Accessing the Recesses of the Fourth Ventricle: Comparison of Tonsillar Retraction and Resection in the Telovelar Approach

OBJECTIVE: To compare the effectiveness of the telovelar approach with tonsillar manipulation for approaching the recesses of the fourth ventricle.

METHODS: A telovelar approach was performed in 8 injected cadaveric heads. Areas of exposure were measured for the superolateral and lateral recesses. Horizontal angles were evaluated by targeting the cerebral aqueduct and medial margin of the lateral recess. Quantitative comparisons were made between the telovelar dissections and various tonsillar manipulations.

RESULTS: Tonsillar retraction provided a comparable exposure of the superolateral recess with tonsillar resection (26.4 ± 17.6 vs 25.2 ± 12.5 mm², respectively; P = .825). Tonsillar resection significantly increased exposure of the lateral recess compared with tonsillar retraction (31.1 ± 13.3 vs 20.2 ± 11.5 mm², respectively; P = .002). Compared with tonsillar retraction, the horizontal angle to the lateral recess increased after either contralateral tonsillar retraction (22.7 ± 4.8 vs 36.7 ± 6.5 degrees) or tonsillar resection (22.7 ± 4.8 vs 31.5 ± 7.6 degrees; all adjusted P < .01). The horizontal angle to the cerebral aqueduct increased significantly with tonsillar resection compared with tonsillar retraction (17.6 ± 2.3 vs 13.2 ± 2.8 degrees; P < .001).

CONCLUSION: Compared with tonsillar retraction, tonsillar resection provides a wider corridor to, and a larger area of exposure of, the cerebral aqueduct and lateral recess. Contralateral tonsillar retraction improves access to the lateral recess by widening the surgical view from the contralateral side.

KEY WORDS: Cerebellar peduncle, Cerebellomedullary fissure, Fourth ventricle, Lateral recess, Microsurgical anatomy, Telovelar approach, Tonsillar resection

The fourth ventricle is a challenging area for neurosurgeons. The complexity and eloquence of nearby neural tissue (eg, medulla, lower cranial nerve nuclei, and cerebellar peduncles) make this area difficult to explore surgically. Devastating complications or even death can be associated with these complicated operations. Transcortical access by splitting the cerebellar vermis (transvermian approach) or resection of part of the cerebellar hemisphere is a longstanding practice. However, such approaches involve injuring normal cortical tissue before the surgical target is reached. The resulting undesired consequences include, for example, disturbances in equilibrium and cerebellar mutism. Working through the cerebellomedullary fissure through the so-called telovelar approach has also been used to access the fourth ventricle effectively without significant injury to neural tissue. However, this technique is still limited for accessing the cerebral aqueduct or lateral recesses, including the cerebellar peduncles. Manipulation of the tonsils by ipsilateral retraction, contralateral retraction, or resection might offer different benefits for accessing these challenging areas around the fourth ventricle. Therefore, we quantitatively compared anatomic exposure for exploration of the fourth ventricular recesses associated with the telovelar approach when the tonsils were retracted ipsilaterally or contralaterally, or resected.

ABBREVIATIONS: PICA, posterior inferior cerebellar artery
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MATERIALS AND METHODS

Eight colored silicone-injected cadaveric heads without known intracranial disease were used for dissection. Formaldehyde-based tissue preservation with glycerol helps to preserve tissue softness in the specimens. The heads were imaged before dissection for later correlation with physical measurements. All approaches were performed under an operating microscope with standard surgical instruments.

Telovelar Approach

The details of the telovelar approach have been described elsewhere. In a midline suboccipital craniotomy was performed to expose the craniovertebral junction. The C1 arches were preserved in all specimens. Rather than flexing the head, which is impossible to achieve in cadavers, the paraspinous muscles were dissected aggressively from the midline on both sides to flatten the bulging of the muscular surface. Under real surgical conditions, flexion of the head helps to reduce obstruction from the cervical spine and paraspinous muscles. The dura was opened widely to expose the suboccipital surface of the cerebellum. Laterally, the dural entrance of the vertebral artery was identified.

