



Case Report

Midline suboccipital approach to a vertebral artery–posterior inferior cerebellar artery aneurysm from the rostral end of the patient using ORBEYE

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Received : 29 December 2021

Accepted : 11 February 2022

Published : 11 March 2022

DOI

10.25259/SNI_1272_2021

Quick Response Code:



ABSTRACT

Background: The midline suboccipital approach with the patient in the prone position is safe and effective for clipping vertebral artery–posterior inferior cerebellar artery (VA–PICA) aneurysms. Using a conventional surgical microscope from the rostral end of the patient for this approach without an extreme head-down position requires the surgeon to overhang the visual axis of the microscope and perform surgical manipulations in an uncomfortable posture. We report performing the midline suboccipital approach from the rostral end with slight head-down position using ORBEYE, a new high-definition (4K) three-dimensional exoscope.

Case Description: A 65-year-old woman was admitted for clipping of a right unruptured VA–PICA aneurysm (maximum diameter, 5mm) located medially and ventral to the hypoglossal canal. After induction of general anesthesia, the patient was placed in the prone position with the head tilted slightly downward. A midline suboccipital approach was performed from the rostral end of the patient using ORBEYE. Clipping was safely accomplished in a comfortable posture. No operative complications occurred. Postoperative computed tomography angiography showed complete aneurysmal obstruction.

Conclusion: Exoscopic surgery using ORBEYE is feasible for a midline suboccipital approach to VA–PICA aneurysms from the rostral end of the patient with the patient in the prone with slight head-down position.

Keywords: Clipping, Exoscope, Midline suboccipital approach, Posterior inferior cerebellar artery aneurysm, ORBEYE

INTRODUCTION

Vertebral artery–posterior inferior cerebellar artery (VA–PICA) aneurysms account for 0.5–3.0% of all intracranial aneurysms.^[19] Although many of these aneurysms are recently treated using an endovascular approach,^[2,14] open surgery remains effective. With open surgery, the operator can directly observe the aneurysm, preserve perforating arteries, and achieve complete aneurysmal obstruction.^[1,5,7,8,13,27] However, open surgery can result in lower cranial nerve (CN) injury.^[1,8] Ideally, proximal control of the VA is obtained and the distal segment is secured without damaging the lower CNs before surgical clipping. Although the lateral suboccipital approach is commonly

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selected for clipping VA–PICA aneurysms,^[7,8,27] the midline suboccipital approach is also safe and effective.^[11,23,24] This approach can provide a wide and superficial operative field and enable clip application to aneurysms positioned high on the VA from beneath the lower CNs.^[11,23,24]

When the midline suboccipital approach is performed using a conventional surgical microscope in the prone position, the visual axis looking down from the rostral end of the patient is suitable for manipulation of a caudal VA–PICA aneurysm. In addition, the visual axis looking up from the caudal end is suitable for manipulation of a rostral lesion.^[23] However, from the operator's perspective, microsurgery using an exoscope can be performed comfortably only from the rostral end, regardless of the operative site and visual axis.^[9,10,16,17,21,22,26]

Recently, multiple exoscope systems are available for neurosurgical use, including the KINEVO (Carl Zeiss AG Carl Zeiss Meditec AG, Oberkochen, Germany), VITOM 3-dimensional (3D) (KARL STORZ SE & Co. KG, Tuttlingen, Germany), Synaptive Modus V (Synaptive Medical, Toronto, Canada), Aeos 3D Digital Exoscope (Aesculap Inc.), and ORBEYE (Sony Olympus Medical Solutions Inc., Tokyo, Japan). These exoscopes contain 4K-3D displays, light filters for 5-aminolevulinic acid and indocyanine green video angiography, flexible arms, adjustable operative settings, multiscreen output, longer focus distance, and a greater magnification power. The ORBEYE (Olympus, Tokyo, Japan), which was the first to have 4K HD clarity concurrently with 3D visualization, provides high magnification function that can range from 1.1 to 25.8 times and high zooming ratio of 1:12 times (6 times through optical zooming and 2 times through digital zooming).^[4,21] VITOM 3D, which is controlled through the IMAGE1 PILOT mounted on a rotation socket and articulation stand, can be switched an endoscope.^[4] The Modus V offers voice-activated control, advanced robotic navigation integration, and cortical tractography.^[4] The KINEVO acts as a combined microscope and exoscope and contains PointLock function that can be very useful in visualizing a larger area inside a cavity by simulating a keyhole movement.^[4,18] Aeos exoscope has a six-joint robotic arm which is controlled by a foot pedal and also provides the point lock function of pivoting around a locked focus.^[6]

We report a patient who underwent VA–PICA aneurysm clipping using the midline suboccipital approach from the rostral end using ORBEYE.

