

Retrosigmoid Approach in the Supine Position Using ORBEYE: A Consecutive Series of 14 Cases

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Abstract

One of the merits of recently introduced exoscopes, including ORBEYE, is that they are superior to a conventional microscope in terms of ergonomic features. Taking advantage of it, the retrosigmoid approach can be performed in the supine position using ORBEYE. We report a consecutive series of 14 operations through the retrosigmoid approach in the supine position using ORBEYE. Fourteen consecutive patients who underwent surgery through the retrosigmoid approach for cerebellopontine (CP) angle lesions in the supine position using ORBEYE were targeted, and surgical outcomes and complications were examined. We evaluated the posture of the operator and the surgical field during this approach compared with those using a conventional microscope. In all 14 cases, all operative procedures were accomplished only using the ORBEYE. There were no operative complications due to this approach. Using ORBEYE, even when the angle of the operative visual axis was horizontal, the operators could manipulate in a comfortable posture. They were not forced to be in an uncomfortable posture that extended their arms, as is often the case with a conventional microscope. Therefore, they could use shorter surgical instruments. As the cerebellum shifted downward with gravity even using slight retraction during this approach, the working space of the surgical field was easily secured. Through this approach, the operators can perform stable microsurgery of CP angle lesions in a comfortable posture. This approach can reduce the burden on the operator and the patient, leading to a refined surgical procedure.

Keywords: ORBEYE, exoscope, retrosigmoid approach, supine position, case report

Introduction

The usefulness of exoscopes, including ORBEYE (Olympus, Tokyo, Japan), which was recently introduced into neurosurgery, has been reported in several fields.^{1–4)} One of their merits is that they are superior to a conventional microscope in terms of ergonomic features. They do not limit the posture of the operator regardless of the angle of the operative visual axis, and we previously reported that ORBEYE facilitates ergonomic microsurgery with the angle of the operative visual axis approximately horizontal.⁵⁾ Taking advantage of it, the retrosigmoid approach can be

performed in the supine position using ORBEYE. We report a consecutive series of 14 operations through the retrosigmoid approach for cerebellopontine (CP) angle lesions in the supine position using ORBEYE.

Materials and Methods

Fourteen consecutive patients (two men and 12 women; age 40 to 76 years) who underwent surgery through the retrosigmoid approach for CP angle lesions in the supine position using ORBEYE between December 2018 and March 2020 were targeted, and surgical outcomes and complications were examined retrospectively. They consisted of five cases of meningioma, four cases of acoustic neurinoma, three cases of hemifacial spasm, and two cases of trigeminal neuralgia (Table 1). We defined the operative position in which the backs of both shoulders were

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Table 1 Characteristics of patients who underwent surgery via the retrosigmoid approach using ORBEYE

Case	Age (y.o.)	Sex	Diagnosis	Laterality	Size (mm)	Remarks	Complication
1	51	Male	Petrous meningioma	Right	29 × 30 × 39	Simpson grade III, partial (87%) removal	(-)
2	71	Male	Schwannoma (CN VIII)	Left	28 × 33 × 28	Subtotal (99%) removal	(-)
3	63	Female	Tentorial meningioma	Right	14 × 24 × 20	Simpson grade II, total (100%) removal	(-)
4	44	Female	Trigeminal neuralgia	Right	N/A	Complete transposition of SCA	(-)
5	75	Female	Petrous meningioma	Left	15 × 35 × 40	Simpson grade III, subtotal (98%) removal	(-)
6	76	Female	Petrous meningioma	Left	19 × 39 × 32	Simpson grade II, total (100%) removal	(-)
7	70	Female	Schwannoma (CN VIII)	Left	40 × 43 × 40	Subtotal (99%) removal	(-)
8	50	Female	Schwannoma (CN VIII)	Right	16 × 18 × 24	Subtotal (99%) removal	(-)
9	74	Female	Hemifacial spasm	Left	N/A	Complete transposition of AICA	(-)
10	66	Female	Hemifacial spasm	Right	N/A	Complete transposition of AICA	(-)
11	70	Female	Trigeminal neuralgia	Left	N/A	Complete transposition of SCA	(-)
12	69	Female	Hemifacial spasm	Right	N/A	Complete transposition of AICA	(-)
13	67	Female	Schwannoma (CN VIII)	Left	27 × 32 × 34	Subtotal (95%) removal	(-)
14	40	Female	Petrous meningioma	Left	15 × 22 × 24	Simpson grade II, total (100%) removal	(-)

All procedures were completed only using ORBEYE. The outcomes were acceptable without complications. AICA: anterior inferior cerebellar artery, CN: cranial nerve, N/A: not applicable, SCA: superior cerebellar artery, y.o.: year old.

touching the operating table as the “supine position.” We evaluated the posture of the operator and the surgical field during this approach compared with those using a conventional microscope. This study was carried out in accordance with the recommendations of institutional review board with written informed consent from all subjects.