For intradural manipulation, the cerebellar tonsil was dissected and elevated with a 1-cm tip retractor first on one side only. The tonsil was elevated in a suprolateral direction to expose the foramen of Magendie in the midline and the paramedian cerebellomedullary fissure. This view includes working through both uvulonsil lar and medullitonsillar spaces.

Next, the 2 contiguous membranes, the tela chooroidea and inferior medullary velum, were identified. The tela choroidae appears as a thin arachnoid-like membrane that connects the taeniae along the dorsal medullary ridge to the inferior medullary velum and to the choroid plexus in the roof of the fourth ventricle. The tela choroidtea extends laterally along the lower half of the lateral recess. The inferior medullary velum is slightly thicker and located superior to the tela choroidae. It connects the nodule medially and the flocculus laterally, thereby forming the upper half of the lateral recess.

Both the tela chooroidea and inferior medullary velum were cut. Cutting the tela choroidae exposes the lateral recess. Dividing the inferior medullary velum provides a wide entrance into the fourth ventricle and suprolateral recess. At this step, most of the fourth ventricle is visible from the cranial aqueduct and the SM point. Because the cadaveric limitations with neck flexion make measurements of vertical angles irrelevant clinically, the angles of approach were compared only in a horizontal plane.

The angle was measured by touching 1 end of a straight probe to the target while swinging the free end to the midline and then to the retracted cerebellar tonsil laterally in the same tangential plane of the tip of the uvula (Fig. 1B).

The Stealthstation Teuron plus Navigation System (Medtronic Surgical Navigation Technologies, Louisville, CO) was used to determine all measurements. The tip of the navigating probe was touched to anatomic targets directly or to the end of the straight probe. Measurements were taken after ipsilateral and contralateral retraction of the tonsils and after tonsillar resection. The areas of exposure of the suprolateral and lateral recesses and the angles of approach were compared only between ipsilateral tonsillar retraction and tonsillar resection. The angles of approach to the SM point were compared among all 3 tonsillar manipulations. Only 1 side was evaluated per cadaveric head. The direct measurements were correlated to navigation images acquired from the Stealthstation system.

Tonsillar Manipulations

Three tonsillar manipulations were performed, including: 1) ipsilateral tonsillar retraction, 2) contralateral tonsillar retraction, and 3) ipsilateral tonsillar resection. The ipsilateral tonsil was retracted (Fig. 1A) as described above. The flexibility of the approach permitted the retractor to be moved along the uvulonsil lary or medullitonsillar space.

In the second step, the contralateral tonsil was retracted (Fig. 1B) while the ipsilateral tonsil was still retracted. This maneuver exposed the contralateral tela membrane.

Finally, the ipsilateral tonsil was resected (Figs. 1C and 2) after the contralateral tonsil was returned to its normal position. The resection started medially at the supratonsillar cleft and progressed laterally. The tonsillobiventral fissure is the lateral continuation of the supratonsillar cleft. Progressive dissection deep into the tonsillobiventral fissure exposes the tonsillar peduncle. With caution, the tonsillar peduncle can be resected from the medial end (supratonsillar cleft) to the lateral end (free margin). Resecting too deep into the tonsillar peduncle can injure cerebellar peduncular tissue. Retraction of the biventral lobule should be minimized.

Anatomic Measurements

Two parameters of the fourth ventricular recesses were quantified, including the area and angle of approach. The area of exposure was measured when tonsillar manipulations exposed additional surface of the brainstem. The angle of approach was measured when the corridor to an already exposed target was widened to improve surgical access.

