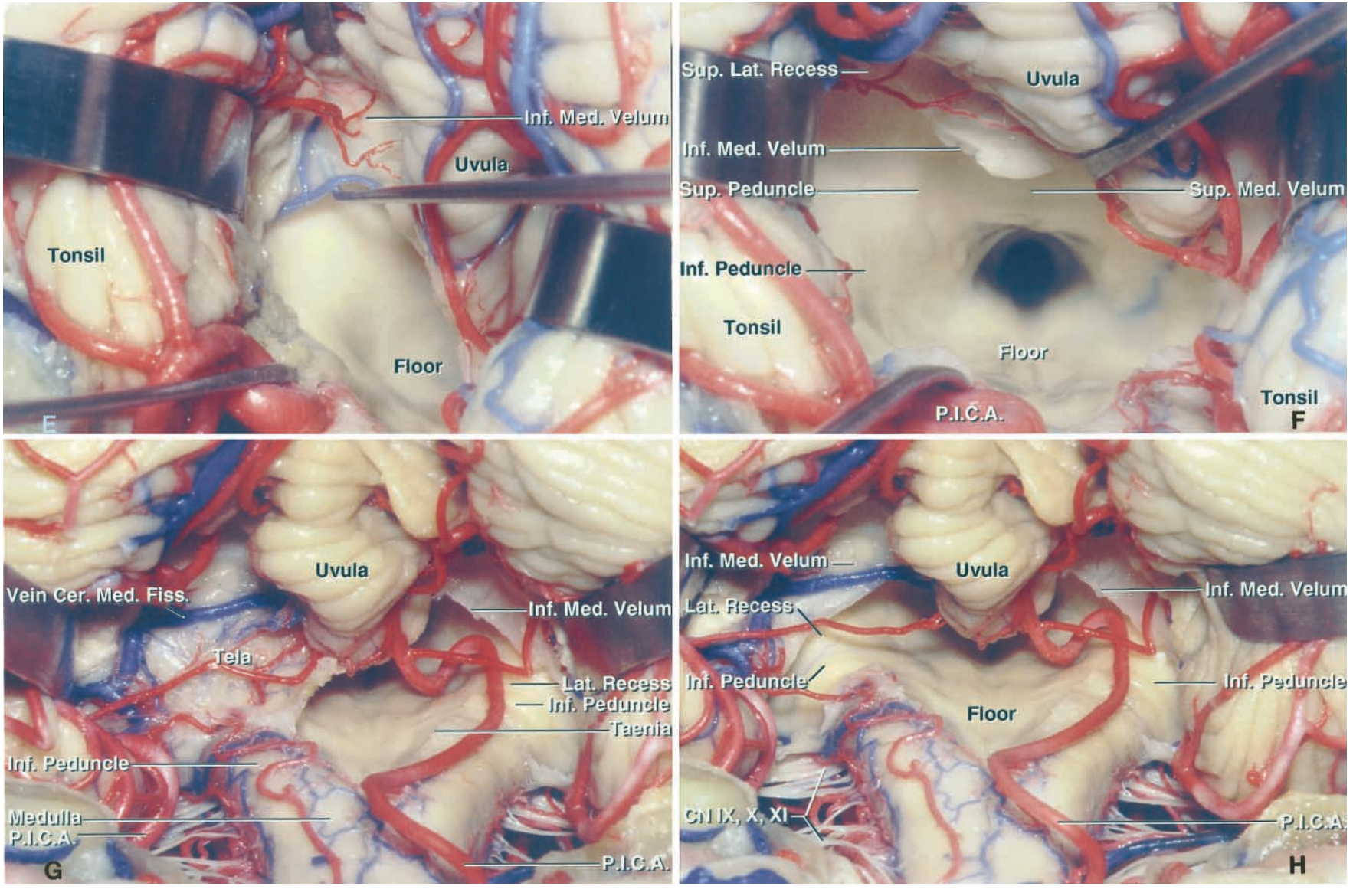


FIG. 5. A: The cerebellomedullary fissure extends upward between the tonsils posteriorly and the medulla anteriorly. The upper pole of the tonsils face the uvula. The vallecula opens between the tonsils into the fourth ventricle. The PICAs pass around the tonsil, often forming a caudal loop, which may approximate the level of the lower pole of the tonsil, and a cranial loop, which approximates the position of the rostral pole of the tonsil. The left PICA is larger than the right PICA. B: Both tonsils have been retracted laterally to expose the inferior medullary velum and tela choroidea, which form the lower portion

FIG. 5. *(continued)*→



of the roof of the fourth ventricle. The nodule of the vermis, on which the inferior medullary arises, is hidden deep with respect to the uvula. C: Enlarged view of the left half of the cerebellomedullary fissure. The choroidal arteries and veins course along the tela choroidea from which the choroid plexus projects into the roof of the fourth ventricle. The vein of the cerebellomedullary fissure is the largest vein in the cerebellomedullary fissure. The *dashed line* shows the site of the incision into the tela to provide the exposure seen in the next step (D). D: The tela choroidea has been opened, extending upward from the foramen of Magendie to the junction of the tela with the inferior medullary velum. The uvula has been displaced to the right side to provide this view of the fourth ventricle from the aqueduct to the obex. E: The tip of a nerve hook has been placed inside the fourth ventricle and is seen through FIG. 5. *(continued)*→

extremities.[7–9,12] Cerebellar mutism is a transient complication that may appear after removal of cerebellar tumors. It is usually observed in children and is characterized by a lack of speech output in the awake patient with intact speech comprehension, which is sometimes associated with oral pharyngeal apraxia.[2,4,19] Although the exact anatomical substrate for the mutism remains unknown, the majority of these complications occurred after removal of midline tumors involving the vermis.[2,4,19,20] The inferior portion of the vermis, including the pyramid, uvula, and nodule, has been implicated.

