Case Report

Neuronavigation-guided endoscopic and hodotopic approach to an arachnoid cyst

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Abstract

**Background:** Arachnoid cysts are intraarachnoid benign cystic lesions filled with cerebrospinal fluid and should be treated without incurring further morbidity to the patients.

**Case Description:** The authors present a case of a 68-year-old elderly female with a large right fronto-parieto-temporal arachnoid cyst who has been suffering from mild left hemiparesis for the past 4 years and presented with sudden onset of seizures. The 3 Tesla MR system with diffusion tensor imaging (DTI) and MR tractography of the brain showed a large right fronto-parieto-temporal cystic lesion measuring 7 × 5 × 5 cm with a midline shift of 1 cm, suggestive of an arachnoid cyst with surrounding ipsilateral white matter projection pathways and inferior occipito-frontal fasciculus or inferior longitudinal white matter tracts. The cyst was successfully treated with neuronavigation-guided endoscopic and hodotopical approach to fenestrate the arachnoid cyst into the sylvian cistern, avoiding inadvertent injury to major white matter tracts portrayed by DTI. Postoperatively, a repeated computed tomography (CT) scan of the brain revealed a smaller arachnoid cyst with correction of the midline shift. The patient was weaned off from the ventilator and her hemiplegia improved gradually.

**Conclusion:** This case report emphasizes the value of neuronavigation-guided endoscopic and hodotopic approach to fenestrate the intra-axial arachnoid cyst.

**Key Words:** Arachnoid cyst, endoscopy, hodotopy, neuronavigation, tractography

INTRODUCTION

Symptomatic arachnoid cysts should be treated without incurring further morbidity to the patients. Advances in neuroimaging from sectional anatomy depicted by magnetic resonance imaging (MRI) of the brain to connectional anatomy represented by diffusion tensor imaging (DTI) with tractography has revolutionized surgical strategies in treating brain lesions. DTI and hodotopic approach have mostly been applied in neurosurgery for craniotomy and brain tumor surgery. We describe the case of an elderly patient with a large intraaxial cerebral convexity arachnoid cyst, which was treated using neuronavigation-guided endoscopic and hodotopical approach to fenestrate the arachnoid cyst into the sylvian cistern, avoiding inadvertent injury to major white matter tracts portrayed by DTI.
CASE REPORT

A 68-year-old elderly female who has been suffering from mild left hemiparesis for the past 4 years presented to our hospital with history of sudden onset of left sided tonic-clonic seizures that became generalized. She was intubated because of airway compromise. Physical examination prior to intubation disclosed that the patient had left hemiplegia and hyperreflexia on the left limbs with extensor plantar reflex. The cranial nerves and systemic examination were normal. The computed tomography (CT) scan of the brain showed a large right fronto-parieto-temporal cystic lesion measuring 7 × 5 × 5 cm with a midline shift of 1 cm, suggestive of an arachnoid cyst [Figure 1a-c].

A neuronavigation-guided endoscopic fenestration of the cyst was done to communicate the arachnoid cyst with the ipsilateral sylvian cistern [Figure 2a-d]. Fenestration of the cyst to directly communicate with the ipsilateral lateral ventricle was thought as an inappropriate choice because of the close proximity of the cyst wall with important ipsilateral white matter projection pathways and inferior occipito-frontal fasciculus or inferior longitudinal white matter tracts revealed by the 3 Tesla MR system with DTI and MR tractography (Gyroscan Intera, Philips Medical System, Eindhoven, Netherlands) [Figure 3a and b]. By using an endoscope mounted navigational system (Medtronic StealthStation TREON™ cranial software; Medtronic Inc., Minneapolis, USA), an appropriate burr hole with intended trajectory to the ipsilateral sylvian cistern was made guiding the neurosurgeon safely while inside the cystic cavity to the area of interest. Subsequently, fenestration was performed with the aid of a biopsy and bipolar forceps. The surgery was uneventful and lasted approximately an hour.

