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Far-anterior Interhemispheric Transcallosal Approach for a Central Neurocytoma in the Lateral Ventricle

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Abstract

To describe the far-anterior interhemispheric transcallosal approach for the treatment of a central neurocytoma at the roof of the lateral ventricle. In comparison to the view obtained during the usual anterior transcallosal approach, the far-anterior approach allowed for a higher view of the lateral ventricle to be obtained without further injury or retraction of the corpus callous. Two patients with central neurocytoma in the lateral ventricle were treated with the far-anterior interhemispheric transcallosal approach. Gross-total resections were achieved in both the patients without any postoperative neurological impairments by only 2–3 cm incisions of the corpus callosum. With the anterior transcallosal approach, which was usually used for the intraventricular tumors, the surgical view was relatively downward into the lateral ventricle and suitable for the resection of the tumors located at the base of the lateral ventricle or even in the third ventricle through the foramen of Monro. However, it was relatively difficult to reach the roof of the lateral ventricle using this approach. In contrast, the surgical corridor of the far-anterior transcallosal approach reaches upward to the roof of the lateral ventricle. The far-anterior transcallosal approach provides an alternative to reach the lesions, especially those located in the upper region of the lateral ventricle near important structures, such as the pyramidal tracts.

Key words: far-anterior interhemispheric transcallosal approach, lateral ventricle, central neurocytoma

Introduction

Central neurocytomas (CNCs) are rare neuroglial brain tumors in the central nervous system, typically located in the lateral ventricle, especially near the foramen of Monro. CNCs, which represent approximately 0.25–0.5% of all intracranial tumors,[1] correspond to grade II according to the classification given by the World Health Organization (WHO) 2016. CNCs are usually benign but recurrence can be observed, and even anaplastic CNCs can be rarely seen.[2] Although currently, it is believed that the surgical removal with a gross-total resection is the best treatment of choice, still some recurrences can be observed. It was thought that at least it is necessary to resect the tumor as much as possible.[2,3] There are some surgical approaches for the tumors in the lateral ventricle, namely, transcortical and transcallosal approaches. However, the selection of a surgical approach depends on the location or attachment of the tumor. Here, we demonstrate the "far"-anterior transcallosal approach which can reach to the wall of the lateral ventricle, especially the upper region (roof) of the lateral ventricle near the pyramidal tract.

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Case Presentations

We demonstrate two cases who underwent the far-anterior transcallosal approach for the removal of the intraventricular central neurocytomas at our institution between April 2015 and December 2018. This study was approved by our Institutional Review Board (IRB # 25-103).

Case 1

A 36-year-old male patient was suffering from vertigo since several months. Magnetic resonance imaging (MRI) demonstrated left intra-ventricular tumor which occupied the foramen of Monro, and obstructed the cerebrospinal fluid (CSF) flow from the lateral ventricle to the third ventricle through the foramen (Figs. 1A and 1B). First, we chose to perform a biopsy through the anterior horn with a

