Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Editor: **James I. Ausman,** MD, PhD University of California, Los Angeles, CA, USA

Fundamental Neurosurgery

Bilateral telovelar approach: A safe route revisited for resections of various large fourth ventricle tumors

Rui Liu, Ekkehard M. Kasper[1]

Departments of Neurosurgery, PLA Navy General Hospital, Beijing, China, [1]Surgery, Division of Neurosurgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, USA

E-mail: Rui Liu - bjlrui@gmail.com; *Ekkehard M. Kasper - ekasper@bidmc.harvard.edu
*Corresponding author

Received: 25 October 13 Accepted: 02 December 13 Published: 30 January 14

This article may be cited as:
Liu R, Kasper EM. Bilateral telovelar approach: A safe route revisited for resections of various large fourth ventricle tumors. Surg Neurol Int 2014;5:16.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2014/5/1/16/126081

Copyright: © 2014 Liu R. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Background: Tumors located in the posterior fossa and especially in the middle and upper fourth ventricle are comparatively rare and technically very challenging. For some lesions, the telovelar approach has been shown to be a suitable approach. The unilateral approach is sufficient in most cases of small lesions. However, large fourth ventricle tumors are more problematic since they distort the normal anatomy with both vermis and cerebellar peduncles thinned and stretched out. This puts the patient at increased risk for a neurological deficit, which is minimized with a bilateral telovelar approach. By illustrating the adequacy of this technique, we emphasize the suitability of a rather unusual bilateral approach, which will provide excellent panoramic visualization of entire fourth ventricle and thus avoids complications usually associated with resections of large fourth ventricle tumors.

Case Description: Here we present three cases of benign intraventricular tumors (meningioma, solitary fibrous tumor and ependymoma) in patients with site specific symptoms from local mass effect. Typical symptoms of posterior fossa lesions were present preoperatively and resolved after surgery. The bilateral telovelar approach was used to remove these tumors completely and the pertinent intraoperative steps are described for each case. All three patients had excellent postoperative outcome and could be discharged after short hospital stays.

Conclusion: The different pathological entities could be completely resected without added neurological deficit employing a bilateral approach. In cases of large or giant fourth ventricle tumors, the bilateral telovelar approach provides excellent intraoperative visibility allowing complete excision of extensive tumors with minimal morbidity.

Key Words: Cerebellomedullary fissure, fourth ventricle, microsurgery, telovelar approach

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.126081

Quick Response Code:

CASE ILLUSTRATIONS, BACKGROUND AND IMPORTANCE

Tumors located deep in the posterior fossa and especially in the middle and upper fourth ventricle are challenging to most neurosurgeons. Especially exhilarating are large fourth ventricle tumors that extend as far as the cerebral aqueduct or grow via the lateral recess toward the cerebellopontine angle, protruding out of the foramina Luschkae and possibly posteriorly through the foramen Magendie.

In the past, traditional approaches involved splitting the inferior vermis to gain better direct access from posteriorly to the fourth ventricle. However, this surgical approach inflicts not insignificant damage to the midline cerebellar structures and has been implicated in the development of postoperative "cerebellar mutism syndromes". In 1982, Matsushima described a new technique utilizing the natural tissue planes to gain ample access to the fourth ventricle and to expose even large lesions.[10] Following this, the telovelar approach has been tried out and refined by a number of surgeons and over the past three decades, it has been demonstrated in various settings to be a reliable approach for access to the fourth ventricle.[9,11,13,15] This method avoids splitting the midline vermis, therefore avoiding the debilitating postoperative "cerebellar mutism syndrome".[1] The unilateral telovelar approach is sufficient in most cases of small fourth ventricular lesions and dissection can be done in standard microsurgical steps by opening the cerebello-medullary fissure. Nevertheless, large fourth ventricle tumors are even more challenging, since they often distort the normal anatomy of the vermis and the cerebellar peduncles, which are unusually thinned and stretched out. This may in some instances still cause a neurological deficit, which is usually not associated with the telovelar approach.[16]

Here we present three such tumor cases, which are extremely rare and technically very challenging, even more so with very large masses originating in the fourth ventricle. The bilateral telovelar approach was used as our access route to remove the differing tumors completely and no neurological deterioration was observed after the operation. By illustrating the adequacy of this important operative technique, we attempt to emphasize the suitability of a rather unusual bilateral approach, which will provide excellent panoramic visualization of entire fourth ventricle and thus helps in avoiding potential complications usually associated with resections of large fourth ventricle tumors.

