

## Somatosensory and auditory brainstem evoked potentials during choroid plexus angioma removal

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### Abstract

Intraoperative combined SEP and BAEP monitoring provides a high level of safety for patients undergoing high risk intracranial surgical procedures. We performed this type of monitoring in a rare case of choroid plexus angioma, embedded into the pulvinar of the right thalamus, which was resected via a transcallosal approach. The SEP pattern deteriorated during parietal brain retraction and thalamic dissection, but never completely disappeared. The BAEP pattern remained unchanged during the entire operation. The patient suffered incomplete hemiparesis postoperatively, but recovered completely within 10 days. After this time the SEP pattern returned to normal. This case points out that pathological change of intraoperative SEP pattern without loss of components suggests an incomplete hemiparesis. There is, however, a good chance of full recovery in the early postoperative period.

**Keywords:** Arteriovenous malformations, auditory brainstem evoked potentials, choroid plexus angiomas, intraoperative monitoring, somatosensory evoked potentials.

### 1 Introduction

Intraventricular vascular disorders such as aneurysms [13] and arteriovenous malformations [17] occur only rarely. Only four of 500 patients in YASARGIL's series suffered from choroidal plexus AVM's [17].

The most frequent clinical symptoms of these deformations are sudden onset of severe headache, vomiting, and, sometimes, meningism and unconsciousness [15] similar to that caused

by subarachnoid hemorrhages [4]. CT shows intraventricular hemorrhage in most cases, according to the location of the lesion [3, 6, 12, 13, 15, 17].

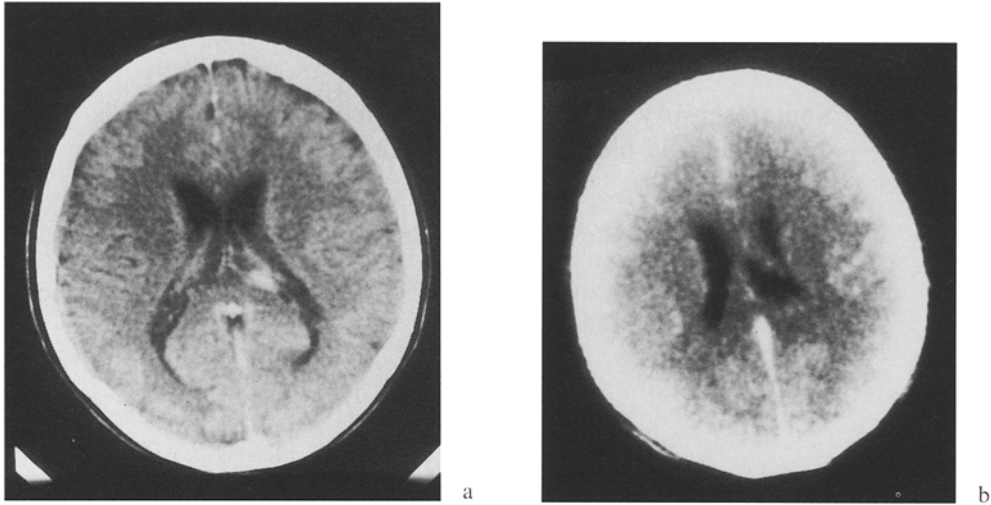
Supratentorial intraventricular lesions can be approached either transcortically or transcallosally. Cortical incisions can be made in the region of the middle temporal gyrus [6, 15] or at the parietal lobe near the midline [3, 4, 5]. Approach via partial temporal lobe resection [6] or resection of latero-basal parts of the temporo-occipital region [5] has also been described. YASARGIL prefers an approach through the surface of the precuneus [17]. A further possibility of approaching the lateral ventricle can be provided by transcallosal dissection [13].

Regardless of the surgical approach chosen, surgical treatment of intraventricular vascular disorders remains a sophisticated and dangerous procedure which involves highly vulnerable structures.

A case of small intraventricular AVM in the trigone is reported. In this case intraoperative monitoring by means of somatosensory (SEP) and auditory brainstem (BAEP) evoked potentials greatly reduced the risks of operation.