Two planar triangles were created to quantify the area of exposure. The first triangle was in the suprolateral recess and the second was in the lateral recess. The area in the lateralmost part of the lateral recess near the foramen of Luschka, which was not assessed because of its circumferential configuration, can be approached adequately with basic tonsillar elevation. These 2 planar triangles were composed of fixed and approach-related anatomic points defined as follows. In the superomedial part of the lateral recess, the SM point was defined as the lateral edge of the rhomboid floor in the vestibular area, crossing at the level of the stria medullaris. The SU point was defined as the uppermost point of exposure of the suprolateral recess. In the inferolateral part of the lateral recess, the IL point was defined as the lateral limit of the taeniae on the medulla. The SL point was defined as the most suprolateral point on the lateral recess provided by manipulation of the ipsilateral tonsil (Fig. 3).

The 2 anatomic targets used to define the angle of approach were the cerebral aqueduct and the SM point. Because the cadaveric limitations with neck flexion make measurements of vertical angles irrelevant clinically, the angles of approach were compared only in a horizontal plane.

The angle was measured by touching 1 end of a straight probe to the target while swinging the free end to the midline and then to the retracted cerebellar tonsil laterally in the same tangential plane of the tip of the uvula (Fig. 1B).

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Statistical Analysis

All coordinate points were entered into a spreadsheet for later analysis with a custom-made program (Spherical Area, Microsearch; Bitwise Ideas Inc., Fredericton, Canada). A paired t test was used to compare the 2 areas of exposure and to compare the 2 angles of approach. One-way repeated-measures analysis followed by pair-wise comparisons with Holm-Sidak correction was used to compare the 3 angles of approach. All statistical calculations were performed with the SigmaStat 3.5 program (Systat Software, Inc., Point Richmond, CA). Significance was defined as a P value of less than .05.

RESULTS

There was no significant difference in the area of exposure of the suprolateral recess between ipsilateral tonsillar retraction and
tonsillar resection \((P = .825)\). However, tonsillar resection significantly increased the area exposure of the lateral recess compared with tonsillar retraction alone \((P = .002)\). The superolateral part of the lateral recess, including the extraventricular area (eg, middle cerebellar peduncles), could be reached without excessive cerebellar retraction (Fig. 4).

Compared with tonsillar retraction, the angle of approach to the cerebral aqueduct was significantly increased by tonsillar resection \((P < .001)\) (Fig. 5). At the SM point, better angles were achieved by both contralateral tonsillar retraction and ipsilateral tonsillar resection compared with ipsilateral tonsillar retraction alone (adjusted \(P < .001\) and adjusted \(P = .007\), respectively) (Fig. 6).

**DISCUSSION**

Approaching the fourth ventricle surgically is a technical challenge. Devastating morbidity can occur at any step. In 1945, Dandy\(^6\), \(p 453\) stated that “complete midsagittal division of the vermis may be made without aftereffects if the dentate nuclei are carefully avoided.” This statement favors the transvermian approach to the fourth ventricle and brainstem through incision of the cerebellar vermis.\(^7,8\) Later, however, the effects of injuring the cerebellum were found to include disturbances of equilibrium and cerebellar mutism.\(^9\) Although the mechanisms underlying these clinical consequences are still debated, most authors recommend avoiding the median and paramedian cerebellar structures, including the dentate nucleus. This concept is the rationale underlying the cerebellomedullary fissure route.\(^10-14\)

Matsushima et al\(^15\) detailed the microanatomy of the fourth ventricle and cerebellomedullary fissure, which was then correlated with findings on imaging.\(^1\) Other surgeons have used similar techniques successfully.\(^16-18\) This approach is now favored for its minimal invasiveness of cerebellar tissue and its appreciable views of the fourth ventricle and brainstem.

**Manipulation of the Cerebellar Tonsil**

The cerebellar tonsil, which is located in the inferior pole of the cerebellar hemisphere, is a key structure in the telovelar approach. Jean et al\(^19\) emphasized that retraction force applied to the cerebellar tonsil caused it to rotate rostrally. This direction of rotation seems to be observed in most cases because the tonsillar peduncle, which attaches the tonsil to the cerebellum, is located on the superolateral surface. Medial surfaces, both superiorly and inferiorly, are free for dissection and elevation.