Operative procedures

After general anesthesia, the head of the patient was fixed at four points using the Sugita multipurpose head frame. With the patient in a supine position, a shoulder pillow was inserted on the affected side and the patient’s neck was sufficiently rotated toward the contralateral side (Fig. 1A). After raising the upper body 15 degrees, the head position was fixed with the vertex slightly up (Fig. 1B). The body of ORBEYE was placed facing the surgeon. Guiding the arm of ORBEYE beyond the patient’s body, the scope was placed around the operative field. The

monitor was placed beyond the patient’s head facing the surgeon (Fig. 1C and 1D). After making a linear skin incision, an approximately 3.5-cm craniotomy was created. The bone flap was fixed using a burr hole plate after the intradural microsurgical procedure using ORBEYE.

Results

In all 14 cases, we accomplished all operative procedures only using ORBEYE. In addition, surgical outcomes were acceptable, and there were no operative complications due to this approach (Table 1). Using ORBEYE, even when the angle of the operative visual axis was approximately horizontal, the operators were able to manipulate in a comfortable posture (Fig. 1E). They did not have to insert surgical instruments over the shoulder of the patient (Fig. 1C, 1D, and 1E), and they were not forced to be in an uncomfortable posture that extended their arms, as is often

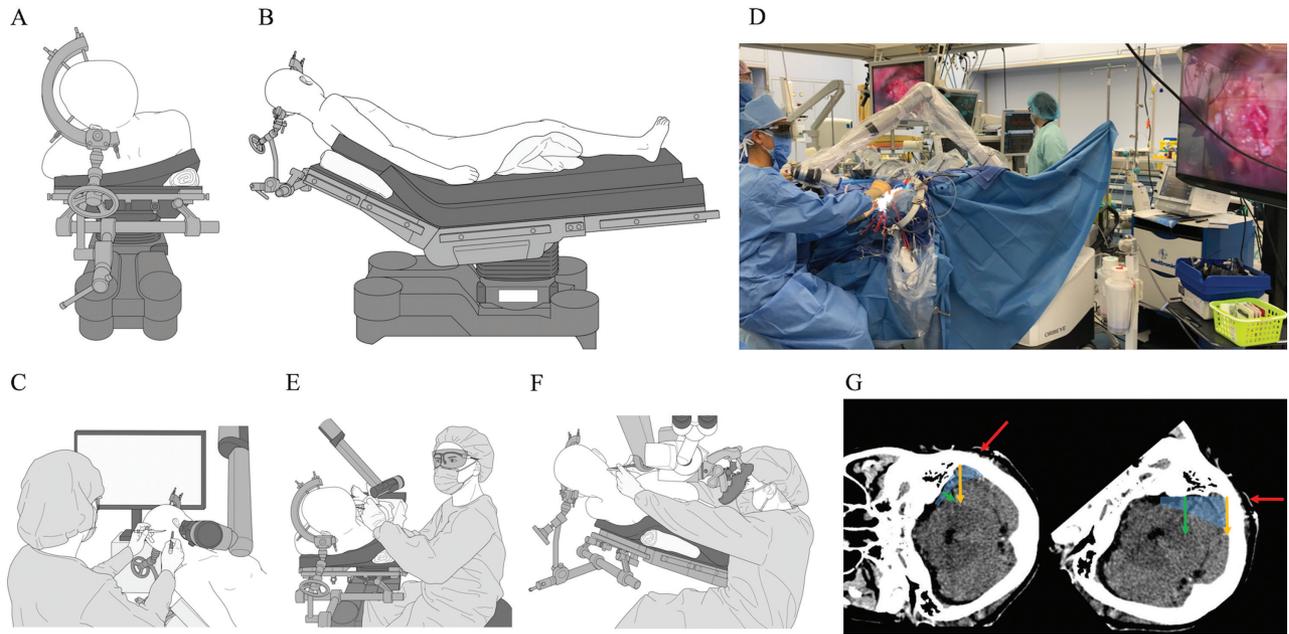


Fig. 1 Concept and overview of ORBEYE setup. (A) Overhead view of the surgical position: The neck is sufficiently rotated toward the contralateral side. (B) Lateral view of the surgical position. The vertex is slightly up after raising the upper body 15 degrees. (C) The operator can perform stable microsurgery in a comfortable posture looking at the monitor without interference by patient's shoulder. (D) Whole view of the operative set-up: the body of ORBEYE is placed facing the surgeon. Guiding the arm of ORBEYE beyond the patient's body, the scope is placed around the operative field. The monitor is placed beyond the patient's head facing the surgeon. (E) Overhead view of the operative set-up: the operator can sit near the surgical field in a comfortable posture using shorter surgical instruments. (F) When performing the retrosigmoid approach using a microscope in a supine position, the operator is forced to be in an uncomfortable