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Technical Notes

Usefulness of endoscope-assisted surgery under exoscopic view in skull base surgery: A technical note

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ABSTRACT

Background: The use of the exoscope has been increasing in the field of neurosurgery, as it can set the visual axis freely, enabling the surgeon to operate in a comfortable posture. Although endoscope-assisted surgery for compensation of insufficient surgical field is useful under the microscope, we report that using an endoscope in exoscopic surgery is safer and more useful.

Methods: The exoscope used was ORBEYE. All surgical procedures were performed exoscopically from the beginning of the surgery. When endoscopic observation was required during the operation, the endoscope was inserted under observation by an exoscope. The exoscopic screen was 4K-3D and endoscopic screen was 4K-2D, the operation was performed while observing both screens at the same time. The endoscope was held manually or by a mechanical holder.

Results: Twenty-two cases, including 14 requiring microvascular decompression (MVD) and eight requiring tumor removal, were performed by endoscopic-assisted exoscopic surgery. The endoscope could be inserted safely because its relationship with the surrounding structure could be observed under the exoscope, and the operator could observe both screens without moving the head. Fourteen of 22 patients required additional endoscopic treatment. Satisfactory two-handed operation was performed in 13 cases. Symptomatology disappeared in all cases of MVD, and sufficient tumor resection was achieved.

Conclusion: Exoscopic surgery provides excellent surgical view that is not inferior to conventional microsurgery. As a large space can be secured between the scope and the surgical field, it is safer and easier to manipulate the endoscope under the exoscope.

Keywords: Craniotomy, Endoscopy, Exoscope, Neurosurgery, ORBEYE, Skull base

INTRODUCTION

Endoscope-assisted surgery for observation of blind spots has been introduced in various neurosurgical approaches, and its usefulness has been reported.[9,17,18] However, it has been noted that the disadvantages of endoscopic assistance in microscopic surgery are the risk of damage to surrounding structures during endoscope insertion and the difficulty of simultaneous observation of microscopic and endoscopic images.[14] Therefore, caution and dexterity are required when operating the endoscope.

The exoscope currently available in neurosurgical field is a so-called "head-up surgery" system that the surgeon operates while looking at the monitor; this approach has changed the concept of conventional microsurgery. Exoscopes currently used in clinical practice, such as VITOM® 3D (KARL STORZ GmbH & Co., Tuttlingen, Germany), KINEVO 900® (Carl Zeiss AG, Oberkochen, Germany), and ORBEYE® (Sony Olympus Medical Solutions Inc., Tokyo, Japan), all provide high-quality and high-definition (4K-HD) 3-dimensional (3D) images and allow for a wide surgical field due to the long focal length.[1,2,7,8,13,15] In addition, since both the surgeon and the assistant observe the same screen, information is shared, and the educational effect is high.[20] Furthermore, even if the visual axis is changed, it is unnecessary for the surgeon to change posture, so the positional burden is minimal.[3,8]

In our hospital, ORBEYE was introduced in November 2018 and used in 216 craniotomies by December 2020. Exoscopic surgery provided a brighter and wider field of view than the microscope, as previously reported,[3] and the surgical feeling was similar. Since the operation space in the surgical field is wider than with the microscope, it was possible to use several surgical support devices simultaneously. In particular, the introduction of an endoscope for cases with blind spots during surgery was safe and useful. There is only report of combined use of an endoscope in exoscopic surgery,[5] though no case with ORBEYE use has been reported. In this study, we retrospectively examined the results of endoscopic-assisted surgery using the exoscope ORBEYE that we performed at our hospital. We reported its usefulness and suggestions for operation.

MATERIALS AND METHODS

Among the 216 cases of craniotomy performed with an exoscope in our hospital from November 2018 to December 2020, 22 cases of surgeries involving endoscope insertion were included in this study. The endoscope was always placed in the operating room during craniotomy and was used in cases where the surgeon found a blind spot during surgery and required further confirmation. The surgeries included 13 cases of trigeminal neuralgia, one case of hemifacial spasm, five vestibular schwannoma, one trigeminal schwannoma, one petrous edge meningioma, and one tentorial edge meningioma.