**FIGURE 1.** Telovelar dissection on the left side of a specimen. A, tonsillar retraction. B, bilateral tonsillar retraction. A straight probe points to the superomedial portion of the lateral recess (SM point) for measurement of the horizontal angle (asterisk). The dashed lines indicate the extent of the horizontal angle of exposure. C, tonsillar resection. Uv, uvula; c-To, contralateral tonsil; To.Ped., tonsillar peduncle; Cor-He, hemispheric branches of the cortical segment of the posterior inferior cerebellar artery (PICA); Cor-Ve, vermian branches of cortical segment of PICA; ChP, choroid plexus. (Courtesy of Barrow Neurological Institute.)
Elevation of the cerebellar tonsil provides 2 surgical corridors to the brainstem and fourth ventricle. First, working through the uvulotonsillar space by retracting the tonsil laterally from the uvula exposes the telovelar membrane. This corridor exposes the superolateral recess and provides access to the fourth ventricle and rostral lateral wall. Second, working through the medullotonsillar space by elevating the tonsil from the posterolateral surface of the medulla exposes the tela choroidea. This corridor provides direct access to the lateral recess. The tela choroidea and the inferior medullary velum contain no neural elements and can be sacrificed without neurological consequences.

To demonstrate the surgical trajectory provided by the telovelar approach in an anatomic dissection, Matsushima et al resected, rather than retracted, the tonsil and then demonstrated the trajectory in related surgical cases. This work indirectly supports the benefits of tonsillar resection compared with performing tonsillar retraction alone and is supported by further arguments. This situation is similar to the approach to the ambient cistern through the subtemporal approach. The temporal lobe itself obstructs the trajectory to the cistern, which curves superiorly. The temporal lobe, however, cannot be sacrificed as the cerebellar tonsil can. Maximal benefit should be obtained by removing the tonsillar mass. Retraction or resection of the tonsil may make little difference to surgeons accessing the floor or lateral wall of the fourth ventricle. However, tonsillar resection may be valuable if the surgical target is located on the extremes of the recesses or on the cerebellar peduncles.

Tonsillar resection has been proposed as an option in surgery for the treatment of a Chiari malformation with associated syringomyelia. This procedure is performed to reduce tonsillar obstruction at the foramen magnum. Resection may be partial or total. Pathophysiological changes in patients with a Chiari...
malformation may differ from normal or near normal intentional tonsillar resection. To our knowledge, however, the cerebellar tonsil subserves no specific neurological function, and neither cerebellar muteness nor pharyngeal apraxia has been reported to follow tonsillar resection. The issue is whether to resect normal unrecognized functional brain tissue to improve exposure to a deep-seated surgical target.

Dissecting along the superior pole of the tonsil in the supratonsillar cleft exposes the tonsillar peduncles laterally. Keeping the inferior medullary velum intact as a dissecting plane before the tonsillar peduncle is resected helps to prevent entry into the lateral recess and to avoid injury of the choroid plexus. Furthermore, the dentate nucleus, which is located just rostral to the superior pole of the tonsil, is less likely to be damaged.

Direct removal of the tonsil usually improves the vertical angle of view, although this feature could not be shown in our study. The C1 arch may or may not need to be removed for tonsillar resection.

Superolateral Recess

This recess is located on the superolateral surface of the fourth ventricle. Opening the inferior medullary velum exposes this
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recess, which includes the lateral wall and roof of the fourth ventricle (Figs. 7 and 8, A and B). In this region, the structures are the superior cerebellar peduncle and dentate nucleus. The superior cerebellar peduncle lies in the rostral portion of the recess. Most of these fibers originate in the dentate nucleus and connect to the upper brainstem. The dentate nucleus lies in the roof just underneath the ventricular surface and creates a prominence, the dentate tubercle, which can sometimes be identified on the ventricular surface (Fig. 2D). The dentate nucleus involves most of the recess, and its injury can cause dyskinesia and dystonia. However, the actual plane between the tonsil and the dentate nucleus can be identified by the inferior medullary velum.