CLINICAL PRESENTATION

Patient 1 (Meningioma WHO II)

A 60-year-old male presented with progressive paraparesis and intractable headaches. The patient was known to suffer from neurofibromatosis type 2, and already had multiple meningiomas removed in the past. Magnetic resonance imaging (MRI) with I/V contrast revealed an oval shaped, partially cystic but homogeneously contrast enhancing, well demarcated tumor, which reached from the mid fourth ventricle to the aqueducts Sylvii mesencephali. The tumor extended also into the lateral recess [Figure 1]. To treat associated hydrocephalus, the patient first underwent an uncomplicated endoscopic third ventriculostomy from a right sided precoronal approach 3 days prior to definite open surgery.

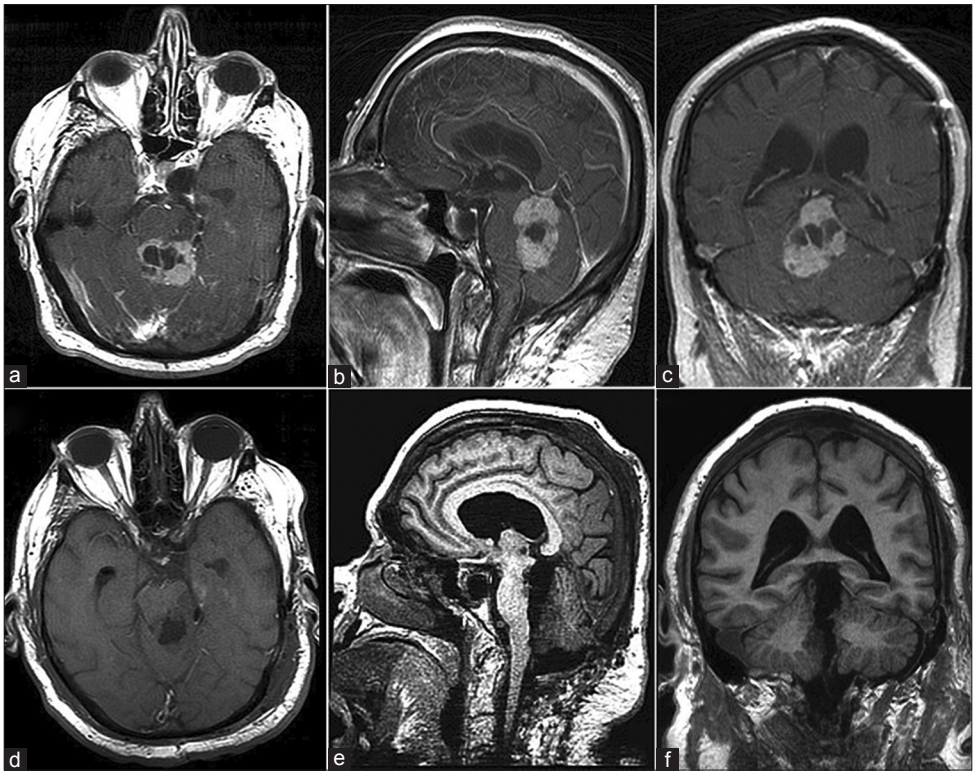

Figure 1: Preoperative axial (a), sagittal (b) and coronal (c), T1-weighted MRI scan with Gd-DTPA showing a large fourth ventricle tumor extend into the cerebral aqueduct. Postoperative axial (d), sagittal (e) and coronal (f), T1-weighted MRI scan with Gd-DTPA demonstrating total resectioz