The exoscope used in this study was an ORBEYE (Olympus Co., Ltd., Tokyo, Japan). ORBEYE provides 4K-3D images with a small camera head, featuring a focus working distance of 220–550 mm and a maximum magnification of ×12. Head-up surgery was performed on a 55″ (140 cm) monitor. In general, a craniotomy was performed under an exoscope from a skin incision. An endoscope was introduced when a blind spot appeared during the operation or when necessary to confirm the operation adequacy.

The endoscope used in this study was an Olympus 4K, 2.7 mm diameter, 30° angled rigid endoscope (Olympus, Tokyo, Japan), which was attached to an EndoArm (Olympus, Tokyo, Japan) or held by hand. The endoscopic images could be observed independently on a 32″ (81 cm) monitor, and simultaneously, images from the exoscope and the endoscope were both projected on a 55″ (140 cm) monitor for observation. The results of endoscopic surgery during craniotomy with an exoscope were examined.

RESULTS

The insertion of the endoscope during exoscopic surgery was performed without difficulty in all cases. As the endoscope can be inserted while looking at the exoscopic screen, it did not damage any surrounding tissue, a possible complication of typical instrument insertion. The movement of the endoscope during the operation was safely performed by observing the two screens simultaneously.

[Table 1] shows a summary of 22 cases. Of the 14 cases of microvascular decompression (MVD), in six cases, endoscopic observation showed that the blood vessels running behind the nerve did not come into direct contact with the nerve, confirming satisfactory surgical outcome. The remaining eight cases required additional treatment. In six of these eight cases, the veins were in contact with the posterior side of the nerve or at the opening of the Meckel's cave and hence distorted the nerve, requiring removal of the vein(s). In one case, nerve distortion by the arachnoid was noted, and the arachnoid was transected. Arterial compression was found in one patient, and additional transposition was performed endoscopically. After the operation, among the 13 cases of trigeminal neuralgia, 11 showed complete disappearance of the pain; two cases had mild residual pain that did not require any medication. The patient with facial spasms had no postoperative symptoms.

Among the eight cases of tumor resection, two cases were confirmed to have no residual mass in the blind spot such as Meckel's cave (Case 15) or internal auditory meatus (Case 18) under the endoscope, and additional resection was performed in six cases under the endoscopic observation. In a case of tentorial meningioma, the tumor had spread to the posterior area of the cerebellar tentorium, and the tent was incised and removed tumor under the endoscopic observation. In a case of petroclival meningioma, the tumor that remained in the shadow of the suprameatal tuberculum was removed. In two of three vestibular schwannomas, residual tumors were found in the inferior part of the internal auditory meatus, and additional resection was performed. Two cases of epidermoid cysts had spread to the ventral side of the auditory nerve and were difficult to observe using the exoscope alone; therefore, additional removal was performed under endoscopic view.

Table 1: Summary of 22 cases of exoscopic surgery with an endoscope.

