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
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

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 x 30 x 39 | Simpson grade III, partial (87%) removal | (–) |
| 2    | 71         | Male   | Schwannoma (CN VIII) | Left      | 28 x 33 x 28 | Subtotal (99%) removal | (–) |
| 3    | 63         | Female | Tentorial meningioma | Right     | 14 x 24 x 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 x 35 x 40 | Simpson grade III, subtotal (98%) removal | (–) |
| 6    | 76         | Female | Petrous meningioma | Left      | 19 x 39 x 32 | Simpson grade II, total (100%) removal | (–) |
| 7    | 70         | Female | Schwannoma (CN VIII) | Left      | 40 x 43 x 40 | Subtotal (99%) removal | (–) |
| 8    | 50         | Female | Schwannoma (CN VIII) | Right     | 16 x 18 x 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 x 32 x 34 | Subtotal (95%) removal | (–) |
| 14   | 40         | Female | Petrous meningioma | Left      | 15 x 22 x 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.
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 × 4.3 × 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 multipurpose 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.
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 shoulder pillow in a supine position. The neck is rotated 60 degrees toward the right side with a shoulder pillow in a supine position. After the operation, the patient’s gait improved without exacerbation of existing facial paralysis.

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.
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). 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. Since Rand and Kurze introduced the microscope to remove acoustic neurinoma in 1957, the retrosigmoid approach has been used mainly using a microscope. When using a microscope, the retrosigmoid approach is generally performed in lateral, lateral oblique, sitting, semi-sitting, supine, or park bench positions.

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. 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. In addition, the risk of air embolism is lower than in the semi-sitting position, and complications, such as pressure sores and brachial plexus injury, related to other surgical positions can be avoided. 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). Moreover, swelling of the cerebellum is unlikely in the supine position because of good venous return. 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. 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 excellency 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). 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). 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). 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). In 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.

References

1) Takahashi S, Toda M, Nishimoto M, et al.: Pros and cons of using ORBEYTE™ for microneurosurgery. Clin Neurol Neurosurg 174: 57–62, 2018
2) Izumo T, Ujifuku K, Baba S, Morofuji Y, Horie N, Matsuo T: Initial Experience of ORBEYETM surgical microscope for carotid endarterectomy. Asian J Neurosurg 14: 839–842, 2019
3) Langer DJ, White TG, Schulder M, Bookvar JA, Labib M, Lawton MT: Advances in intraoperative optics: a brief review of current exoscope platforms. Oper Neurosurg (Hagerstown) 19: 84–93, 2020
4) Murai Y, Sato S, Yui K, et al.: Preliminary clinical microneurosurgical experience with the 4K3-dimensional microvideoscope (ORBEYE) system for microneurological surgery: observation study. Oper Neurosurg (Hagerstown) 16: 707–716, 2019
5) Iwata T, Toyota S, Kudo A, et al.: Microsurgery “under the eaves” using ORBEYE: a case of dural arteriovenous
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fistula of the anterior cranial fossa. World Neurosurg 138: 178–181, 2020

6) Khoo HM, Yoshimine T, Taki T: A “sling swing transposition” technique with pedicled dural flap for microvascular decompression in hemifacial spasm. Neurosurgery 71: 25–30; discussion 30–31, 2012

7) Sade B, Lee JH: Significance of the tentorial alignment in approaching the trigeminal nerve and the ventral petrous region through the suboccipital retrosigmoid technique. J Neurosurg 107: 932–936, 2007

8) Samii M, Mattheis C: Management of 1000 vestibular schwannomas (acoustic neuromas): surgical management and results with an emphasis on complications and how to avoid them. Neurosurgery 40: 11–21, 1997

9) Sampath P, Rini D, Long DM: Microanatomical variations in the cerebellopontine angle associated with vestibular schwannomas (acoustic neuromas): a retrospective study of 1006 consecutive cases. J Neurosurg 92: 70–78, 2000

10) Malis LI: Nuances in acoustic neuroma surgery. Neurosurgery 49: 337–341, 2001

11) Samii M, Gerganov V, Samii A: Hearing preservation after complete microsurgical removal in vestibular schwannomas. Prog Neuropath Surg 21: 136–141, 2008

12) Nakamizo A, Mori M, Inoue D, et al.: Long-term hearing outcome after retrosigmoidal removal of vestibular schwannoma. Neurol Med Chir (Tokyo) 53: 688–694, 2013