For surgery, the patient underwent standard general endotracheal anesthesia and was placed into prone position in Mayfield 3-point skeletal fixation. He was resting on a Wilson frame with the neck in a highly flexed position. The Brain-LAB navigation system was used and fiducials were registered. Landmarks such as the superior sagittal sinus were marked and best trajectories were visualized. A standard bilateral suboccipital approach was chosen and the incision was carried out at the midline, starting about 3 cm above the inion and reaching down to the level of the C2 spinous process. A chiari-type bilateral suboccipital craniectomy was performed using a high-speed craniotome, thus achieving a bone window spanning high from near the inion to the foramen magnum. The margin of the bone flap was extended laterally to expose the sigmoid sinus. The posterior arch of C1 was resected bilaterally up to the sulcus arteriosus of the lateral mass. The best approach-angle was confirmed according to Brain-LAB criteria. A y-shaped durotomy was performed and the dural leaves where tagged up with 4-0 Nurolon (Ethicon) to expose the underlying cerebellum. The pia was transected and cerebrospinal fluid (CSF) was removed. Arachnoidal adhesions were lyzed. We then used a Greenberg retractor and both tonsils were gently retracted upwards and outwards under the microscope, after opening the bilateral cerebellomedullary fissures to gain access to the fourth ventricle. The floor of each cerebellomedullary fissure, composed by tela choroidea and inferior medullary velum, was exposed. Then the bilateral tela choroideae, lucent membranes covering the fourth ventricle around the foramen of Magendie, were opened with microinstruments to visualize and access the posterior-superior part of the fourth ventricle. Using this approach, an inferior vermian split was avoided and the caudal vermis could be easily elevated. Both the Posterior inferior cerebellar artery (PICAs) and the veins of each cerebellomedullary fissure were preserved. Tumorous tissue lodged in the fourth ventricle was immediately encountered and identified when looking from the obex superiorly. A small specimen was obtained upfront for intraoperative fresh frozen histopathological analysis.

In patient number 1, this revealed the diagnosis of a meningioma with some atypical features. Careful microscopic dissection in a circumferential plane and internal debulking were performed alternately. Cutting the margin of the inferior medullary velum on each side created a wide operative field allowing panoramic views superiorly toward the mesencephalic aqueduct as well as laterally toward the foramina Luschkae. At the end of the tumor dissection and its gross total removal, the caudal aqueductal opening and CSF egress via the bilateral foramina of Luschkae was seen. After absolute hemostasis was achieved, the ventricle was copiously irrigated until the irrigant remained clear and the durotomy was closed with a pericranial autograft. The latter was sutured in with a running 4-0 Nurolon stitch and augmented by a fibrin tissue sealant. The wound was closed in layers. The patient was kept intubated until imaging and the postoperative magnetic resonance image (MRI) revealed no residual tumor burden [Figure 1]. No new neurological deficit was noticed after the operation and the patient was successfully extubated POD#1. The patient had an unremarkable postoperative course and was discharged to rehab on POD #4.

Patient 2 (Solitary fibrous tumor of the central nervous system)

