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## Case study

## The pathogenesis of delayed epidural hematoma after posterior fossa surgery

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## ABSTRACT

The purpose of this study was to analyze the pathogenesis of delayed epidural hematoma (EDH) after posterior fossa surgery. Non-traumatic, non-arterial origin delayed EDH after posterior fossa surgery is extremely rare. Moreover, the pathogenesis of its supratentorial extension is obscure. Between April 1997 and June 2016, over 3300 patients underwent microvascular decompression (MVD) for neurovascular compression syndrome. The medical chart of four patients with delayed EDH were retrospectively reviewed. The median time from MVD to re-CT scan was 58 h (range, 33–100). All patients underwent hematoma evacuations. Intraoperative findings during hematoma evacuation revealed only an oozing hemorrhage from the transverse sinus with no definitive bleeding focus. The patients spent a median of 21.5 days (range, 11–39) at the hospital. At the last follow-up, all patients had fully recovered without significant neurological deficits and exhibited complete relief or minimal symptoms from hemifacial spasm (HFS). Postoperative uncontrolled bleeding from the dural venous sinus can sometimes cause an insidious-onset or delayed posterior fossa EDH.

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## 1. Introduction

Microvascular decompression (MVD) for neurovascular compression syndrome requires a retrosigmoid approach after lateral suboccipital craniectomy or craniotomy. During posterior fossa cranial opening, venous bleeding is often experienced, especially if an intracranial procedure requires exposure to the edges of the transverse or sigmoid sinus. Bleeding from a dural venous sinus tear can be massive, although an emissary vein tear more commonly occurs and can be managed properly without postoperative complications. However, postoperative uncontrolled bleeding from the dural venous sinus can sometimes cause an insidious-onset or delayed posterior fossa epidural hematoma (EDH).

The incidence of postoperative EDH is less than 2%, and the majority of cases are associated with post-traumatic head injury.

**Abbreviations:** MVD, microvascular decompression; EDH, epidural hematoma; ICU, intensive care unit; POD, postoperative day; CT, computed tomography; HFS, hemifacial spasm; TN, trigeminal neuralgia; BAEP, brainstem auditory evoked potential; CSF, cerebrospinal fluid; REZ, root exit zone.

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Most of these postoperative EDHs are in a supratentorial location and have an arterial origin [1–4]. Posterior fossa EDHs account for 0.3% of all head injuries and 10% of all EDHs [1]. Among all traumatic EDHs, only 9.7% are of non-arterial origin [5]. Likewise, reports on delayed-onset, non-traumatic, non-arterial origin, and postoperative posterior fossa EDHs are scarce, and, to the best of our knowledge, none have been identified after MVD surgery with relatively small cranial opening. Moreover, the mechanism of its supratentorial extension is obscure.

Although our institution has acceptable complication rates for over 3000 MVD experiences in the past 20 years, postoperative hematoma including EDH remains a possible complication [6]. Herein, we analyzed our experiences of non-traumatic, non-arterial origin delayed EDHs after a lateral suboccipital retrosigmoid approach for posterior fossa surgery, MVDs, proposed the pathogenesis of it.

## 2. Methods

Between April 1997 and June 2016, a total of 3316 patients underwent MVD for neurovascular syndrome, hemifacial spasm (HFS), or trigeminal neuralgia (TN) by a single neurosurgeon (KP). The medical charts for four patients with delayed EDH were

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retrospectively reviewed with approval from our Institutional Review Board (No. 2016-08-018). Past medical history such as coagulopathy, preoperative laboratory findings including blood coagulation tests, intraoperative findings, and postoperative outcomes were evaluated.

### 2.1. Operative procedure in common

All surgeries were performed with a lateral suboccipital craniectomy and retrosigmoid approach. Intraoperative facial electromyography and brainstem auditory evoked potential (BAEP) were closely monitored to assess the abnormal muscle response phenomenon in HFS and hearing loss in both HFS and TN.

The patient was placed in a park bench position with the head rotated approximately 10 degrees away from the affected site, and the vertex was dropped 15 degrees toward the floor to locate a mastoid tip on the top. An approximately 2–2.5 × 3 cm-sized craniectomy was performed medially to the edge of the sigmoid sinus. In a TN case, the edge of the transverse sinus was also exposed; this was not necessarily exposed in HFS cases. A curvilinear ear dural incision was made parallel to the sigmoid sinus, and cerebrospinal fluid (CSF) was drained at the cerebello-medullary cistern. After dissection of the arachnoid membrane of the cerebello-pontine cistern and retraction of the cerebellum, the root exit zone (REZ) of the facial nerve was observed. The offender was typically identified near the REZ. Teflon felt pieces were placed between the offender and the REZ. Fibrin sealant was applied to stabilize the Teflon felt. The dura was closed, cranioplasty using polymethyl methacrylate bone cement, and plate-screw fixation of the artificial bone flap to the surrounding skull were performed sequentially. Layer-by-layer scalp sutures were done without surgical drains.

