Placement of subdural electrode grids for seizure focus localization in patients with a large arachnoid cyst

Technical note

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Subdural electrode arrays are placed to localize seizure foci for possible resection. The procedure is usually straightforward when an electrode grid array is placed on the brain convexity but can become complicated if the surface on which the grids are applied is not convex. Arachnoid cysts can be associated with seizures, but their topography presents a challenge to standard techniques for the placement of subdural grids. The authors report on a technique for electrode grid placement that successfully localized seizure foci in the depths of arachnoid cysts in two patients.

Subdural grids were placed to conform to the concave cyst cavity. They were held in place with rolled gelatin foam padding, which filled the arachnoid cyst. The padding was removed before removing the electrode grids and resecting the seizure focus.

Although arachnoid cysts present a technical challenge when seizure foci are located within the cyst cavity, the technique of packing the cyst cavity with gelatin foam provides good electrode contact on the concave cyst wall, allowing adequate seizure focus localization.

ILLUSTRATIVE CASES

Case 1

History and Examination. This 17-year-old boy presented for elective resection of a seizure focus. He had a history of intractable epilepsy that, according to scalp electrode evaluation, was linked to an area near a large convexity arachnoid cyst. Initial imaging data in this patient, obtained 6 years before his first presentation to us, had revealed a 6 x 12 x 7.5-cm arachnoid cyst in the left frontotemporal region with mass effect on the ipsilateral cerebral hemisphere. Intracystic hemorrhage after trauma led to the placement of a cystoperitoneal shunt once hydrocephalus developed. Shortly thereafter, a seizure disorder developed and progressed to a medically intractable state. The patient eventually presented to us for invasive monitoring of the cortex in and around the cyst for localization of the seizure focus.

First Operation. After standard craniotomy and exposure, the cyst’s internal membrane was opened. The electrode grids were placed over the lateral temporal cortex in the usual manner, and then the cortex within the cyst was covered with subdural electrode arrays (one or two electrodes wide; Fig. 1). Multiple sheets of gelatin foam (Surgifoam, Johnson & Johnson) were then folded or rolled into small cigar-shaped forms (Fig. 2) to fill the cyst gently to the point of applying mild pressure on the electrodes and thus holding them in place. A 35-cm ventriculostomy catheter was placed through this gelatin foam array toward an area of previous cyst fenestration to allow for CSF drainage before removing the electrode grids and resecting the seizure focus.
Second Operation. One week later, the patient was taken back to the operating room, his craniotomy was reopened, and the gelatin foam “cigars” were gently removed individually. Markers were placed on the brain as each electrode array was removed to identify the seizure focus found under one of the intracyst electrode grids. A topectomy of the seizure focus was then performed in a standard fashion.

Case 2

History and Examination. This 23-year-old man with a history of tuberous sclerosis and intractable epilepsy underwent cortical tuber resection in the right parietooccipital area when he was young. After a seizure-free period, the epilepsy returned and became medically intractable. Scalp EEG recordings localized seizure generation to an area within the prior surgical cavity that had regenerated as an arachnoid cyst–like structure with intact cortex anteriorly (Fig. 4).

First Operation. This patient underwent seizure surgery similar to that described in the patient in Case 1. During the first surgery, the previously created craniotomy was opened with extended margins. The dura mater was widely opened over the large cyst to fit large electrode arrays over the cortex anterior and posterior to the cyst. Two strip electrode arrays (2 × 8 electrodes in size with a length of 8 cm) were placed anteriorly and posteriorly within the cyst. After copious irrigation, the entire cavity was filled with rolls of gelatin foam dipped in saline to exert mild pressure to hold the grids in place. The craniotomy was then closed in the usual manner. The electrode position was confirmed on postoperative CT (Fig. 5). A single parietal focus was identified within the depths of the cyst on invasive EEG monitoring.

Second Operation. At the second surgery 9 days later, after bone flap removal and dural reopening, the gelatin foam “cigars” lying over the intracystic electrodes were removed. The electrode grids were then removed after markers were placed on the cortex in the depths of the cyst. A topectomy of the cortex surrounding the seizure focus on the anterior wall of the cyst was then performed in the standard fashion.
Discussion

Arachnoid cysts are fluid-filled lesions most commonly located within the cerebral fissures or on the cerebral convexities. They are thought to represent septations within the subarachnoid space that result from incomplete separation of perimedullary mesh. Most arachnoid cysts do not change over time; however, it is possible for the compartments to enlarge due to pressure, active CSF secretion by the cyst membrane, or by communication of the cyst with the CSF compartment via a ball-valve mechanism. Clinically, these lesions can become symptomatic in the first two decades of life. They have a slight male predominance. Presenting symptoms can include headaches, focal neurological signs, seizures, and signs of intracranial hypertension. Most arachnoid cysts are located within the temporal portion of the sylvian fissure, but they can occur in the suprasellar compartment, over the cerebral convexities, interhemispherically, or in the quadrigeminal cistern. One of the patients in the current report had presented with a large arachnoid cyst that dilated the left sylvian fissure to the point of compressing the frontal and temporal lobes. The second had presented with a postoperative cyst that was cortically lined after a previous surgery.

Subdural electrode arrays are used to conform to the surface anatomy of the brain, allowing anatomically defined contacts of the electrodes with the brain surfaces to localize seizure-generating cortex. The surgical procedure required for subdural electrode grid placement is usually straightforward when the grid is placed over the gently curved convex shape of the cerebral hemisphere. However, the complex curves of the infratemporal or medial temporal areas, the interhemispheric fissure, or a large arachnoid cyst represent significant challenges to the smooth recording of subdural EEG data. Surface recordings from the depths of an arachnoid cyst are generally not performed, and depth electrodes are sometimes used when it is anticipated that subdural electrodes alone will provide inadequate information for seizure foci localization.

Conclusions

In the cases in the present report, subdural electrode grids were placed inside the cavity of the large arachnoid cyst. After the grids were carefully laid in their intended positions, they were secured with gentle pressure exerted by gelatin foam rolls packed into the cyst. This construction of gelatin foam packing prevented inadvertent misplacement or removal of the electrodes for the duration of the invasive monitoring period and allowed removal of the electrodes after appropriate brain marking. Our experience in these cases demonstrated that this technique is one solution to the problem of the unorthodox surface topography in arachnoid cysts considered for subdural electrode array coverage for seizure localization.

Disclaimer

None of the authors has a financial interest in the devices used in this study.

References


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