The superolateral recess can be accessed adequately after ipsilateral tonsillar retraction. The main working corridor is along the uvulotonsillar space. Tonsillar resection does not increase the area of exposure to this recess. Contralateral tonsillar retraction was not considered for comparing access to this recess because the midline uvula obstructs the view.

A “lateral wall opening method” provides access to the cerebellar peduncles, which face the ventricular surface (superior and inferior cerebellar peduncles). Dissection proceeds through this recess and can enter the lateral wall when the lesion is near the ventricular surface or if the patient already has a neurological deficit. However, if a lesion involves the lateral portion of the cerebellar peduncles, this technique could transgress the dentate nucleus unnecessarily (Fig. 7). If possible, it is best to manipulate an extraventricular lesion without entering the ventricle.

**Lateral Recess**

The rostral wall of each lateral recess is primarily formed by the caudal margin of the inferior cerebellar peduncle. The inferior cerebellar peduncle courses upward in the floor ventral to the lateral recess and turns posteriorly at the lower portion of the pons to form the ventricular surface of the rostral wall. The medial portion of the floor of the lateral recess is formed by the vestibular area and inferior cerebellar peduncle. The lateral portion is formed by the rhomboid lip, which is encircled by the tela chooroidea and by the peduncle of the floculus to form the foramen of Luschka.

A standard telovelar approach provides access to the lateral recess primarily through elevation of the tonsil and division of the tela choroidea and division of the tela choroidea and division of the tela choroidea and division of the tela choroidea. However, the superolateral portion of the lateral recess is difficult to access. The excessive retraction on the tonsil needed to reach the middle cerebellar peduncle creates an extremely tangential view in the inferomedial-superolateral direction. This limitation is important because pathological conditions might not be confined to the ventricular surface of the lateral recess. Infiltrations deep into cerebellar peduncles are common.

To overcome this shortcoming, the lateral surface must be exposed adequately. The lateral recess is best approached by resecting the tonsil. With tonsillar resection, the area of exposure is at least 1.5 times larger than that provided by tonsillar retraction alone (31.1 ± 13.3 versus 20.2 ± 11.5 mm2; *P* = .002). Tonsillar resection also facilitates access to the extraventricular surface of the middle cerebellar peduncle (Figs. 7 and 8C).

The supratonsillar approach also offers an extraventricular approach to the cerebellar peduncles. Unlike in the telovelar approach, the surgical route is created by splitting the tonsillo-biventral fissure over the cerebellar tonsil. The cerebellar tonsil is retracted in an inferomedial, rather than a superolateral, direction. This approach has been used successfully to resect cavernous malformations in the inferior cerebellar peduncle without inducing additional neurological deficits. As opposed to the subtonsillar approach, the supratonsillar approach helps to minimize excessive retraction of the cerebellar tonsil, avoids inadvertent violation of the fourth ventricle, and helps to decrease the depth of the tra-
jectory to the cerebellar peduncles. However, in our opinion, a deepened corridor that transgresses the tonsillar peduncle produces tissue injury comparable to tonsillar resection performed in a larger working space. The wide corridor provided by tonsillar resection achieves the additive effect of both supratonsillar and subtonsillar approaches. Peduncular lesions involving the middle or inferior cerebellar peduncle can be reached through a trajectory that provides a direct view.

Unlike Kashimura et al, Jean et al used a lateral decubitus position with the lesion side down to approach the lateral recess.