posture that extends their arms and the patient's shoulder interferes. (G) The schema of the cerebellum shifting downward with gravity (left: lateral position, right: supine position). As the petrosal surface of the cerebellum is nearly horizontal in the supine position, the vector to open the CP angle by its own weight with gravity is larger than in the lateral position. Red arrows: the operative visual axis. Orange arrows: the vector of gravity. Green arrows: the vector to open the CP angle by gravity. Blue regions: the working space in the CP angle. CP: cerebellopontine.

the case using a conventional microscope (Fig. 1F). Therefore, they were able to use shorter surgical instruments (Fig. 1C, 1D, and 1E). As the cerebellum often shifted downward with gravity even using slight retraction during this approach, the working space of the surgical field was easily secured (Fig. 1G).

Representative case

Case 7

A 70-year-old female with acoustic neurinoma who developed gait disorder was referred to our hospital. The patient was deaf and had partial facial paralysis. Contrast-enhanced MRI demonstrated a $4.0 \times 4.3 \times 4.0$ -cm tumor from the left ear canal to the CP angle (Fig. 2A). Cystic degeneration was marked, and septum-like and nodular contrast effects were observed. Constructive interference in steady state (CISS) revealed that the tumor compressed lower cranial nerves near the jugular foramen. After general

anesthesia, the neck of the patient was rotated 60 degrees toward the right side with a shoulder pillow in a supine position (Fig. 2B). After raising the upper body 15 degrees, the head position was fixed with the vertex slightly up using a Sugita multi-purpose head frame (Fig. 2C). After an 8-cm linear skin incision was made, subperiosteal dissections were performed using an electric knife. A 3.5×5.5 -cm diameter craniotomy was created along the transverse sinus and sigmoid sinus. The dura was cut in a curve and turned to the medial direction. After entering the lateral cerebellomedullary cistern at a looking-up angle, the cerebellum was relaxed by drainage of spinal fluid. Gravity was also helpful to open the CP angle because the cerebellum and brain stem shifted downward.

First, after detaching the lower cranial nerves adhering to the tumor, we reached the inner ear canal and decompressed the tumor under facial nerve monitoring using the NIM-eclipse system