CASE PRESENTATION

The patient provided written informed consent for publication of her information and related images.

A 65-year-old woman who had previously undergone clipping of a right internal carotid artery–posterior communicating artery bifurcation aneurysm [Figure 1a] was

admitted for clipping of an unruptured right-sided VA–PICA aneurysm. Preoperative computed tomography angiography showed that the aneurysm (maximum diameter, 5 mm) was located medially and ventral to the hypoglossal canal [Figure 1b]. After induction of general anesthesia, the patient was placed in the prone position with her neck flexed and head slightly tilted downward and rotated 10° to the right [Figure 2a]. The head was fixed in position using the Sugita surgical head frame (Mizuho, Tokyo, Japan). The main body of the ORBEYE exoscope was placed on the surgeon's right side and the guide arm was placed around the operative field. The monitor was placed beyond the patient and facing the surgeon. A J-shaped skin incision was made from the midline at C4-5 through theinion to the right mastoid groove. A 4 cm × 4 cm craniotomy was performed; 3 cm to the right and 1 cm to the left of midline, and the foramen magnum was opened posteriorly using bone rongeurs. Then, the right occipital bone was resected to the level of the condylar fossa using a drill. C1 laminectomy was not performed. The dura was incised caudally to the midline and cranially to the right lateral bend.

After the visual axis of ORBEYE was set to overhang, rostral retraction of the lateral cerebellum revealed CNs IX, X, and XI. Caudal to the nerves, the right VA and PICA were visible. The aneurysm was found slightly anterior to the origin of the PICA and its distal neck was adherent to CN XII. Using the high magnification function of ORBEYE, CN XII was detached from the aneurysm neck. Although the anterior inferior cerebellar artery (AICA) was found on the ventral side of the aneurysm, the structures were not in contact [Figure 2b]. A 7 mm mini straight Yasargil® titanium clip (Aesculap, Center Valley, PA, USA) was applied to the aneurysm neck from beneath the lower CNs using forceps with a 15° downward bend [Figures 2c and d]. Intraoperative indocyanine green angiography showed no blood flow within the aneurysm and preservation of flow in the VA and PICA [Figure 2e]. The dura was closed in a watertight fashion and

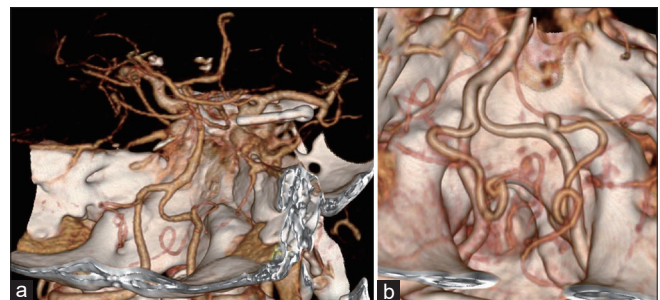


Figure 1: Preoperative imaging. (a) The patient had previously undergone clipping of a right internal carotid artery–posterior communicating artery bifurcation aneurysm. (b) Preoperative computed tomography angiography showed an unruptured right-sided vertebral artery aneurysm (maximum diameter, 5 mm) located medially and ventral to the hypoglossal canal.

the seam line reinforced with fibrin glue. The muscle, fascia, and skin were then closed in layers.

All microsurgical procedures were performed from the rostral end of the patient using ORBEYE. Adjusting the visual axis of ORBEYE enabled surgery to be performed with the surgeon in a comfortable posture. In addition, an extreme head-down position was not required.

No operative complications occurred. Postoperative computed tomography angiography showed complete obliteration of the VA–PICA aneurysm and preservation of the VA and PICA [Figure 3a-c].

DISCUSSION

Although VA–PICA aneurysms are generally clipped using the lateral suboccipital approach,^[1,5,7,8,13,27] several reports have