### 2.2. Postoperative management

All patients were under ICU monitoring overnight after surgery and underwent computed tomography (CT) scans on postoperative day (POD) 1. A delayed EDH was defined as an EDH that developed more than 24 h after surgery. A wait-and-see strategy was applied to patients with a small amount of hematoma without neurological deficit. Otherwise, patients underwent revisional hematoma removal. Patients without complications were usually discharged on POD 5. Routine outpatient follow-up visits to the clinic were conducted at postoperative 3–4 weeks, 3 months, 6 months, 1 year, and annually thereafter.

## 3. Results

Among 3316 patients treated with MVDs, four (0.12%) (4 HFS) developed postoperative delayed EDHs. No distinctive past medical history including coagulopathy was revealed in the four patients. Preoperative blood coagulation profiles showed values within the normal range in all patients. Patient age ranged from 40 to 60 years, and all patients were female. Left side predominance (75%) was shown in the distribution of affected side. Intraoperative findings described in the operation records also revealed no special commentary for all cases except one case with BAEPs that were reduced to 10% of the preoperative BAEPs.

### 3.1. Delayed EDH after MVD

Four delayed EDHs were detected on CT scans performed due to the patients' neurological changes. These neurological changes included deterioration of mental status, severe dizziness, dysarthria, vomiting, and motor weakness. The median time from MVD to re-

CT scan was 58 h (range, 33–100). One case showed that the EDH was confined infratentorially, and three cases showed that the infratentorial EDHs extended supratentorially (Fig. 1). All four patients underwent revisional surgeries for hematoma evacuations. Intraoperative findings during hematoma evacuation showed that there was only an oozing hemorrhage from the transverse sinus, and no definitive bleeding focus was found. For the three cases in which infratentorial EDH extended supratentorially, various degrees of transverse sinus detachment from the cranium were detected.

### 3.2. Prognosis of patients with delayed EDH after MVD

The patients who suffered from delayed EDHs spent a median of 21.5 days (range, 11–39) at the hospital. At the last follow-up, all patients recovered fully without significant neurological deficits and exhibited complete relief or minimal symptoms from HFS during a median of 15.5 months (range, 8–25) of follow-up after MVD. No facial palsy was observed; however, hearing loss was noted in one patient whose BAEPs decreased to 10% of the amplitude of the baseline BAEP during MVD (Table 1).

## 4. Discussion

The goal of MVD operation is to free the vascular conflict from the cranial nerve while the surrounding neurovascular units are kept intact both anatomically and physiologically. Although MVD has relatively small posterior fossa opening, it has surgical risks related to the surgical approach, such as the retrosigmoid approach after lateral suboccipital craniectomy or craniotomy and the manipulation of the cranial nerves and vessels [6,7]. Despite the good cure rate and acceptable complication rates for over 3000 MVD experiences at our institution in the past 20 years, postoperative hematoma such as EDH continues to be a potential complication. Therefore, neurosurgeons should be careful when performing surgery and make every effort to know the pathogenesis, clinical course, and prevention of complications.

### 4.1. Delayed EDH after lateral suboccipital retrosigmoid approach for MVD

Most of the studies on postoperative posterior fossa EDHs have been conducted with traumatic cases. Posterior fossa EDHs account for 0.3% of all head injuries and 10% of all EDHs [1]. Only 9.7% of all traumatic EDHs were of non-arterial origin [5]. Postoperative posterior fossa EDH with a non-traumatic etiology has been scarcely reported. Sade et al. reported vascular complication rates after vestibular schwannoma surgery and found that, among five patients with postoperative EDHs, the origin was the muscle in two patients and the occipital artery in two patients, while no source was identified in one patient [8]. Tao et al. reported a case in which rebleeding from the end of the coagulated occipital artery caused posterior fossa EDH on the 5th postoperative day after infratentorial tumor surgery [2]. Prognosis was worse in cases where the origin of the EDH was non-arterial regardless of etiology. In particular, EDH originating from venous sinus bleeding raised mortality as high as 33.3–41%. The higher mortality in non-arterial EDH compared to arterial EDH has been attributed to an insidious accumulation of hematoma, late detection by the medical team, and an initial poor neurological status with a large amount of hematoma [4,9,10].

The postoperative EDHs in four patients that we experienced were delayed-onset, non-traumatic, non-arterial, and posterior fossa EDHs. The onset of EDH after MVD was delayed so that EDHs were identified at a median of 58 h (range, 33–100) after the sur-

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