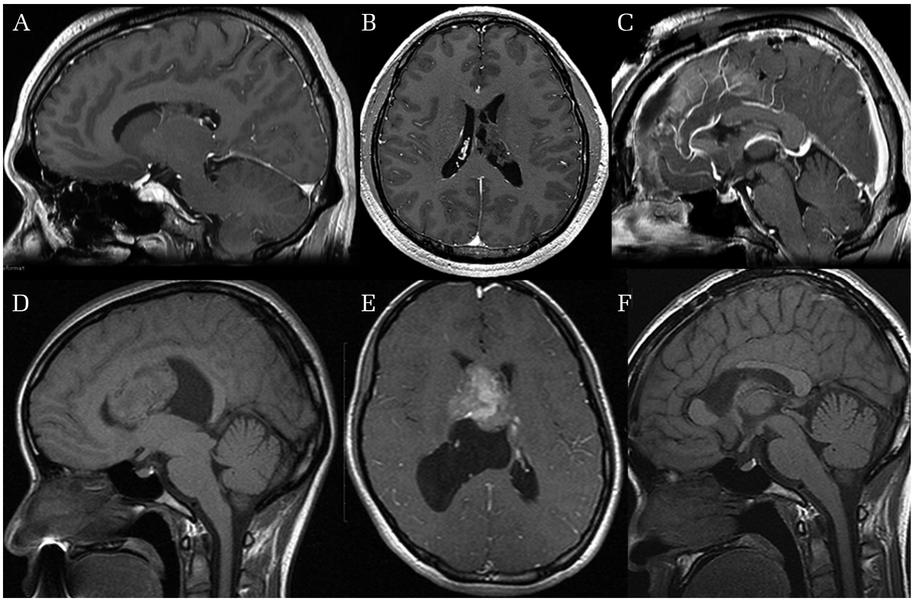

Fig. 1 Magnetic resonance imaging in case 1 showing a mass lesion in the left lateral ventricle; gadolinium enhancement on a T1-weighted image (WI) revealing a heterogeneous formation, and a T2-WI image presenting a slightly hyperintense lesion with microcysts (A and B: sagittal and axial images, respectively, on enhanced T1-WI). (C) Postoperative gadolinium enhancement on a T1-WI showing surgical corridor to the lateral ventricle. Magnetic resonance imaging in case 2 showing a mass lesion in the right lateral ventricle, which extended into the left lateral ventricle; a T1-WI revealing a heterogeneous formation (D); and a gadolinium enhancement on a T1-WI presenting heterogeneously enhanced lesions (E: axial image on enhanced T1-WI). (F) Postoperative sagittal image on T1-WI showing a defect of the corpus callosum without a residual tumor.

neuroendoscopy; and it was simultaneously possible to set an intraventricular drainage tube, which can prevent the isolated ventricles from the obstructed CSF flow. The appearance of the intra-ventricular tumor was rugged with small swollen, reddish colored waves. The tumor was attached to the roof of the lateral ventricle close to the pyramidal tract. The pathological examination revealed a central neurocytoma, WHO grade II. Subsequently, we decided to remove the maximum possible extent of the tumor by performing a craniotomy with an approach named "far-anterior interhemispheric transcallosal approach" to the lateral ventricle achieving a gross-total resection (Fig. 1C).

Case 2

A 36-year-old female was suffering from headache since 3 months. A well-enhanced mass lesion was found in the right lateral ventricle on MRI (Figs. 1D and 1E). The tumor was resected sub-totally. The pathological examination revealed a central neurocytoma, WHO grade II (Fig. 2). Three years after the first operation, the recurrence of the tumor was found in the right lateral ventricle. The second operation was performed by the far-anterior interhemispheric transcallosal approach achieving a gross-total resection (Fig. 1F). The pathological examination revealed an anaplastic central neurocytoma. After the operation, radiotherapy was performed with 54 Gy/30 fr.

The MRIs, which were obtained at 8 months in case 1 or at 2 years in case 2 after the surgeries, demonstrated no evidence of a recurrent tumor. The patients manifested no hemiparesis or memory disturbances after the surgeries in both the cases.

Presurgical evaluations The venous system was evaluated preoperatively; and the operative approach was selected, such as performing a three-dimensional CT reconstruction.

Surgical procedures The head of the patient was placed in a Mayfield head-holder with the vertex slightly downward to optimize the angle of the view into the ventricle. A coronal skin incision was made, and bilateral craniotomy crossing the superior sagittal sinus was performed, which was shifted 3–5 cm anteriorly as compared with the craniotomy performed in the conventional anterior transcallosal approach. Ipsilateral or contralateral of the dura was opened with a U-shaped flap based along the superior sagittal sinus. The choice of the ipsi- or contra-lateral interhemispheric approach depends on the position of the bridging veins or on the location or the attachment of the tumor. Sometimes it becomes necessary to dissect some bridging veins to protect them, if the working space is located between