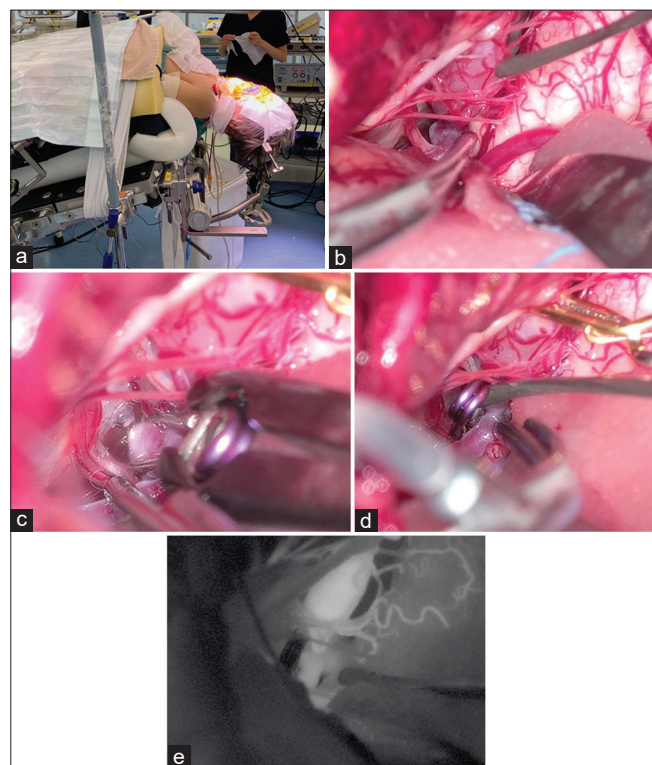


Figure 2: Intraoperative views. (a) The patient was placed in the prone position with her neck slightly flexed and head slightly bent forward, rotated 10° to the right, and fixed in a Sugita surgical head frame (Mizuho, Tokyo, Japan). (b) Overhanging the visual axis of ORBEYE, the aneurysm was visible caudal to cranial nerves (CNs) IX, X, and XI. CN XII was attached to the distal neck of the aneurysm. The AICA was found on the ventral side of the aneurysm but the structures were not in contact. (c) A 7 mm mini straight titanium Yasargil® titanium clip (Aesculap, Center Valley, PA, USA) was applied to the aneurysm neck from beneath the lower CNs using forceps with a 15° downward bend. (d) Clipping achieved complete aneurysmal obstruction. (e) Intraoperative indocyanine green angiography showed no blood flow within the aneurysm and preservation of flow in the VA and PICA.

indicated that the midline suboccipital approach is also safe and effective.^[11,23,24] With the midline approach, the patient is placed in the prone position and the head is rotated 10–30° without the need for any complicated bed preparation or limb posturing. C1 laminectomy is not required either. Furthermore, the proximal and distal segments of both VAs and the aneurysm itself can be easily secured from beneath the lower CNs.^[23] Based on the previous reports, the incidence of postoperative lower CN injury is lower with the midline suboccipital approach (27%) than the lateral approach (36–48%).^[1,8,24,27]

The exoscope is currently being used by some surgeons as an alternative to the conventional microscope.^[16,21,26] Compared to conventional microscopes, exoscopes (including ORBEYE) are ergonomically superior for the surgeon.^[9,17,21,22] In our previous reports, we have noted that stable and comfortable microsurgery can be performed with ORBEYE regardless of the operative visual axis, because it is not necessary for the operator to sit along the visual axis of the exoscope.^[9,17,22,25] In particular, ORBEYE facilitates ergonomic microsurgery when the angle of the operative visual axis is set to overhang.^[17]

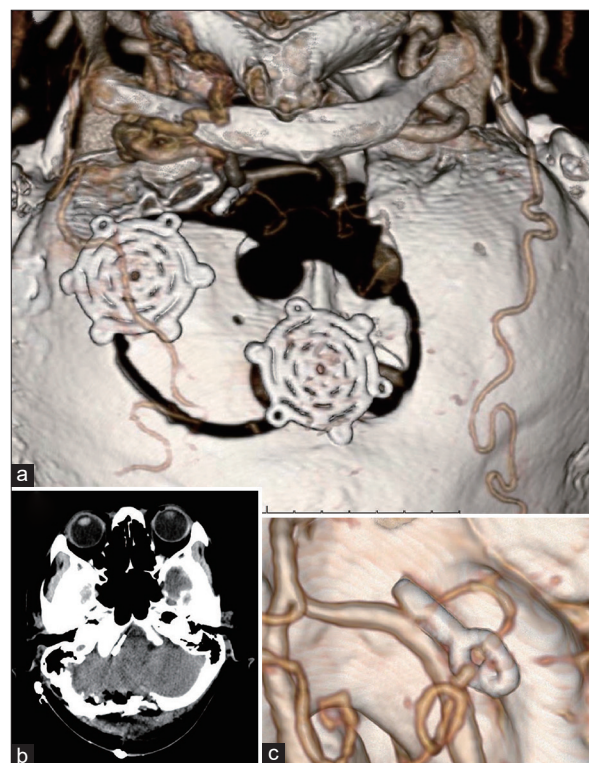


Figure 3: Postoperative imaging. (a) Three-dimensional computed tomography (CT) reconstruction showed the paramedian craniotomy, foramen magnum craniectomy, and resection of the right occipital bone out to the level of the condylar fossa. (b) Postoperative plain CT showed no bleeding or cerebral infarction. (c) Postoperative CT angiography showed complete obliteration of the aneurysm and preservation of the vertebral and posterior inferior cerebellar arteries.