A 2-year-old girl presented with slight headache and gait disturbances, which had developed over the month prior to admission. MRI with contrast enhancement showed an irregularly shaped, avidly enhancing tumor mass, measuring about 40 mm in diameter and located in fourth ventricle. There was rostral extension into the cerebral aqueduct and also extension into the lateral recess accompanied by obstructive hydrocephalus [Figure 2]. For definite surgery, the patient was positioned in the left lateral decubitus position with the head well flexed. A standard external ventricular drain (EVD) was placed. The p-fossa access was achieved via an incision that was carried out in the midline, from about 1 cm above the inion to the level of C4 spinous process. A bilateral suboccipital craniotomy was performed as described earlier and the mid portion of the posterior arch of C1 was resected. Durotomy was performed and the underlying brain was exposed. CSF was released gradually after opening the cistern magna. A microscopic dissection was started. After opening the bilateral cerebellomedullary fissures both cerebellar tonsils were retracted upwards and laterally using a Leyla-type retractor equipped with Ruggles blades. The bilateral tela choroidea and inferior medullary velum were exposed. Then the tela choroidea was opened bilaterally to access the dorsal fourth ventricle. We stayed away from any resection involving or splitting the inferior vermis. Both PICAs and the veins of the bilateral cerebellomedullary fissures were preserved. Tumorous tissue in the fourth ventricle was immediately visible and adequately accessible. Careful establishment of a circumferential plane was achieved and internal tumor debulking was performed. Cutting the lateral margins of the inferior medullary velum created a wide operative field with easy visibility toward the aqueduct and the bilateral foramen Luschkae. At the end of the tumor dissection and removal, the caudal opening of the aqueduct and both foramina Luschkae were well visible. The case was closed as pointed out above. No new neurological deficit was encountered after this operation. The postoperative MRI revealed no residual tumor [Figure 2]. Histopathological analysis revealed a solitary fibrous tumor of the central nervous system WHO I with low mitotic index. Since a gross total resection was achieved, no adjuvant radiation was

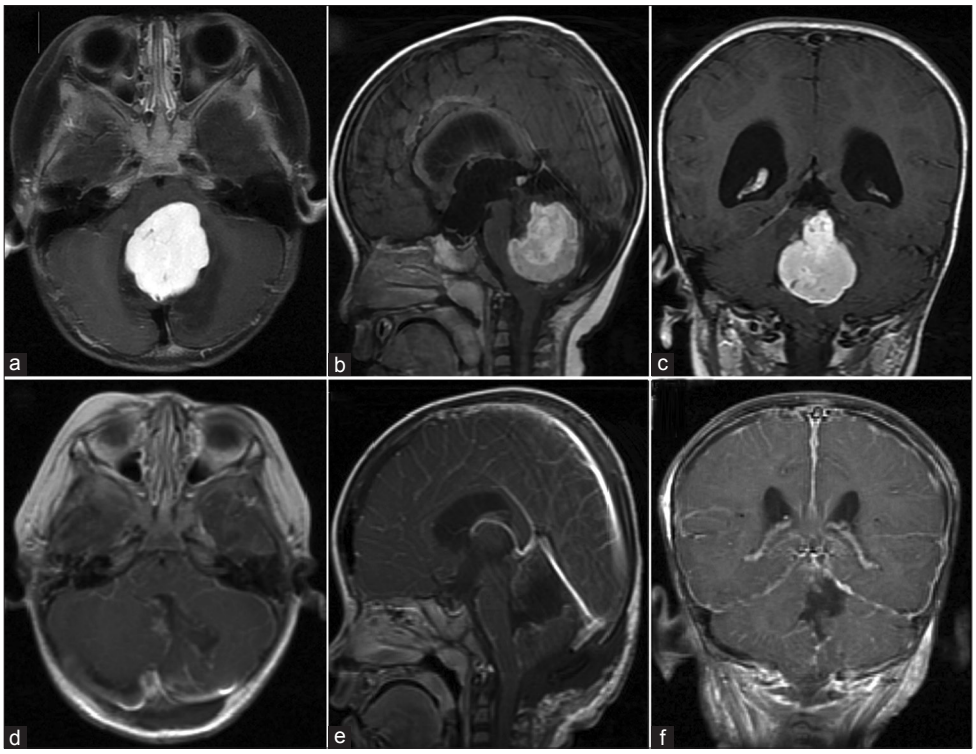

Figure 2: Preoperative axial (a), sagittal (b) and coronal (c), T1-weighted MRI scan with Gd-DTPA showing a large fourth ventricle tumor extend into the lateral recess. Postoperative axial (d), sagittal (e) and coronal (f), T1-weighted MRI scan with Gd-DTPA demonstrating total resection

recommended. At 6 months follow-up, the patient was neurologically without deficit.