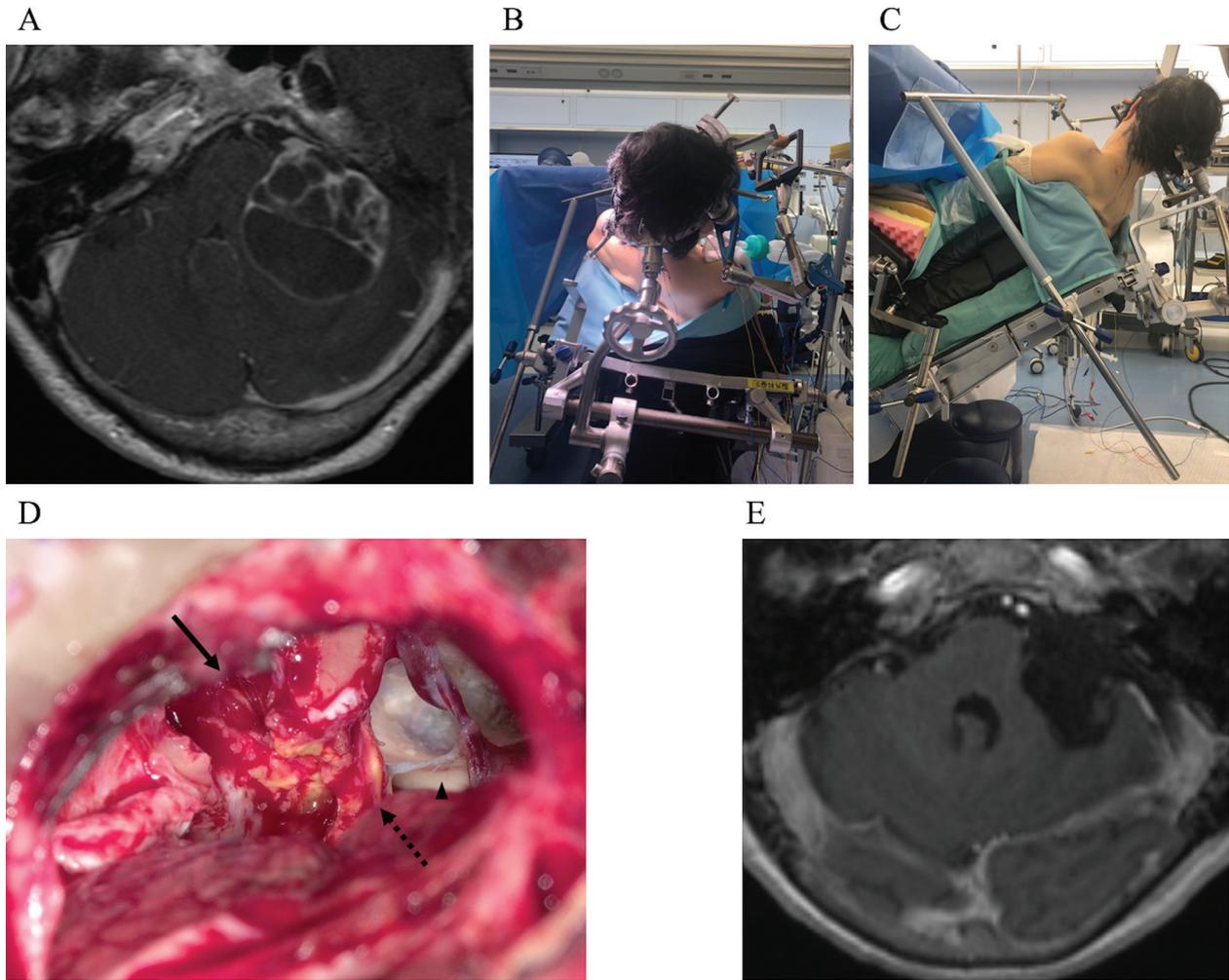


Fig. 2 Illustrations of case 7 (left acoustic neurinoma). (A) Contrast-enhanced MRI shows an acoustic neurinoma from the left ear canal to the CP angle compressing lower cranial nerves downward. (B) Overhead view of the surgical position: The neck is rotated 60 degrees toward the right side with a shoulder pillow in a supine position. (C) Lateral view of the surgical position: after raising the upper body 15 degrees, the head position is fixed with the vertex slightly up using a head frame. (D) Intraoperative findings using ORBEYE. Subtotal removal of acoustic neurinoma is achieved without facial nerve injury. The working space of the CP angle is well secured. Arrow: opened inner ear canal. Dashed arrow: acoustic neurinoma attached to the facial nerve. Arrow head: trigeminal nerve. (E) Contrast-enhanced MRI shows subtotal removal of the acoustic neurinoma. CP: cerebellopontine.

(Medtronic, Minneapolis, MN, USA). The facial nerve was compressed toward the ventral side. Next, the inner ear canal was released by 10-mm-long bone drilling. Intraoperative bleeding was well controlled in general. The operator was able to maintain a comfortable posture sitting beside the surgical field using short instruments (18-cm straight-type bipolar and shorter instruments) by inserting them from the bottom of the operative field even when the angle of the operative visual axis was set approximately horizontal (Fig. 1D).

Subtotal removal (99%) was achieved except for adhesion to the facial nerve (Fig. 2D and 2E). After hemostasis, watertight suturing of the dura was

performed. The bone window was repaired using a mesh-type titanium plate, and the scalp was sutured. After the operation, the patient's gait improved without exacerbation of existing facial paralysis.