### 2 Case report and techniques

In the morning of June 13th, 1988, a 26-year-old pregnant woman suffered a severe attack of headache followed by vomiting. A few hours later somnolence developed and the patient was



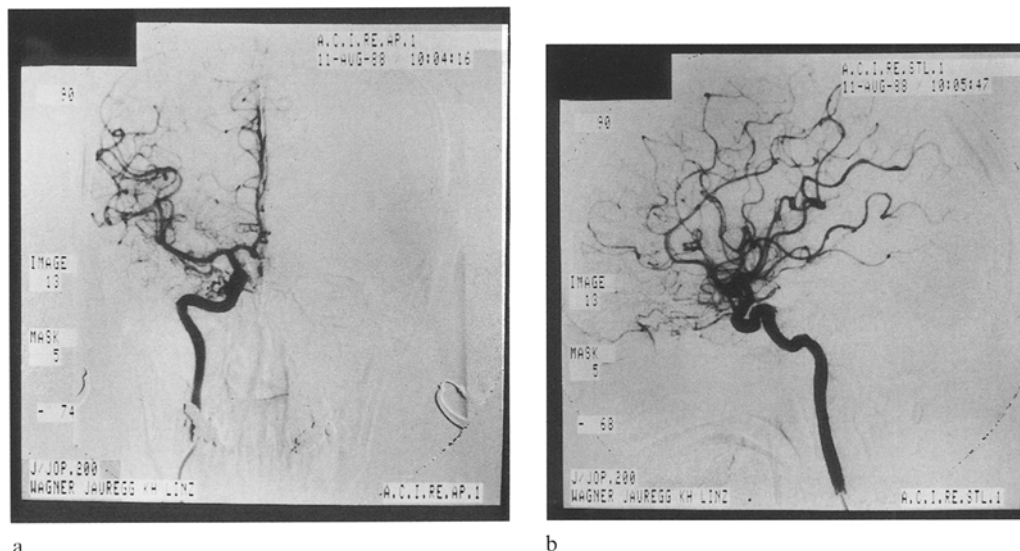
**Figure 1.** **a:** CT presents a small AVM in the right trigone, embedded into the pulvinar of the thalamus. **b:** Postoperative CT control: small hypodense area in the former AVM localization.



**Figure 2.** Preoperative angiography: small AVM in the right trigone fed by the medial posterior choroidal artery. The arrow indicates the AVM. **a:** ap angiogram. **b:** lateral angiogram.

admitted to a hospital. The patient was transferred to our department on the evening of June 13th, 1988, because of further clinical deterioration. Upon admission she showed signs of severely impaired consciousness, un-

directed reaction to pain stimulus, small pupils with reduced reaction to light, and a mild tendency to flexion position in the upper extremities. There were no signs of meningism or motor neurologic deficit. CT revealed a severe



**Figure 3.** Postoperative angiography: the AVM has been completely removed. **a:** ap angiogram. **b:** lateral angiogram.

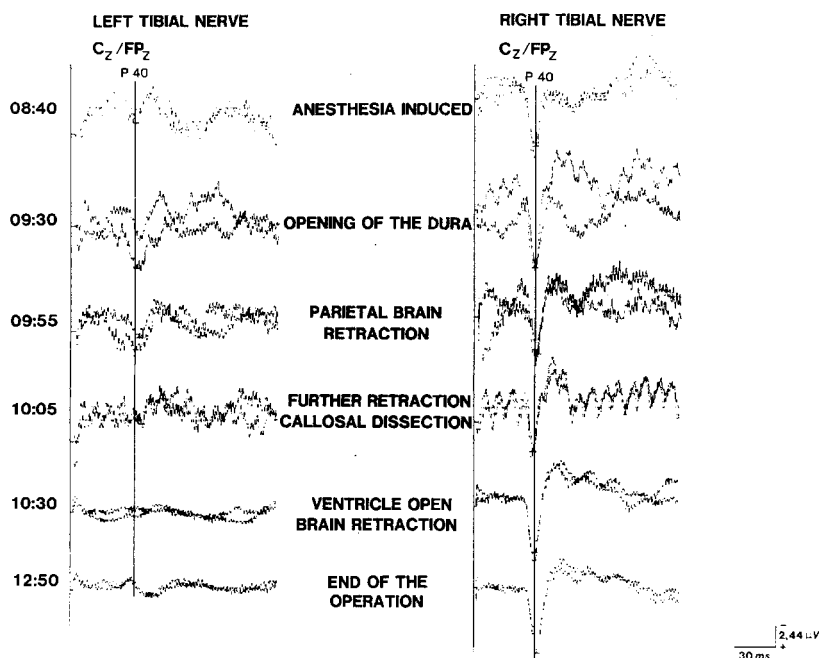
intraventricular hemorrhage with blood clots in all four ventricles and dilatation of the supratentorial ventricular system. Immediately after diagnosis a bilateral frontal burr hole was cut and ventricular drains were inserted on both sides. The patient was then transferred to the intensive care unit where pregnancy was interrupted on June 27. CT and angiography performed after absorption of blood showed a small intraventricular haemangioma on the right, which was embedded into the pulvinar of the thalamus (Figure 1a). The angioma was fed by the medial posterior choroidal artery (Figure 2). During the following weeks she recovered completely. On July 26, a right parietooccipital craniotomy was performed and the angioma was completely removed via a transcallosal approach (Figures 1b, 3).