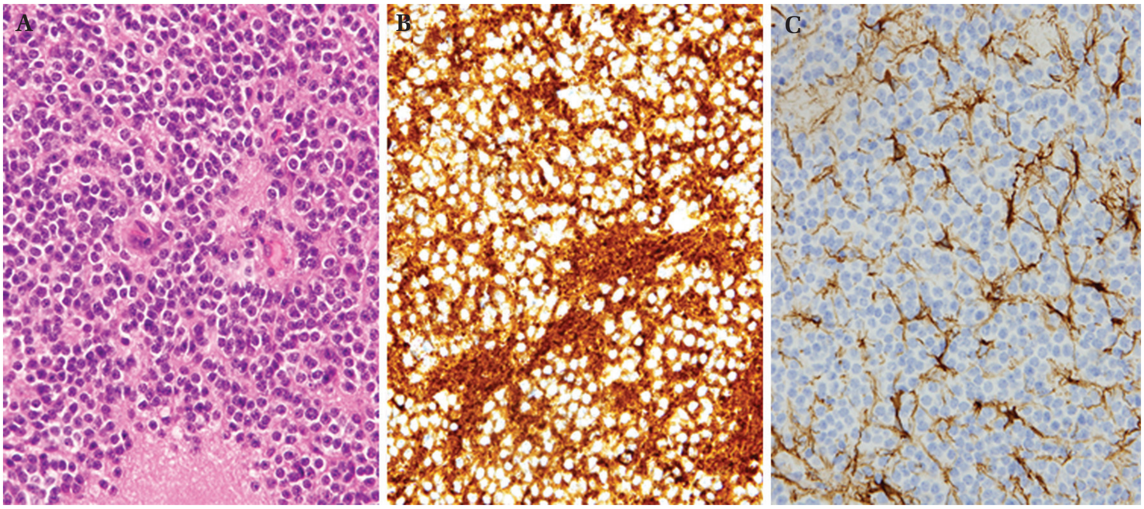

Fig. 2 (A) The tumor consisted of markedly uniform round cells with honeycomb architectures as shown by hematoxylin and eosin (HE) staining (HE 40×). On immunohistochemistry, the tumor cells expressed positivity for synaptophysin (B), but negativity for glial fibrillary acidic protein (C).

the bridging veins. The arachnoid membrane was opened to expose the pericallosal arteries and the corpus callosum. Retraction of the superior sagittal sinus should be minimum and performed carefully; otherwise, stenosis or occlusion can be promoted with sinus thrombosis and venous infarction.[4,5]

Then, 20–30 mm incision of the corpus callosum was set with a fine raspatory. After proceeding into the midline of the corpus callosum, the septum pellucidum was identified and the ependymal wall of the lateral ventricle on the ipsilateral side was cut.

After the entry into the lateral ventricle, the normal ventricular anatomy (including choroid plexus, thalamostriate vein, septal vein, foramen of Monro, and fornix) was identified and the location of the ipsilateral ventricle was confirmed with these anatomical landmarks. The tumor was then identified and resected (Fig. 3).

Discussion

Central neurocytomas may derive from neuroglial precursor cells with the potentiality of dual differentiation, because there are some evidences for both glial and neuronal differentiation in some tumors.[2,6–11] Many reports have demonstrated that there are many stem or precursor cells in the subependymal or subventricular zone. That may be a reason why the tumors occur in the subependymal or subventricular zone of the lateral ventricles.[11] Although most CNCs originate from the septum pellucidum in the lateral ventricle,[12–14] the tumors in the presented cases originated from the roof of the lateral ventricle near the pyramidal tracts and did not attach to the septum pellucidum. Although, there are some surgical approaches for the tumors in the lateral ventricle, including transcortical and interhemispheric transcallosal approaches, it can be difficult to reach the upper region of the lateral ventricle, especially near the pyramidal tract. It is necessary to choose an approach to the lateral ventricle depending on the tumor locations and attachments. It can be difficult to expose and resect a tumor located in the body of the lateral ventricle with a transcortical approach, because the tumor-attachment is close to the eloquent areas such as pyramidal tract. Cortical injuries can produce postoperative seizures[15–17] and functional neurological deficits, especially when a tumor is situated close to the eloquent areas. With the traditional approaches, including the transcortical approach for the lesions in the superior or middle temporal gyrus or the superior parietal lobule, and even with the anterior interhemispheric transcallosal approach, it can be easy to reach the septum pellucidum or the base of the lateral ventricle; however, it is relatively difficult to reach the roof of the ventricle with these approaches. The anterior interhemispheric transcallosal approach was developed by Dandy,[18] Milhorat and Baldwin,[19] Shucart and Stein,[16] and Stein.[20] Although, many articles have demonstrated that the transcallosal approach is well tolerated and induces no functional neurological deficits or postoperative seizures,[21–25] the surgical working space is limited in the position of callosotomy, if the tumor is located superior to the lateral ventricle. It is difficult to expose