Case 9

A 74-year-old female was referred to our hospital for left hemifacial spasm. CISS revealed that the root exit zone (REZ) of the facial nerve was compressed by the anterior inferior cerebellar artery (AICA). As the symptoms were refractory to internal medicine, she underwent microvascular decompression. After general anesthesia, the neck of the patient was rotated 60 degrees toward the right side with a

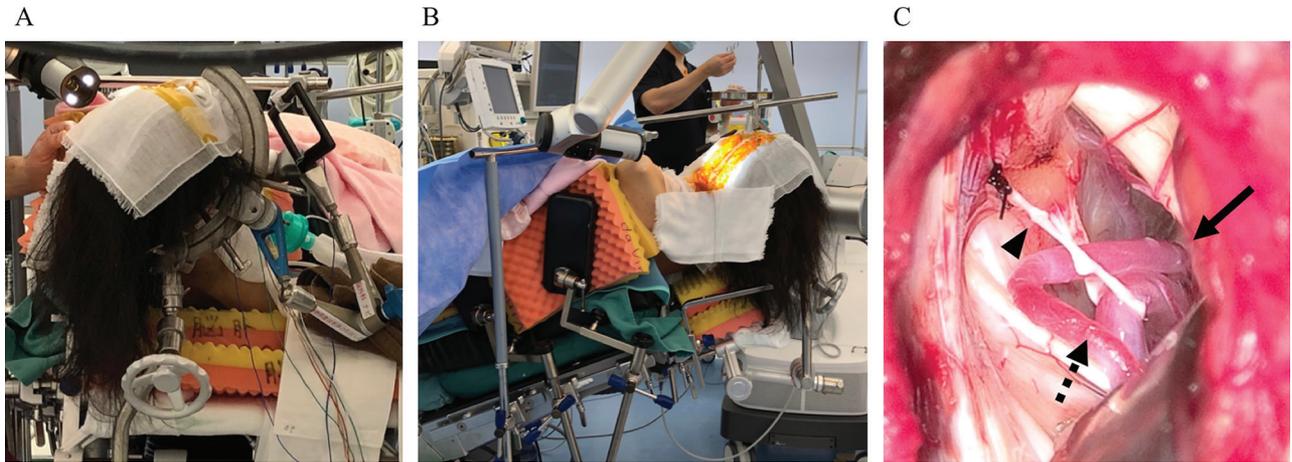


Fig. 3 Illustrations of case 9 (left hemifacial spasm). (A) Overhead view of the surgical position: the neck is rotated 60 degrees toward the right side with a shoulder pillow in a supine position. (B) Lateral view of the surgical position: After raising the upper body 15 degrees, the head position is fixed with the vertex slightly up using a head frame. (C) Intraoperative findings using ORBEYE. The REZ of the facial nerve is completely decompressed by the “sling swing transposition” technique. The working space of the CP angle is well secured. Arrow: REZ of the facial nerve. Dashed arrow: AICA. Arrow head: periosteum of petrous bone. AICA: anterior inferior cerebellar artery, CP: cerebellopontine, REZ: root exit zone.

shoulder pillow in a supine position (Fig. 3A). After raising the upper body 15 degrees, the head position was fixed with the vertex slightly up using a Sugita multipurpose head frame (Fig. 3B). After a 5.5-cm linear skin incision was made, subperiosteal dissections were performed using an electric knife. Making a burr hole, a 2.5-cm diameter craniotomy was created along the sigmoid sinus edge. The dura was cut linearly along the sinus. After entering the lateral cerebellomedullary cistern at a looking-up angle, the cerebrospinal fluid was released, and the subarachnoid between the auditory nerve and the lower cranial nerves was separated. The cerebellar medullary area was sufficiently exposed with a slight retraction of the cerebellum because the cerebellum and brain stem shifted downward by gravity. Gently retracting the flocculus cerebelli upward, facial nerve REZ and the AICA compressing REZ upward from below were exposed. The REZ of the facial nerve was completely decompressed by a “sling swing transposition” technique (Fig. 3C).⁶⁾ The operator was able to manipulate in a comfortable posture sitting beside the surgical field using short instruments (18-cm straight-type bipolar and shorter instruments) even while keeping the angle of the operative visual axis approximately horizontal. After hemostasis, watertight suturing of the dura was performed. The bone window was repaired using a titanium plate, and the scalp was sutured. Immediately after the operation, the patient’s symptoms disappeared.

