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Clinical features and pathophysiological mechanism of the hemianoptic complication after the occipital transtentorial approach

Koji Yoshimoto[a,*], Yukie Araki[a], Toshiyuki Amano[a], Kenichi Matsumoto[b], Akira Nakamizo[a], Tomio Sasaki[a]

[a] Department of Neurosurgery, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan
[b] Department of Neurosurgery, Kyushu Central Hospital of the Mutual Aid Association of Public School Teachers, Fukuoka, Japan

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ABSTRACT

Objective: To obtain detailed insight into neuro-ophthalmological characteristics and pathophysiology of hemianoptic complications after occipital transtentorial surgery.
Methods: We reviewed the cases of 14 patients surgically treated by the occipital transtentorial approach. Treated lesions included 6 posterior third ventricle tumors, including pineal and tectal lesions, 3 falcotentorial meningiomas, and 5 superior cerebellar lesions. The surgeries were performed by the unilateral occipital transtentorial approach with patients in the prone position.
Results: Visual functions were preoperatively normal in all patients. After surgery, 11 patients (79%) showed hemianoptic complications detected by a confrontation test in the immediate postoperative period. The condition began to improve in the early postoperative days. The visual field recovered completely in 6 patients within 10 days, 2 patients recovered within 3 months, and 3 patients complained of permanent visual field defects. Optometric neuro-ophthalmic evaluation in the early postoperative period failed to detect complete homonymous hemianopsia, but homonymous inferior quadrantanopia and scotomatous defects were observed in 6 patients. These visual field defects were permanent in 3 patients. Postoperative MRI showed no morphological abnormality except these three patients. Atrophic change of the occipital lobe with preservation of striate cortex was associated with persistent visual field defects in two patients. Cerebral blood flow evaluation by single photon emission computed tomography suggested that temporary local hyperperfusion of the retracted occipital region when visual field defect was present.
Conclusion: Hemianoptic visual field defects can recover via inferior quadrantanopia or scotomatous defect. All of these defects are attributable to injury to the optic radiation as well to the occipital lobe. Hyperperfusion of the retracted occipital region may underlie the pathophysiology of hemianoptic complications after the occipital transtentorial approach.

1. Introduction

The occipital transtentorial approach (OTA) is a useful surgical approach for the treatment of tumors and vascular diseases of the posterior third ventricle [1–3]. Because the approach provides wide operative views of midline neurovascular structures, superior cerebellar regions can also be operated using this technique [4–7]. However, one of the major disadvantages is the occurrence of postoperative visual field defects due to damage to the occipital lobe, which can be caused by brain retraction injury during surgical procedures or by occlusion or injury of the internal occipital vein. Visual field defects, manifested as homonymous hemianopsia, usually resolve spontaneously within a few months after surgery, but permanent visual field defects have been reported in some cases [6,8,9]. Although several investigators have reported the incidence of hemianoptic complications, their frequency has likely been underestimated because of rapid resolution of the symptoms in the early postoperative period. In addition, the pathophysiology of this complication has not been completely investigated, and how this visual field defect improves is unknown. The aims of this study were to clarify clinical features of the visual field defect after OTA and to gain insight into the pathophysiology of this complication. To this end, we performed frequent neuro-ophthalmological evaluation of patients operated by OTA, and performed sequential cerebral blood flow assessment by single photon emission computed tomography (SPECT) as well as MRI.

* Corresponding author at: Department of Neurosurgery, Graduate School of Medical Sciences, Kyushu University, 3-1-1 Maidashi, Higashi-Ku, Fukuoka 812-8582, Japan. Tel.: +81 92 642 5524; fax: +81 92 642-5526.
E-mail address: kyoshimo@ns.med.kyushu-u.ac.jp (K. Yoshimoto).

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2. Patients and methods

2.1. Patient population

Between 2003 and 2012, 14 patients were operated by the OTA at our hospital and affiliated hospitals (Table 1). The patients comprised 5 males and 9 females, ranging in age from 21 to 71 years (median 54). Treated lesions included 3 falco-tentorial meningiomas, 1 tentorial meningioma, 1 tentorial hemangiopericytoma, 4 pineal tumors (papillary tumor of the pineal region, pineal parenchymal tumor, germinoma, pineal cyst), 1 tectal glioma, 1 cavernoma in the tectum, and 2 cerebellar tumors (metastatic tumor, hemangioblastoma) and 1 cerebellar arteriovenous malformation (AVM). Tumor size ranged from 15 to 45 mm. The nidus of the AVM, of which the feeder was the bilateral superior cerebellar artery and which drained into the Galenic system, was located on the superior cerebellum and exhibited Spetzler-Martin grade II. Clinical summaries of all cases are presented in Table 1.