Patient 3 (Ependymoma WHO II)

A 72-year-old male presented with progressive nausea, occasional vomiting, and intractable morning headaches. The patient had an unremarkable past medical history and was treated by his primary care physician for a stomach bug for several weeks.

Eventually, imaging was requested for non-resolving symptoms and MRI with I/V contrast revealed a multilobulated, irregularly shaped, partially cystic but avidly contrast enhancing, mostly well demarcated tumor, which reached from within the mid fourth ventricle posteriorly toward the inferior velum and laterally into the recess of the fourth ventricle [Figure 3]. There was no significant associated hydrocephalus.

As for patient 1, this patient underwent standard general endotracheal anesthesia and was placed into prone position in Mayfield fixation pins with the neck in a highly flexed position. The Brain-LAB system was used and best trajectories were determined. A standard wide bilateral suboccipital approach was chosen. Durotomy was performed as described earlier and the arachnoidea was dissected off. The tonsils were retracted, the cerebellomedullary (CM) fissure split and the tela choroidea was opened on both sides to access the posterior-lateral part of the fourth ventricle. Both PICAs were immediately visualized and could be dissected of the tumor mass and the veins of the cerebellomedullary fissure could also be preserved. Tumor tissue in the fourth ventricle was readily identified and some of the left sided cystic portions of the lesion could be accessed and drained, which greatly facilitated our dissection. A small specimen for intraoperative histopathological analysis revealed a well differentiated ependymoma. Careful microscopic dissection in a circumferential plane was performed. Cutting the juncture of the tela and inferior medullary velum on each side created a wide operative field allowing bilaterally panoramic views especially laterally toward the recess. After gross total resection, brisk CSF flow from the aqueduct and through the foramina Luschkae was observed. Absolute hemostasis was achieved, the ventricle was copiously irrigated and the durotomy was closed as described earlier with pericranial autograft and fibrin sealant augmentation. The patient was successfully extubated in the OR and no neurological deficit was noticed upon examination. Postoperative MRI revealed no residual tumor burden [Figure 3]. The patient had an unremarkable postoperative course and was discharged to home on POD #4.

DISCUSSION

Approaches to large tumors in fourth ventricle can be a formidable challenge to even experienced neurosurgeons.