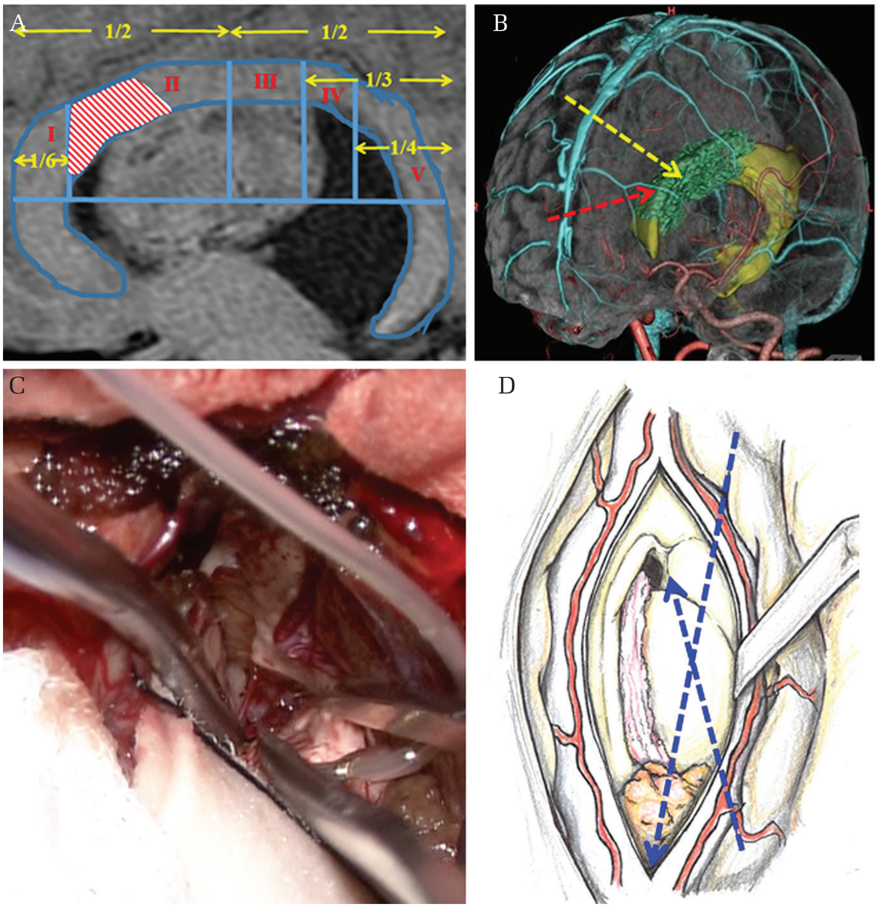

Fig. 3 MRI sagittal image (A) showing the surgical corridor with Hofer and Frahm segmentation of the corpus callosumt (*red-shaded area*). Three-dimensional CT reconstruction (B) showing comparison of the trajectory between the conventional (*yellow arrow*) and far (*red arrow*)-anterior interhemispheric transcallosal approach to the lateral ventricle. Intraoperative photographs (C) showing the view of the surgical space during the resection of the tumor after a 2–3 cm incision of the corpus callosum. Schematic diagram (D) showing the surgical view, and demonstrating longitudinally wide view and the possibility to reach the tumors attaching to the roof of the lateral ventricle through the foramen of Monro.