## 2.1 Monitoring procedure and results

Cerebral function monitoring during the surgical procedure was carried out by SEP (median and tibial nerve stimulation) and BAEP recording. The median nerve was stimulated simultaneously on both sides. This was fol-

lowed by alternating stimulation of the right and left tibial nerves and alternating stimulation of the two ears. Electrodes for SEP recording were placed in a modified C3', C4', and Cz pattern [16]. BAEP recording electrodes were placed at A1 and A2. Reference electrodes were placed at FPz (SEP recordings) and Cz (BAEP recordings). Stimulation and recording procedures have been described in detail elsewhere [16]. The basic "circular" monitoring was adapted to the surgical situation and the structure involved. SEP recording in response to tibial nerve stimulation was performed mainly during dissection of cortical veins draining to the sinus sagittalis superior and during parietal brain retraction. The median nerve was usually stimulated during thalamic angioma dissection. A few BAEP recordings were also carried out during this stage of surgery.

The amplitude of tibial nerve SEP's was depressed to a greater degree in the right hemisphere than in the left, even after induction of anaesthesia. Parietal brain retraction and vein dissection led to a considerable increase of amplitude depression as well as prolongation of the latency of the P40 component (Figure 4).



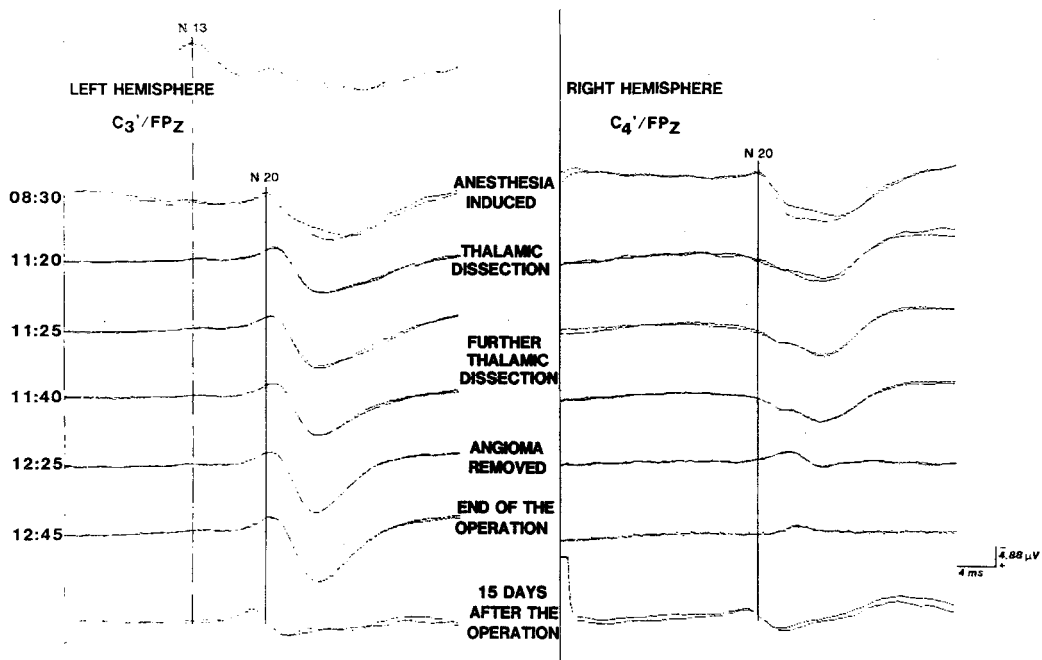
**Figure 4.** Intraoperative SEP response to tibial nerve stimulation. Parietal brain retraction causes amplitude depression and prolongation of latency of the P40 component over the right hemisphere. No recovery before the end of operation.