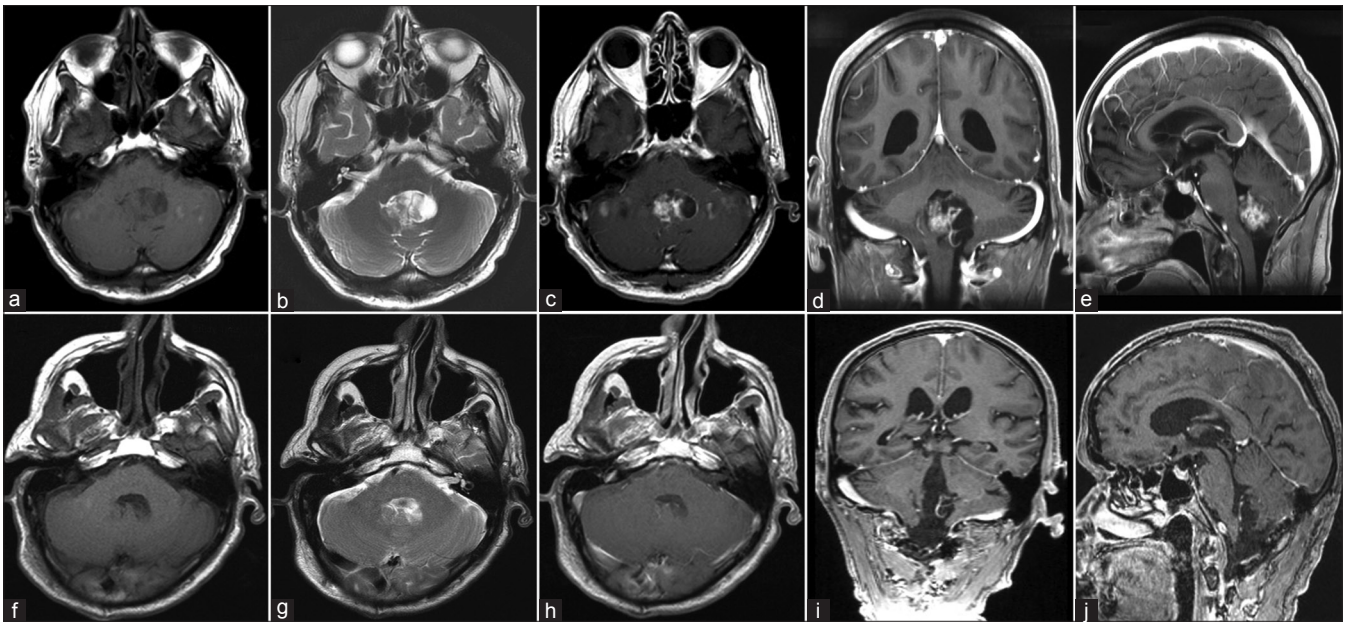

Figure 3: Preoperative axial T1 (a), axial T2 (b) and axial (c), coronal (d) and sagittal (e) with Gd-DTPA MRI scan showing a fourth ventricle tumor enclosed posterior inferior cerebellar artery. Postoperative axial T1 (f), axial T2 (g) and axial (h), coronal (i) and sagittal (j) with Gd-DTPA MRI scan demonstrating total resection and reserving posterior inferior cerebellar artery.

Since Dandy's original statement regarding the splitting of the cerebellar vermis (claiming that this could be achieved without significant disturbance in function)[2] the transvermian approach with an inferior vermian split has been the most commonly used road to access tumors of the fourth ventricle. However, a distinct "syndrome of the caudal vermis" was described after damage to the inferior vermis and this typically includes a disturbance in equilibrium, truncal ataxia, gait disturbance, oscillation of the head and neck, as well as nystagmus.[5,6] To avoid these debilitating complications, suitable approaches to resect fourth ventricle tumors have been tried out and modified repeatedly over the past decades, attempting and emphasizing a resection of these tumors without transgressing or incising the vermis. After a detailed description of the microsurgical anatomy of the ventricles had been published,[10] and native embryological tissue planes were taken into consideration, the use of a telovelar approach (also named the cerebellomedullary fissure approach, subtonsillar approach) was first successfully reported by Matsushima *et al*. This allowed access to the fourth ventricle without splitting the vermis. Numerous reports of resection of various fourth ventricle tumors via the unilateral telovelar approach have been described since.[3,4,7,8,12,14,16]

This unique approach accesses the fourth ventricle through natural openings in the inferior portion of the roof of the fourth ventricle, utilizing tissue planes formed by the inferior medullary velum and the tela choroidea during embryogenesis: The inferior medullary velum is a thin bilateral layer of neural tissue that extends from the cerebellar nodule medially and blends into the dorsal margin of each lateral recess, forming the peduncle of each flocculus laterally. Caudally and laterally, the inferior medullary velum attaches to the tela choroidea ventriculi quarti. The tela choroidea contains a vascular layer of choroidal arteries and veins between its layers and the choroid plexus projects from its ventricular surface. Most importantly, no known functional neural tissue or pathway resides within these structures that form the inferior portion of the roof of the fourth ventricle.[15] The cerebellomedullary fissure is thus a suitable natural cleavage plane utilizing the space between cerebellum and medulla oblongata. The roof of the cerebellomedullary fissure is formed by the uvula, tonsils, and biventral lobules. The floor attachment of the cerebellomedullary fissure is also formed by the posterior surface of the medulla, the inferior medullary velum, and the tela choroidea. The telovelar approach is thus an optimal access route to the ventricle route not inflicting any injury to any functional neural tissue [Figure 4].