2.2. Surgical treatment

Prior to craniotomy, ETV and biopsy was performed for 2 patients (cases 2 and 5) with hydrocephalus. Case 3 was a recurrent case and had been previously treated twice by endoscopic third ventriculostomy (ETV) and biopsy at 5 and 14 years before craniotomy. Although we do not routinely place spinal or ventricular drains when hydrocephalus is not present, spinal drainage was performed for 4 patients for the purpose of reducing brain retraction pressure during surgical extirpation (Table 1). For OTA, patients were placed in the prone position with the head turned toward the side of approach, which was decided by the location of the lesion. This positioning, like three-quarter positioning, confers less retraction pressure on the brain because the occipital lobe of the approached side falls away from the falx due to gravity. When occipital lobe retraction was required, a tapered brain spatula was placed on the medial surface of the occipital lobe. Intermittent and step-wise brain retraction was performed to get a wider view of the surgical field.

2.3. Magnetic resonance imaging (MRI) and single-photon emission computed tomography (SPECT) evaluation

All patients were evaluated by MRI before and after surgery. Most images were obtained using a 3.0-T MR imaging unit (Achieva Quasar Dual; Philips Medical Systems, Best, Netherlands), and some were obtained with a 1.5 T MR imaging unit (Magnetom Vision or Symphony units; Siemens, Erlangen, Germany). T2-weighted, fluid inversion recovery (FLAIR), and diffusion-weighted images were always included. After craniotomy, MRI examination was performed on the day following surgery, and again 1–3 months after surgery. After discharge, MRI examination was repeated every 6 months to a year as regular follow-up. Cerebral blood flow was evaluated by Technetium-99m-ethyl cysteinate dimer (ECD) SPECT in the most recent 4 cases. For 2 cases, SPECT images were obtained both on the day when the patient complained of visual field defect and when the symptoms improved completely. To assess cerebral blood flow in the occipital lobe, we placed regions of interest (ROIs) on the bilateral occipital lobe and frontal lobe as a control, and evaluated laterality.

2.4. Visual examination

Visual field was evaluated by ophthalmologists using the Goldman perimetry before and after surgery. Basically, postoperative visual field was evaluated in the early postoperative days, within 7 days if possible, followed by further sequential examination as needed. In the immediate postoperative evaluation, some patients were evaluated by a confrontation test only because these patients had not fully recovered to take ophthalmologic tests.

3. Results

3.1. Operative results

Gross total removal was achieved for 12 patients (Table 1). Partial removal of the tumor was performed for case 14 because of age and tight adherence to the venous drainage system, and only biopsy was performed for case 4 after intraoperative confirmation of diagnosis as germinoma. Operation time ranged from 4 to 13 h. Excluding visual function, preexisting symptoms improved after surgery in all patients, and there was no morbidity or mortality due to surgical manipulation.

3.2. Visual function and related neurocognitive function

Preoperatively, visual function was normal in all patients. Homonymous hemianopsia was detected in 11 patients by a confrontation test within 1 day following surgery (Table 2), whereas visual fields were normal immediately after surgery in 3 patients. We do not see any association between operation time and the occurrence of hemianopsia. Visual acuity was found to be normal. All patients complaining of homonymous hemianopsia began to show improvement in the early postoperative period. Resolution of the subjective symptoms began the day after surgery at the earliest, and less than 3 days for all. Goldman perimetry, which was performed during recovery on postoperative days 4–37, showed that 5 of 11 patients who complained of homonymous hemianopsia on the first postoperative day exhibited a normal visual field, whereas homonymous inferior quadrantanopia or homonymous scotomatous defect was noted in 6 patients. The visual field defects in these 6 patients were congruent in 3 and incongruent in 3 patients (Table 2). When visual field defects are identical in both eyes, visual field defects are said to be congruent; otherwise, they are defined as incongruent. Complete homonymous hemianopsia on Goldman perimetry was not noted in any patient. Regarding recovery time, 6 patients returned to normal visual field within 10 days, and 2 patients recovered normal visual field between 1 and 3 months. Three patients suffered from persistent visual field defect as complete inferior quadrantanopia, homonymous scotomatous defect, and incomplete inferior quadrantanopia, which were present at 1 year, 4.5 years, and 1.5 years after surgery on last follow-up examination (Fig. 1).

Upon postoperative examination of neurocognitive function, visual hallucination was clearly observed in 4 patients during the same period when the patients complained of hemianopsia (Table 2). Visual hallucinations were described as seeing various kinds of object in the area of the visual field defect. These hallucinations disappeared spontaneously as the visual field defect improved. In addition, 5 patients demonstrated signs of postoperative delirium. This symptom was characterized by a reduced awareness of the environment, a disturbance in attention, and cognitive impairment such as disorientation and temporary memory dysfunction. The patients expressed hyperactive, hypoactive, and mixed psychomotor behaviors. Three patients exhibited coexistence of visual hallucination and delirium state (Table 2).

3.3. MRI findings and cerebral blood flow assessment by SPECT

Postoperative MRI demonstrated morphological changes in 3 patients (cases 9, 11, and 14) with persistent hemianoptic complications (Fig. 2). Case 9 exhibited a small infarction in the occipital lobe, whereas cases 11 and 14 demonstrated atrophic changes.