Discussion

This is the first report of the feasibility of the retrosigmoid approach in a supine position using an exoscope. A retrosigmoid approach is the conventional approach for treating CP angle lesions, e.g., acoustic neuroma, meningioma, epidermoid, hemifacial spasm, trigeminal neuralgia, and intrinsic brain stem tumors.^{6–17)} Since Rand and Kurze introduced the microscope to remove acoustic neurinoma in 1957, the retrosigmoid approach has been used mainly using a microscope.¹⁸⁾ When using a microscope, the retrosigmoid approach is generally performed in lateral, lateral oblique, sitting, semi-sitting, supine, or park bench positions.^{10,19–23)}

The advantages of the supine position when using the retrosigmoid approach were previously reported. Set-up of the supine position can reduce the burden on medical staff compared with other surgical positions.^{20,21)} The physical load during surgery on the patient is also reduced because there is less stress on ventilation and venous return obstruction is less likely than in other surgical positions.^{20,21)} In addition, the risk of air embolism is lower than in the semi-sitting position,^{20,21,23–25)} and complications, such as pressure sores and brachial plexus injury, related to other surgical positions can be avoided.^{20,21)} Furthermore, injury to the cerebellum due to surgical retraction can be reduced. As the petrosal surface of the cerebellum is nearly horizontal in the supine position, the vector to open the CP angle by its

own weight with gravity is larger than in the lateral position (Fig. 1G).²¹⁾ Moreover, swelling of the cerebellum is unlikely in the supine position because of good venous return.^{20,21)} As a result, it is possible to develop the surgical field of the CP angle with a slight retraction of the cerebellum.

Recently, the exoscope has been proposed as an alternative to the microscope in the field of neurosurgery.^{1–5,26–32)} One of the merits of exoscopes, including ORBEYE, is that they are superior to microscopes in terms of ergonomic features. The advantage of our method mainly depends on the excellence of the ergonomic operability. One important merit of ORBEYE is that we can perform stable microsurgery in a comfortable posture regardless of the angle of the operative visual axis (Fig. 1D and 1E).⁵⁾ This advantage is especially useful for approaching surgical fields under the eaves like the anterior cranial fossa. It is not necessary for the operator to sit along the visual axis of the exoscope (Fig. 1C).^{2,27)} The operator can use short surgical instruments sitting nearby the operative field throughout the surgery (Fig. 1C, 1D, and 1E). When using a conventional surgical microscope in the same supine position, we set the angle of the operative visual axis approximately horizontal and the distance from the eyepiece to objective lens was maximized. As a result, the distance from our eyes to the operative field was also maximized and we were forced to be in an uncomfortable posture that extended our arms (Fig. 1F).⁵⁾ In addition, in contrast to using a microscope, the patient's shoulder did not interfere with the operator's movements during the procedure (Fig. 1C).²⁰⁾ In the cases of acoustic neuroma reported in this study, it was possible to detach the tumor from the facial nerve with the high magnification using ORBEYE's digital zoom. If there is a blind space even if the opening of inner canal is enlarged, the endoscope is useful, and the field of view can be reflected on the ORBEYE monitor as a picture in picture. There are some problems compared to the conventional surgical microscope. First, the cooperation with other modalities such as navigation system is immature. Second, although the function of digital zoom is useful, there is still room for improvement in contrast at the high magnification. Third, the visibility of the monitor depends on the operator's eyesight compared to the conventional microscope that can be adjusted with the eyepiece. Finally, a mobile monitor is necessary because the monitor needs to face the surgeon from an appropriate distance. As a point to note in the initial experience, it is necessary to become accustomed to the dissociation from the empirical intuition caused by the difference between the visual axis of the scope and that of the operator and to become familiar with

using the scope. In our intuition, the residents are trained in suturing exercises using a webcam. In the future, we can expect the sharpening of the contrast by improving the color adjustment ability and resolution and the realization of cooperation with other modalities such as the navigation system. If these problems are solved, ORBEYE will be functionally equivalent to the microscope, and ORBEYE will become widespread as the cost decreases. At that time, it is expected that the positioning using ORBEYE will be different from the conventional one.

Conclusions

Through this method, operators can perform stable microsurgery in a comfortable posture regardless of the angle of the operative visual axis, without being obstructed by the shoulder of the patient. This approach can reduce the burden on the operator and patients, leading to a stable surgical procedure.

Contribution

Dr. Toyota, Dr. Taki, and Dr. Shimizu contributed to the conception and design of the study. Dr. Toyota, Dr. Nakagawa, Dr. Murakami, Dr. Mori, Dr. Taki, and Dr. Shimizu recruited the patients and performed retrosigmoid approach using ORBEYE. Dr. Toyota, Dr. Kishima, Dr. Taki, and Dr. Shimizu contributed to writing and revising the manuscript.

Conflicts of Interest Disclosure

None of the authors have any conflicts of interest to disclose.

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