However, despite all advantages listed and even with all possible intraoperative precautions implemented, some profound neurological sequelae have been reported, including substantial syndromes of cerebellar dysfunction, especially when attempts were made to resect large fourth ventricle tumors via a unilateral telovelar approach.[3,4,12,16]

Rhoton[13] pointed out that the telovelar incision can be divided in three parts. The first part of the incision, which opens the tela choroidea, makes the full length of the floor of the fourth ventricle come into view. The second part involves extending the incision superiorly through the inferior medullary

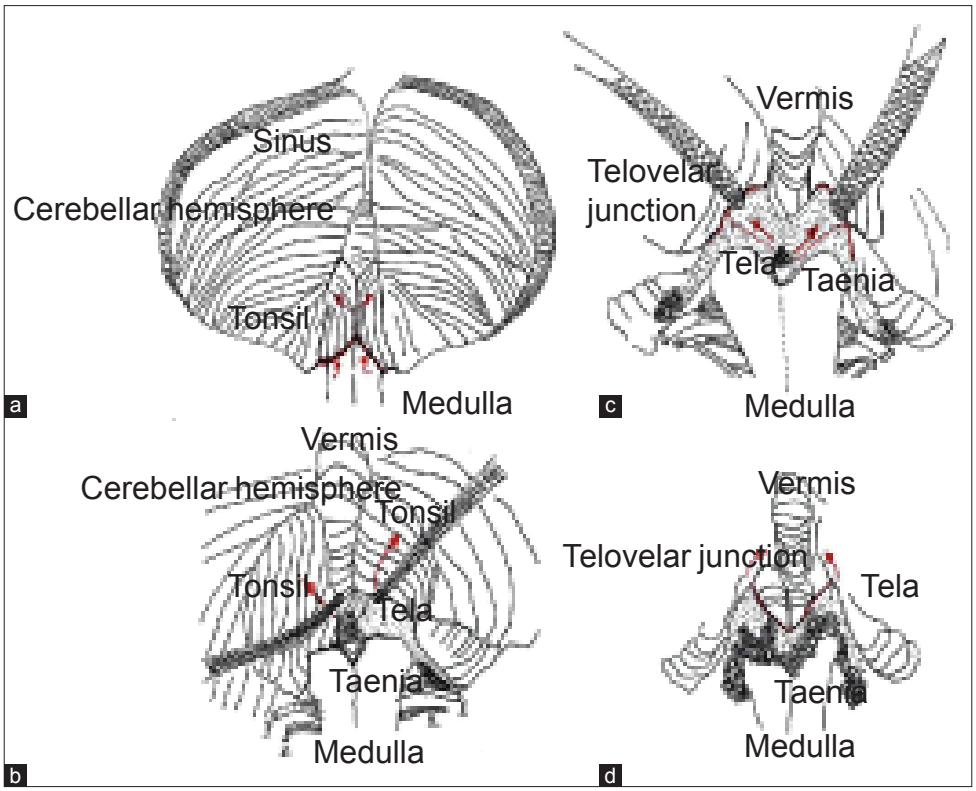

Figure 4: (a) Step 1: Cerebello-medullary fissure, (b) Elevation of tonsils. (c) Step 3: Medial opening of the tela choroidea. (d) Extension to telovelar junction

velum to expose the ipsilateral superolateral recess, which provides access to the entire depth of the fourth ventricle in all circumstances. The third incision, which should be directed between the tonsil and medulla oblongata through the tela forming the lower posterior wall of the lateral recess, provides additional access to the full length of the lateral recess and the foramen Luschkae. So depending on the extent of the incisions employed (one part or three parts) and employing this approach unilaterally or bilaterally, the surgeon can achieve different exposures tailored individually for the needs of each encountered pathology.