The prone position is generally recommended for the midline suboccipital approach.^[23,24] For surgery in the prone position, setup is relatively quick and easy and surgeons can easily identify the midline.^[11,23,24] However, prone positioning can cause reduced intracranial venous return if the neck is hyper-flexed or the head is located extremely low relative to the level of the heart. Reduced venous return can raise intracranial pressure and cause increase intraoperative bleeding.^[3] We were careful not to hyper-flex the neck with our patient positioning. When using ORBEYE from the rostral end of the patient, an extreme head-down position is not necessary because the operator can perform stable microsurgery even when the visual axis of ORBEYE is ventral [Figure 4]. Therefore, we could maintain intracranial venous return and control intracranial pressure during surgery.

When the midline suboccipital approach in the prone position is used for aneurysms located ventrally in the posterior fossa, such as distal VA and proximal PICA aneurysms, use of a conventional surgical microscope from the rostral end of the patient requires the surgeon to overhang the visual axis of the microscope and perform surgical manipulations in an uncomfortable posture.^[11,23,24] An extreme head-down position may be needed, which can adversely affect intracranial venous return. An alternative is moving the microscope around the patient in response to the operative site, as the operative visual axis looking up over the shoulder from the caudal end of the patient is suitable for manipulations needed to clip rostral lesions.^[11] However, when using ORBEYE for the midline suboccipital approach, the operator can perform stable manipulations in a comfortable posture from the rostral end of the patient with slight head-down position, regardless of the



Figure 4: Using ORBEYE for a midline suboccipital approach performed from the rostral end of the patient, an extreme head-down position is not necessary because the operator can perform stable microsurgery even when the visual axis of ORBEYE is ventral.

operative site and visual axis. In addition, as we previously indicated,^[9,17,22,25] even when the angle of the operative visual axis is approximately horizon, we could also maintain ergonomically comfortable posture and perform stably surgical manipulation.

In other hands, we also experienced some limitations of the ORBEYE in the present case. First, it is necessary to adjust camera position frequently to focus the most deep-seated structures such as AICA on the ventral side of the aneurysm. One of the reasons may be related to depth-of-field. In general, depth-of-field was defined by the distance from subject to lens, the focal length, and the aperture. The longer focal length, the shallower the depth-of-field. ORBEYE has longer focal length (220–550 mm) without the function of aperture, compared to conventional optical microscope.^[6,12] When observing the deep-seated and narrow region with ORBEYE, depth-of-field was shallow without adjustment of distance from subject to lens and/or focal length. Therefore, it is necessary to adjust camera position and/or focus mode, observing deep and narrow region. Furthermore, Roethe *et al.* have previously mentioned that small focus ranges (shallow depth-of-field) in the deep-seated region using exoscope significantly limit in-focus working compared to optical microscope where ocular accommodation make up for off-focus actions. Then, in-focus working area in deep-located structures finds out smaller. Since the field of view is projected to fit the rectangular monitor, camera position needs to be adjusted frequently during surgical manipulation.^[20] Furthermore, Montemurro *et al.* have also indicated in the present review of the literature that depth perception using exoscope was seemed to be inferior, compared to optical microscope (63%, 7/11 case series were inferior, and compared to optical microscope).^[15] This reason was not mentioned clearly in this report; we presume that this is because depth-of-field in deep-seated region can be shallow. Secondary, the phenomenon of overexposure of the white matter is sometimes apparent, especially in the deep-seated region, this can interfere with the surgical manipulation. This limitation could overcome using digital zoom or changing the focus mode.^[21] Therefore, we assume ORBEYE may have a few disadvantages in relation to maneuverability in the deep and narrow operative site.

Further studies of exoscopes and microscopes are needed.

CONCLUSION

Exoscopic surgery using ORBEYE is feasible for a midline suboccipital approach to VA–PICA aneurysms from the rostral end of the patient with the patient in the prone with slight head-down position. This technique enables the

surgeon to perform stable microsurgery in a comfortable posture regardless of the operative visual axis.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Murakami T, Toyota S, Nakagawa K, Hagioka T, Hoshikuma Y, Suematsu T, *et al.* Midline suboccipital approach to a vertebral artery–posterior inferior cerebellar artery aneurysm from the rostral end of the patient using ORBEYE. *Surg Neurol Int* 2022;13:87.