13) Lee B, Marquez YD, Giannotta SL: Resection of a cystic brainstem hemangioblastoma via a retrosigmoidal approach. Neurosurgery Focus 36: 1, 2014

14) Amin AG, Wainwright JV, Gandhi CD, Bowers CA: Retrosigmoid craniectomy for resection of epidermoid causing trigeminal neuralgia. J Neurol Surg B Skull Base 80: S320–S321, 2019

15) Farhoud A, Khedr W, Aboul-Enein H: Surgical resection of cerebellopontine epidermoid cysts: limitations and outcome. J Neurol Surg B Skull Base 79: 167–172, 2018

16) Bricolo AP, Turazzi S, Talacchi A, Cristofori L: Microsurgical removal of petroclival meningiomas: a report of 33 patients. Neurosurgery 31: 813–828; discussion 828, 1992

17) Barker FG, 2nd, Jannetta PJ, Bissonette DJ, Larkins MV, Jho HD: The long-term outcome of microvascular decompression for trigeminal neuralgia. N Engl J Med 334: 1077–1083, 1996

18) Rand RW, Kurze T: Preservation of vestibular, cochlear, and facial nerves during microsurgical removal of acoustic tumors. Report of two cases. J Neurol Surg 28: 158–161, 1968

19) Yamaokami I, Uchino Y, Kobayashi E, Yamaura A, Oka N: Removal of large acoustic neuromas (vestibular schwannomas) by the retrosigmoid approach with no mortality and minimal morbidity. J Neurol Neurosurg Psychiatry 75: 453–458, 2004

20) Velho V, Naik H, Bhide A, Bhople L, Gade P: Lateral semi-sitting position: a novel method of patient’s head positioning in suboccipital retrosigmoid approaches. Asian J Neurosurg 14: 82–86, 2019

21) Wait SD, Gazzieri R, Galarza M, Teo C: Simple, effective, supine positioning for the retrosigmoid approach. Minim Invasive Neurosurg 54: 196–198, 2011

22) Elmaraezy A, Ebraheem Morra M, Tarek Mohammed A, et al.: Risk of cataract among interventional cardiologists and catheterization lab staff: a systematic review and meta-analysis. Catheter Cardiovasc Interv 90: 1–9, 2017

23) Scheller C, Ramp S, Tatagiba M, et al.: A critical comparison between the semisitting and the supine positioning in vestibular schwannoma surgery: subgroup analysis of a randomized, multicenter trial. J Neurosurg doi: 10.3171/2019.1.JNS181784 Epub 2019 May 3

24) Duke DA, Lynch JJ, Harner SG, Faust RJ, Ebersold MJ: Venous air embolism in sitting and supine patients undergoing vestibular schwannoma resection. Neurosurgery 42: 1282–1286; discussion 1286–1287, 1998

25) Zeilstra DJ, Groen RA: Venous air embolism in sitting and supine patients undergoing vestibular schwannoma resection. Neurosurgery 44: 426, 1999

26) Krishnan KG, Schöller K, Uhl E: Application of a compact high-definition exoscope for illumination and magnification in high-precision surgical procedures. World Neurosurg 97: 652–660, 2017

27) Moisi MD, Hoang K, Tuhbs RS, et al.: Advancement of surgical visualization methods: comparison study between traditional microscopic surgery and a novel robotic optoelectronic visualization tool for spinal surgery. World Neurosurg 98: 273–277, 2017

28) Nishiyama K: From exoscope into the next generation. J Korean Neurosurg Soc 60: 289–293, 2017

29) Beez T, Munoz-Bendix C, Beseoglu K, Steiger HJ, Ahmadi SA: First clinical applications of a high-definition three-dimensional exoscope in pediatric neurosurgery. Cureus 10: e2108, 2018

30) Ahmad FI, Mericli AF, DeFazio MV, et al: Application of the ORBEYE three-dimensional exoscope for microsurgical procedures. Microsurgery 40: 468–472, 2019

31) Muhammad S, Lehecka M, Niemelä M: Preliminary experience with a digital robotic exoscope in cranial and spinal surgery: a review of the Synaptive Modus V system. Acta Neurochir (Wien) 161: 2175–2180, 2019

32) Baksheshian J, Strickland BA, Jackson C: Multicenter investigation of channel-based subcortical trans-sulcal exoscopic resection of metastatic brain tumors: a retrospective case series. Oper Neurosurg (Hagerstown) 16: 159–166, 2019

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