From our perspective, this strategy is helpful. The view provided by the trajectory crosses from the other side for a lateral target. Instead of looking up toward a lesion, surgeons can look down on it, especially around the foramen of Luschka. We agree with the idea of using contralateral retraction of the cerebellar tonsil to widen the horizontal angle to expose the lateral recess. When the target is located in the lateral recess, a medial-to-lateral trajectory is required. Comparable to the more aggressive procedure of tonsillar resection, contralateral retraction of tonsil helps to widen the surgical corridor of the telovelar approach to the medial portion.
of the lateral recess (Figs. 2 and 6). However, at our institution, we prefer the prone position, which provides the flexibility to explore both the medial intraventricular region and lateral recess.

**Rostral Recess**

The rostral recess, or the cranial apex of the fourth ventricle, is located posterior to the pons just below the cerebral aqueduct. The ventricular surface of the roof is formed in the midline by the superior medullary velum and laterally by the ventricular surface of the superior cerebellar peduncle. The middle cerebellar peduncle is not exposed on the ventricular side. The inferior cerebellar peduncle is encountered on the rostral lateral wall, which includes the lateral recess, but not on the rostral end. The floor is divided by the median sulcus in the midline, creating the median eminence bilaterally.

The rostral recess is the most distal portion of the fourth ventricle, which makes it difficult to access when approaching from the cerebellomedullary fissure (Fig. 8D). The mean horizontal angle of approach was less than in an earlier quantitative anatomic report (13.2 ± 2.8 versus 22.4 ± 2.3 degrees, respectively). This difference reflects the difference in dissection techniques. Our study was intentionally performed unilaterally to impose the medial limitation of the horizontal angle by the uvula. Working across the midline is possible, but the view is obstructed by the vermis. An extreme tangential angle or significant vermian retraction is required to work across the midline, but manipulation of the vermis could cause significant sequelae. Furthermore, if the target is located in the midline, a lateral-to-medial trajectory is required. Therefore, to access this target, the ipsilateral tonsil was manipulated, whereas the contralateral tonsil was not.

Ipsilateral retraction of the tonsil helps surgeons to reach the rostral recess, but the space is obstructed by the tonsil itself, potentially providing a less-desirable surgical view in some cases.

Compared with tonsillar retraction alone, resection of the tonsil increases the horizontal angle to work around the rostral recess significantly (17.6 ± 2.3 versus 13.2 ± 2.8 degrees, respectively; \( P < .001 \)). However, this measurement is considered within a context of what is able to be measured, and that is for this experiment, 1 point. In the real surgical situation, there is a variable small area, not merely 1 point, but an “area exposure.” Thus, these values might be larger or smaller. In setting up this study, we tried to err on area measurements producing the least value differences and, therefore, in most surgical situations, these values will actually be greater. Resection of the tonsil widens the direct view to the rostral lateral walls on both the ipsilateral and contralateral sides (Fig. 9).

**Vascular Concerns**

During a telovelar approach or tonsillar resection, the posterior inferior cerebellar artery (PICA) is the most important vascular structure. This vessel typically originates from the vertebral artery anteriorly, then curves posteriorly around the medulla through the lower cranial nerves. This portion of PICA can give rise to choroidal branches that supply the lateral segment of the choroid plexus. Subsequently, the PICA enters a cleft between the tonsils (the tonsillomedullary segment) and courses in a posterior midline position. Thereafter, the vessel forms a cranial loop between the upper pole of the tonsil and the telovelar membranes (telovelars tonsillar segment) and gives rise to choroidal branches supplying the medial segment of the choroids plexus. Finally, the PICA exits the supratonsillar cleft and appears on the cortical surface (cortical segment). The cortical segment divides into 2 groups of branches: the vermian, and the hemispheric. Most of these cortical branches are located superior to the tonsil.