Previously, the natural clefts in the cerebellomedullary fissure were not considered as a route because they were so complex or poorly understood.[18] More recently, several reports of the use of this fissure for approaching the fourth ventricle have appeared; however, opening the tela alone or both the tela and velum located within the fissure is not widely appreciated as a means of exposing the fourth ventricle.[10,16,21] Opening the tela alone will provide adequate ventricular exposure in most cases; however, the velum, another paper-thin layer, can also be opened if opening the tela does not provide adequate exposure. Opening the tela provides access to the full length of the floor and the whole ventricular cavity except, possibly, the fastigium, superolateral recess, and superior half of the roof (Figs. 1 and 5). Opening the velum accesses the latter areas. Extending the telar opening laterally toward the foramen of Magendie opens the lateral recess and exposes the peduncular surfaces bordering the recess. Tumors in the fourth ventricle may stretch and thin these two semitranslucent membranes to such a degree that one may not be aware that they are being opened while exposing a fourth ventricular tumor. There are no reports of deficits following isolated opening of the tela and velum. However, other structures exposed in the ventricle walls and at risk for producing deficits include the dentate nuclei, cerebellar peduncles, floor of the fourth ventricle, and the PICA.

If the dentate nucleus, whose surface on the ventricular wall is marked by the dentate tubercle, is involved, equilibratory disturbances are more severe and enduring than those observed with vermian lesions alone; in addition, they are accompanied by intention tremor during voluntary movement of the extremities.[7,12] During an operation performed on the caudal portion of the roof, one should remember that the dentate nuclei are located just rostral to the superior pole of the tonsils underlying the dentate tubercles, in the posterolateral portion of the roof, where they are wrapped around the superolateral recesses near the lateral edges of the inferior medullary velum (Figs. 3B and 4A and B).

All cerebellar peduncles converge on the lateral wall and roof, where they may be damaged. The superior cerebellar peduncle is more likely to be injured during operations on lesions involving the superior portion of the roof above the level of the dentate tubercles; the inferior peduncles are more susceptible to damage when exposing lesions within the lateral recess; and the middle cerebellar peduncle is susceptible to injury during procedures that take place near the external wall of the superior half of the roof, such as those in the CPA, because the middle peduncle forms a major portion of the cisternal surface of the ventricular wall (Fig. 4B and C). Lesions of the middle cerebellar peduncle cause ataxia and dysmetria during voluntary movement of the ipsilateral extremities, with hypotonia similar to that produced by damage to the lateral portion of the hemisphere.[7,12,18] Lesions of the superior cerebellar peduncle cause severe ipsilateral intention tremor, dysmetria, and decomposition of movement. The syndrome is mild and subsides rapidly if there is only partial sectioning of the peduncle. Sectioning the inferior cerebellar peduncle causes disturbances of equilibrium with truncal ataxia and staggering gait. The consequence of removal or gentle manipulation of tumors attached to the floor of the fourth ventricle include an intraoperative decrease in blood pressure, apnea, and/or an increased respiratory rate and postoperative diplopia, disturbances of speech and swallowing, and a poor cough reflex, associated with incidental disturbances of gastrointestinal bleeding, aspiration pneumonia, and electrolyte disturbances.[1]

The PICA is frequently exposed during approaches directed through the tela choroidea or inferior medullar velum, but is only infrequently occluded during operative approaches to the fourth ventricle. Occlusion of branches of the PICA that are distal to the medullary branches at the level of the roof of the fourth ventricle avoids the syndrome of medullary infarction but produces a syndrome resembling labyrinthitis, which includes rotatory dizziness, nausea, vomiting, inability to stand or walk unaided, and nystagmus without appendicular dysmetria.[13] Opening the tela may require that some choroidal branches of the PICA will be obliterated; however, these choroidal branches rarely have neural branches once they enter the tela.[6] The main trunk of the anterior inferior cerebellar artery is infrequently exposed while opening the cerebellomedullary fissure, but it may also extend choroidal branches to the tela and choroid plexus in the lateral recess.

the paper-thin inferior medullary velum. The PICA courses in the cleft between the rostral pole of the tonsil below and the tela choroidea and inferior medullary velum above. F: The left half of the inferior medullary velum has been divided to expose the superolateral recess and the ventricular surface formed by the superior and inferior peduncles. The uvula has been retracted to the right to expose the entire floor and much of the roof of the ventricle. G and H: Views of another specimen showing the relationship between the tela choroidea and the ventricle. G: The right half of the tela choroidea has been removed up to its junction with the inferior medullary velum. The taeniae constitute the site of attachment of the tela along the inferolateral margins of the floor. The vein of the cerebellomedullary fissure crosses the inferior medullary velum on the left side. H: The tela has been removed bilaterally to expose the floor and both lateral recesses. Cer. Med. Fiss. = cerebellomedullary fissure; Choroidal A. = choroidal artery.

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