To this end, we reported here three different large fourth ventricle tumors extending into the cerebral aqueduct and into the lateral recess. These tumors were resectable via a *bilateral telovelar approach* without noticeable complications. Although large fourth ventricle tumors often distort the normal anatomy, stretching out the vermis and the cerebellar peduncles are usually thinned, these need to be spared any further injury by minimizing traction. During the operation, a most careful dissection of the circumferential planes and internal debulking of tumor mass were performed alternately. Opening of the bilateral tela choroidea and gentle elevation of the inferior medullary velum did provide enough space to allow an excellent view into the operative site and thus enabled us to completely resect these extensive tumors without injury to adjacent normal tissue. We therefore want to bring this technical aspect again to the attention of dedicated tumor surgeons encountering such challenging lesions in select patients.

CONCLUSION

In cases of large or giant fourth ventricle tumors of different histopathological types, (such as meningiomas, solitary fibrous tumors or ependymomas but also other neoplasms arising in or from the choroid plexus) the bilateral telovelar approach provides excellent intraoperative visibility via a wide exposure of the fourth ventricle allowing complete excision of even extensive tumors and minimizes surgical morbidity.

REFERENCES

1. Dailey AT, McKhann GM 2nd, Berger MS. The pathophysiology of oral pharyngeal apraxia and mutism following posterior fossa tumor resection in children. J Neurosurg 1995;83:467-75.
2. Dandy WE. The Brain. In: Lewis D, editor. Practice of Surgery. Hagerstown, MD: WF Prior; 1966. p. 452-8.
3. El-Bahy K. Telovelar approach to the fourth ventricle: Operative findings and results in 16 cases. Acta Neurochir 2005;147:137-42.
4. Gok A, Alptekin M, Erkutlu I. Surgical approach to the fourth ventricle cavity through the cerebellomedullary fissure. Neurosurg Rev 2004;27:50-4.
5. Holmes G. The Croonian lectures on the clinical symptoms of cerebellar disease and their interpretation. Lancet 1922;2:59-65, 111-5.
6. Holmes G. The Croonian lectures on the clinical symptoms of cerebellar disease and their interpretation. Lancet 1922;1:1177-82, 1231-7.

7. Jean WC, Abdel Aziz KM, Keller JT, van Loveren HR. Subtonsillar approach to the foramen of Luschka: An anatomic and clinical study. Neurosurgery 2003;52:860-6.
8. Lee CC, Lin CF, Yang TF, Hsu SP, Chen HH, Chen SC, *et al*. Telovelar approach for choroid plexus papilloma in the foramen of Luschka: A safe way using a neuromonitor. Clin Neurol Neurosurg 2012;114:249-53.
9. Matsushima T, Fukui M, Inoue T, Natori Y, Baba T, Fujii K. Microsurgical and magnetic resonance imaging anatomy of the cerebello-medullary fissure and its application during fourth ventricle surgery. Neurosurgery 1992;30:325-30.
10. Matsushima T, Rhoton AL, Jr, Lenkey C. Microsurgery of the fourth ventricle: Part 1. Microsurgical anatomy. Neurosurgery 1982;11:631-67.
11. Mussi AC, Rhoton AL Jr. Telovelar approach to the fourth ventricle: Microsurgical anatomy. J Neurosurg 2000;92:812-23.
12. Rajesh BJ, Rao BR, Menon G, Abraham M, Easwer HV, Nair S. Telovelar approach: Technical issues for large fourth ventricle tumors. Childs Nerv Syst 2007;23:555-8.
13. Rhoton AL Jr. Cerebellum and fourth ventricle. Neurosurgery 2000;47 (3 Suppl):S7-27.
14. Sharifi G, Jahanbakhshi A, Sabeti S. A large choroid plexus papilloma removed by the cerebellomedullary fissure approach. Case report and review of the literature. Turk Neurosurg 2008;18:302-6.
15. Tanriover N, Ulm AJ, Rhoton AL Jr., Yasuda A. Comparison of the transvermian and telovelar approaches to the fourth ventricle. J Neurosurg 2004;101:484-98.
16. Zaheer SN, Wood M. Experiences with the telovelar approach to fourth ventricular tumors in children. Pediatr Neurosurg 2010;46:340-3.