During dissection in the lateral recess area, branches of the anterior inferior cerebellar artery can also be encountered. These branches supply the inferior portion of the petrosal surface of the cerebellum, flocculus, and lateral segment of the choroid plexus.
Anatomically, the tonsil can be dissected or resected without major disturbances to the arterial vasculature of the cerebellum. The choroidal branches can be sacrificed if needed. However, the tonsillomedullary segment, which mostly gives rise to perforators of the posterolateral medulla, must be protected to avoid lateral medullary syndrome. Distal branches of the PICA must also be preserved to prevent a syndrome resembling labyrinthitis.  

Risk of injury to distal PICA branches might be higher with tonsillar resection than with tonsillar retraction. Furthermore, hemispheric branches of the cortical segment of PICA could be at risk from the extensive dissection needed for resection of the tonsil. To approach the rostral recess, vermian branches of the cortical segment of PICA are not at increased risk compared with the basic telovelar approach because the uvulotonsillar space is dissected in both retraction and resection techniques. A major vein that can be encountered and must be divided in the telovelar approach is the vein of cerebellomedullary fissure. This vein lies on the telovelar membrane in the cerebellomedullary fissure and courses laterally in the lateral recess to drain into the superior petrosal sinus.  However, adverse sequelae are rarely associated with venous injury because of the diffuse anastomosis between veins. 

Postoperative spasm of the arteries supplying the cerebellum may cause ischemia, and the resultant disturbance in cerebellar perfusion or edema can lead to mutism.  This mechanism could underlie the delayed onset of mutism. However, the duration of mutism, which ranges from 4 days to 4 months, is difficult to explain on the basis of vascular spasm alone. Dissection of the cerebellar tonsil through the tonsillobiventral fissure in the supra-tonsillar approach does not affect major vascular structures to the cerebellum compared with the physiological condition.  

Therefore, tonsillar resection can be used to approach the recesses of the fourth ventricle. This study demonstrates the utility of an approach through the cerebellomedullary fissure. The versatility of this approach helps in accessing most of the fourth ventricular region. Contralateral tonsillar resection should be considered to “widen” the surgical corridor to lesions in the lateral recess. Tonsillar resection offers the beneficial effects of both the telovelar and supratonsillar approaches. Tonsillar resection may be considered when pathology in the lateral or rostral recesses requires meticulous dissection. It may be used as an adjunct whenever the basic telovelar approach cannot provide adequate exposure to these regions.

**Study Limitations**

The response of living tissue to surgical manipulations cannot be reproduced exactly in preserved cadaveric tissue. The effects of gravity, drainage of cerebrospinal fluid, venous congestion, and elasticity of brain tissue are all lacking in cadaveric specimens, although all heads were preserved in the same manner to allow anatomic comparisons among the groups identified in this study. To achieve adequate exposure of the fourth ventricle and associated recesses, more traction can be exerted on a cadaveric cerebellar tonsil compared with the physiological condition. This point is especially relevant to any study involving the tonsillar region. Retraction pressure was not measured in this cadaveric study and could not be compared realistically to a live situation. Furthermore, such measurements would be almost impossible to obtain in any clinical situation. Nonetheless, we think that the use of a cadaveric model, especially one in which a special preservation method was used to maintain tissue softness (glycerol injection), provides relevant data for comparisons and conclusions regarding the live human surgical experience.

**CONCLUSION**

This study demonstrates the utility of an approach through the cerebellomedullary fissure. The versatility of this approach helps in accessing most of the fourth ventricular region. Contralateral tonsillar resection should be considered to “widen” the surgical corridor to lesions in the lateral recess. Tonsillar resection offers the beneficial effects of both the telovelar and supratonsillar approaches. Tonsillar resection may be considered when pathology in the lateral or rostral recesses requires meticulous dissection. It may be used as an adjunct whenever the basic telovelar approach cannot provide adequate exposure to these regions.