The thalamic dissection of the angioma was followed by a severe depression and prolongation of the latency of the cortical response elicited by median nerve stimulation over the right hemisphere (Figure 5). These SEP disturbances persisted even after the end of surgery. BAEP recording was disturbed by external artefacts, but potentials remained interpretable: they remained unchanged (Figure 6). At the end of the surgical procedure the tibial nerve SEP pattern showed remarkable amplitude depression and latency delay. The median nerve SEP pattern revealed both considerable latency delay and amplitude depression. The BAEP pattern remained unchanged and, although pathological changes in SEP pattern did occur, the evaluated components (P40, N20) were never lost throughout the entire procedure.

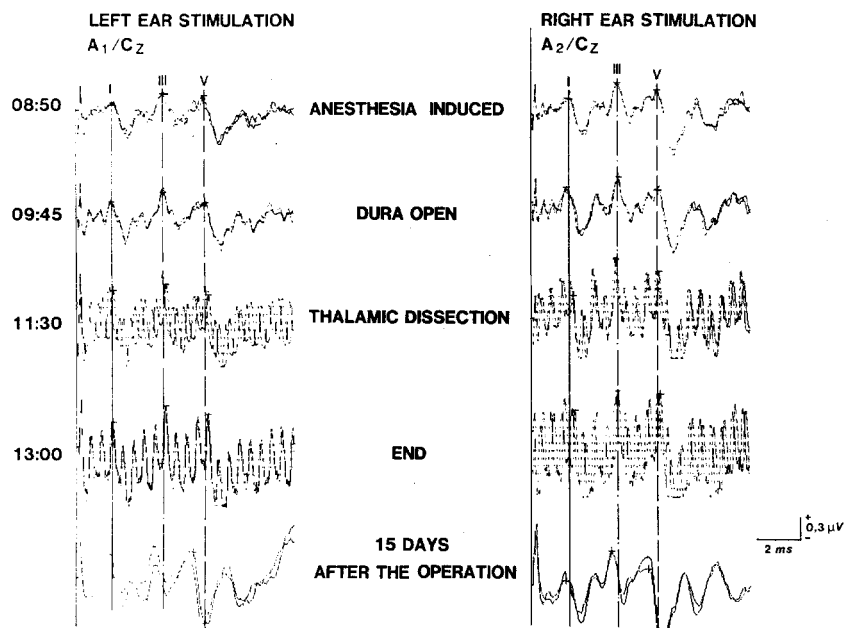
## 2.2 Postoperative course

The patient was kept under barbiturates for two days. After regaining consciousness she revealed considerable left hemiparesis but recovered completely within ten days. The patient was then able to support herself without aid and walk. By the 15th day after the operation the median nerve SEP pattern as well as the auditory evoked response had completely returned to normal (Figures 5, 6). At this point she began to suffer genuine peripheral facial nerve palsy. CT did not offer any explanation for this. She was transferred to a neurological unit for the medical as well as physical treatment of the VIIth nerve palsy, and recovered after three weeks of treatment.

**Figure 6.** Intraoperative brainstem auditory evoked potentials: traces are contaminated by artefacts from thalamic dissection until the end of operation. Components are, however, recognizable. No change throughout the entire operation.



**Figure 5.** Intraoperative SEP in response to median nerve stimulation. Thalamic dissection is followed by considerable depression and latency delay of the N20 component over the affected hemisphere. No recovery before the end of operation. Full recovery at the 15th day after operation.



### 3 Discussion

We chose the transcallosal approach because of the relatively short distance to the intraventricular space and the small risk of approach-related neurologic deficits [13].

SEP monitoring is now well established in aneurysm surgery [9–11, 14] and has been used increasingly often during intracranial tumor removal [1, 16]. BAEP monitoring has mainly been used during surgery for infratentorial lesions [8, 16]. There are only a small number of reports concerning the use of evoked potential monitoring in spinal [7] or intracranial [2] AVM resection in the literature.

As demonstrated previously [16], intraoperative loss of the SEP component N20 and BAEP components III and V before the end of operation indicates poor recovery in the postoperative period and a poor final outcome. The

attending surgeon should, therefore, promptly change his strategy or even interrupt surgery if loss of SEP and/or BAEP components occurs. The case discussed in this report demonstrates the significance of a combined SEP and BAEP monitoring during high risk operations. The SEP responses deteriorated during the operation, but were never lost. This bioelectrical phenomenon was reflected in postoperative incomplete hemiparesis which recovered within 10 days. This hemiparesis was probably partly due to the mechanical disturbance caused by thalamic AVM dissection, but mainly due to temporary change of the regional cerebral blood flow pattern. After clinical recovery the SEP pattern also reverted to normal.

In conclusion, this case stresses the usefulness and significance of multimodal intraoperative evoked potential monitoring for the prognosis of outcome of high risk surgical procedures.

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