sufficiently by performing a callosotomy with the conventional anterior interhemispheric transcallosal approach, if the tumor located in the upper region of the lateral wall of the lateral ventricle. The contralateral transcingulate gyrus approach may be a valuable alternative that provides better angles of approach.[26,27] However, the longitudinal planes of these approaches are still small and not sufficient, because the callosotomy can provide limited and small surgical corridor. On the other hand, the far-anterior interhemispheric transcallosal approach is suitable for such a tumor located in the upper roof of the lateral ventricle, because the far-anterior transcallosal approach offers a better angle of approach which increases the longitudinal exposure of the lateral ventricle with a minimum incision of the corpus callosum (Fig. 4). The retraction of the corpus callosum rostrally to expose the roof of the lateral ventricle can be minimum with this approach. For the patients with the division of the anterior midbody of the corpus callosum (Segment II, according to Witelson's[28] classification, there has been no report until now demonstrating clinically significant neurological deficits. In order to avoid any executive dysfunctions, it is necessary to minimize the damage of Segment I, according to Hofer and Frahm[29] classification, as much as possible. Without this angle of approach, the upper portion of the tumor can be reached only after excessive retraction of the corpus callous (posterior midbody of the corpus callosum; Segment III according to Witelson's classification). In the chronic postoperative period, the patients with the Segment III division of the corpus callosum may experience some symptoms such a "foreign" or "Alien" hand. The advantages of this approach include preventing the injuries of the cerebral cortex and decreasing the risk of postoperative seizures as well as preventing the superfluous injury to the corpus callosum, as compared with the transcortical approach. Therefore, we emphasize that with the far-anterior interhemispheric transcallosal approach, it is easy to expose the attachment of the tumor arising from the roof of the ventricle, as compared with the conventional anterior interhemispheric transcallosal approach. On the other hand, the disadvantage is that in this approach, the distance from the brain surface to the tumor is relatively longer than that in the other approaches.

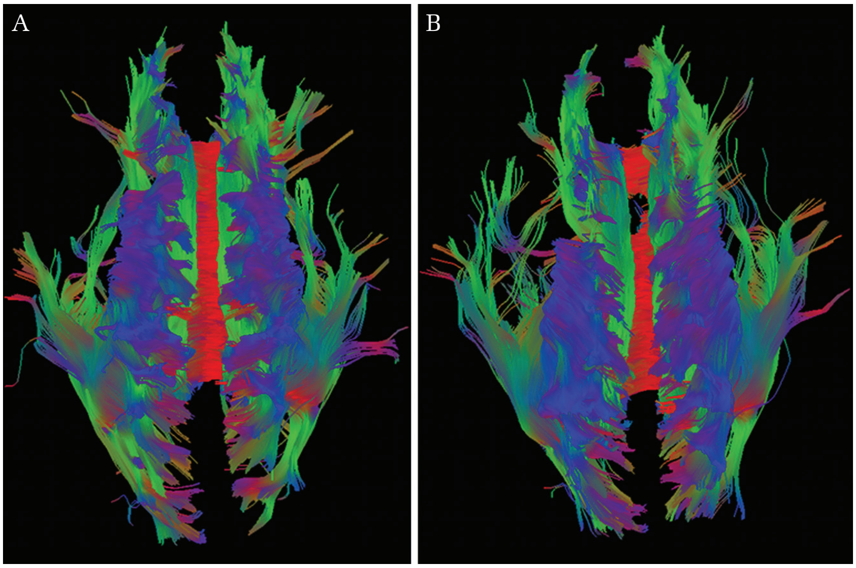

Fig. 4 Diffusion tensor images after pre-callosotomy (A) and post-callosotomy (B). Transverse fibers between the cerebral hemispheres demonstrating a small defect without any damage to the corpus callosum.

Ethical Approval

We declare that this study has been approved by the Ethics Committee of Sapporo Medical University Hospital (No. 25-103), and have been performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Informed Consent

All patients provided informed consent before participating.

Conflicts of Interest Disclosure

The authors declare that they have no conflicts of interest.

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