**Disclosure**

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This is a careful and well documented study. A basic tenet of neurosurgery is that we do not resect brain if the target can be reached with gentle and safe retraction. One should be careful in extending a study on formalin fixed brains which are very rigid and require significantly greater force to resect than can be done safely at surgery in the living operative situation. The difference of 4 degrees of retraction angle between tonsillar resection and resection shown in figure 5 could probably be achieved by gentle retraction of the normal brain without tonsillar resection. The authors conclude that tonsillar resection may be considered if the pathology “requires meticulous dissection.” This reader feels that tonsillar resection should be done only if the telovelar approach does not allow for adequate exposure and meticulous dissection. Tonsillar resection also involves more extensive dissection along the vermian and hemispheric branches of the cranial loop of the PICA than an accurately focused telovelar approach. This reader agrees with their final concluding statement that tonsillar resection may be used as an adjunct whenever the basic telovelar approach cannot provide adequate exposure to the region.

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Posterior surgical access to the fourth ventricle is limited by dorsal overhang of the vermis (uvula and nodule, located dorsal, rostral and medial) and tonsils (located dorsal, caudal, and lateral). The traditional transvermian approach of lateral retraction of the tonsils and midline division of the vermis has significant risk of cerebellar ataxia and mutism. The telovelar approach \(^1\) traverses the rostral extension of the cerebellomedullary fissure (which lies between the rostral tonsil dorsolaterally and the tela choroidea-inferior medullary velum-.vermis ventromedially\(^2\)) to open the roof of the inferior half of the fourth ventricle by (1) Dividing the tela choroidea (TELO-more caudal, extending between the tenia of the dorsal medullary ridge and the inferior medullary velum) to expose the lateral recess; and (2) dividing the inferior medullary velum (VELAR-more rostral, extending between the nodule and the flocculus) to expose the superolateral recess.

This telovelar approach provides superior exposure at reduced risk, relative to the transvermian approach.\(^3\) An earlier anatomic study\(^4\) showed that the telovelar approach offers greater horizontal angles of approach at the levels of the superior recess, foramina of Luschka and obex than does...
the transvermian approach. The vertical angle of approach to the obex was also better, but that to the superior recess was worse, unless C1 laminectomy was also performed.

This study extends these findings by comparing the horizontal angles of approach to the cerebral aqueduct and the superomedial point within the lateral recess and the areas of exposure of the superolateral and lateral recesses achieved by ipsilateral tonsillar retraction, bilateral tonsillar retraction, and ipsilateral tonsillar resection.

There are 3 key findings:

1. Tonsillar resection exposes significantly more area of the lateral recess (31 vs 20 mm$^3$) but not of the supralateral recess (25 vs 26 mm) than does unilateral tonsillar retraction;
2. Tonsillar resection provides a significantly greater horizontal angle of approach to the aqueduct (17.6 vs 13.2 degrees) than does unilateral tonsillar retraction; and
3. Both tonsillar resection and bilateral tonsillar retraction provide a significantly greater angle of horizontal approach to the lateral recess (superomedial point) than does ipsilateral retraction (32 and 37 vs 23 degrees), and bilateral tonsillar retraction is at least as helpful as ipsilateral resection (37 vs 32 degrees).

If resection is performed, one must avoid extension beyond the tonsillar peduncle into the dentate nucleus, middle cerebellar peduncle, and pons (whose anatomic relationships are nicely illustrated in Figures 7A and 7B).

With the caveat that tissue characteristics in the laboratory do not fully replicate those in the live patient, this study adds significantly to the literature in describing the advantages of tonsillar resection over unilateral tonsillar retraction in the telovelar approach.

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1. Rhoton AL Jr. Cranial anatomy and surgical approaches; cerebellum and fourth ventricle. Neurosurgery 53:450-451, Figure 1.9
2. Rhoton AL Jr. Cranial anatomy and surgical approaches; cerebellum and fourth ventricle. Neurosurgery 53:445, Figure 1.5

Drawing showing the different grades of access and working area after the retrosigmoid (red), pure far-lateral (blue), and combined retrosigmoid and far-lateral approaches (green) in the sagittal plane. See Figure 3D, page 59.