Postoperatively, a repeated CT scan of the brain revealed a smaller arachnoid cyst with correction of the midline shift [Figure 4a-c]. The patient was weaned off from the ventilator and her hemiplegia improved gradually.

DISCUSSION

Arachnoid cysts are intraarachnoid benign cystic lesion filled with cerebrospinal fluid. It is derived from developmental abnormalities during growth. Some suggested it result from traumatic injury of arachnoid layer. Generally, arachnoid cyst can be divided into supratentorial and infratentorial cyst. Supratentorial cysts consist of sylvian fissure cyst, suprasellar cyst, cerebral convexity cyst, interhemispheric cyst, and quadrigeminal cyst. The clinical presentation of arachnoid cyst depends on site of the lesions. In our case, left sided hemiparesis and focal seizure in an elderly lady were thought secondary to an arachnoid cyst. MRI is the preferred imaging study for arachnoid cyst.

Location and content of the cyst and the relationship to neural and vascular structure are best demonstrated on
T1 and T2 images. DTI is an emerging and noninvasive MRI-based technique that can demonstrate white matter anatomy by measuring the directional anisotropy of water.\(^1\) In our case, the usage of DTI with MR tractography helped us to decide the best area to fenestrate the cyst. Since tractography depicted two important large white matter pathways lie in between a cystic lesion and the ipsilateral lateral ventricle, direct fenestration of the cyst to the lateral ventricle is thought as dangerous and might aggravate the hemiparesis. Instead, direct fenestration to the sylvian cistern is thought as a safer approach injuring only some of small U fibers. Besides, in presence of major artery such as middle cerebral artery in the sylvian cistern, transmitted vascular pulsation would certainly ease the outflow of fluid inside the arachnoid cyst.

De Benedictis and Duffau have studied the brain white matter anatomy and listed out some of important white matter tracts and their connections.\(^6,8\) Based on this knowledge, the two large white matter fibers were projection pathways, colored in blue from and to sensorimotor cortex; and association pathways colored in green, which represent an inferior occipitofrontal or inferior longitudinal fasciculus. Projection pathways carry sensory and motor information of ascending and descending fibers that functionally connect the peripheral and central nervous systems. Corticospinal, corticobulbar, and ascending thalamic tracts are some that form a complex projection system. Equally important are the inferior occipito-frontal bundle of white matter tract that connects occipital with frontal cortices via fibers that lie above the uncinate fasciculus at level of external capsule; and inferior longitudinal fasciculus, tract connecting occipital with temporal regions. Injury to these major connections would cause varieties of deficits; examples are difficulty to retrieve visual images during awake and sleep states, visual neglect, visual agnosia and color and object anomia. DTI with MR tractography has significantly increased our knowledge in white matter pathways and changed neurosurgeon approach to the brain. In contrast to topological approach (consider brain functions is localized in specific cortical regions), this hodotopical approach (include consideration of brain white matter pathways) offers a safer approach to the brain structures and lesions.\(^6-9\)

The management of arachnoid cyst remains controversial. At the moment, there are no class I or class II studies on management of arachnoid cyst. Generally, surgery is reserved for symptomatic patient with neurological deficit regardless of the age of the patient. Objective of surgery is to reduce intracranial pressure as a result from pressure effect of the arachnoid cyst. Options of surgical techniques are craniotomy and cyst wall excision,\(^2,14\) cystoperitoneal or cystoventricular shunt or endoscopic fenestration.\(^10,11,13,15,20\) In agreement with a study by Cincu et al., it was concluded that communicating the cyst with the ventricular system or basal cisterns appears to offer the best chance of a success in the treatment of arachnoid cysts.\(^5\) Nonetheless, this case report highlights the importance of knowing further major connectional anatomical structures that lie between the cyst, ventricle, or cistern before embarking on definitive endoscopic surgery.

**CONCLUSION**

Hodotopic endoscopic approach to the brain is possible nowadays by using noninvasive MRI technique called DTI
with tractography. This noninvasive imaging technology has helped us to plan an alternative endoscopic approach to fenestrate the symptomatic large cerebral convexity arachnoid cyst to the pulsating sylvian cistern.

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