Case No.*	Age/sex	Diagnosis	Side	Operation	Endoscopic procedures	Position
1	71/F	Trigeminal neuralgia	Rt	MVD	Observation	SL
2	38/M	Trigeminal neuralgia	Rt	MVD	Detach. vein	PB
3	72/M	Trigeminal neuralgia	Rt	MVD	Transposition	PB
4	75/F	Trigeminal neuralgia	Rt	MVD	Detach. vein	PB
5	61/F	Trigeminal neuralgia	Rt	MVD	Detach. vein	PB
6	52/F	Trigeminal neuralgia	Rt	MVD	Detach. vein	PB
7	72/F	Trigeminal neuralgia	Rt	MVD	Observation	L
8	54/M	Trigeminal neuralgia	Rt	MVD	Dissect. arachnoid	SL
9	69/F	Trigeminal neuralgia	Lt	MVD	Detach. vein	SL
10	73/M	Trigeminal neuralgia	Rt	MVD	Detach. vein	SL
11	76/F	Trigeminal neuralgia	Rt	MVD	Observation	SL
12	45/F	Trigeminal neuralgia	Lt	MVD	Observation	SL
13	45/F	Trigeminal neuralgia	Rt	MVD	Observation	SL
14	60/F	Facial spasm	Rt	MVD	Observation	PB
15	42/F	Trigeminal schwannoma	Rt	Craniotomy	Observation	SL
16	63/M	Tentorial meningioma	Rt	Craniotomy	Add. removal	SL
17	75/M	Petroclival meningioma	Lt	Craniotomy	Add. removal	PB
18	39/M	CP angle schwannoma	Lt	Craniotomy	Observation	PB
19	41/F	CP angle schwannoma	Lt	Craniotomy	Add. removal	SL
20	59/M	CP angle schwannoma	Lt	Craniotomy	Add. removal	SL
21	64/F	CP angle epidermoid	Rt	Craniotomy	Add. removal	PB
22	63/M	CP angle epidermoid	Lt	Craniotomy	Add. removal	SL

Case No.*	Holding of endoscopy	Bimanual operation	Equipment installation side**		Outcome	Complication
			Exoscope	Endoscope		
1	EndoArm	No	Rt	Lt	Pain reduction 80%	None
2	EndoArm	Yes	Lt	Rt	Pain reduction 100%	Rhinorrhea
3	EndoArm	Yes	Rt	Lt	Pain reduction 100%	None
4	EndoArm	Yes	Rt	Lt	Pain reduction 100%	None
5	EndoArm	Yes	Rt	Lt	Pain reduction 100%	None
6	EndoArm	Yes	Rt	Lt	Pain reduction 90%	None
7	EndoArm	No	Rt	Lt	Pain reduction 90%	None
8	EndoArm	No	Rt	Lt	Pain reduction 100%	None
9	EndoArm	Yes	Lt	Rt	Pain reduction 100%	None
10	EndoArm	Yes	Rt	Lt	Pain reduction 100%	None
11	Operator	No	Rt	Rt	Pain reduction 100%	None
12	Assistant	No	Lt	Rt	Pain reduction 100%	None
13	Assistant	No	Rt	Lt	Pain reduction 100%	None
14	EndoArm	Yes	Rt	Lt	Disappearance	None
15	EndoArm	No	Rt	Rt	Total resection	None
16	EndoArm	Yes	Rt	Lt	Total resection	None
17	EndoArm	Yes	Lt	Lt	Total resection	None
18	EndoArm	No	Lt	Lt	Total resection	None
19	EndoArm	Yes	Lt	Rt	Total resection	None
20	Operator	No	Lt	Lt	Total resection	None
21	EndoArm	Yes	Rt	Lt	Subtotal resection	None
22	EndoArm	Yes	Lt	Rt	Total resection	None

*Cases are listed by diagnosis in ascending chronological order of surgery date. **Side indicates the side as seen by the operator. MVD: Microvascular decompression, Detach. vein: Detachment of the vein, Dissect. arachnoid: Dissection of the arachnoid, Add. removal: Additional removal of the residual tumor, SL: Supine-lateral position, L: Lateral position, PB: Park bench position, CP: Cerebellopontine angle

Total removal was achieved in seven of eight tumor cases, in the case, the recurrent epidermoid had adhered to the inner part of the brainstem and was not removed.

The EndoArm was used to hold the endoscope in 18 cases. Manual holding was performed in the last four cases (cases 11, 12, 13, and 20). In the 13 cases requiring additional treatment under the endoscope held by the EndoArm, satisfactory two-handed operation was possible in 12 cases, but only one-handed operation was possible in one case (case 8). Of the four recent cases of manual holding, two cases (cases 11 and 20) were held by the operator and two cases (cases 12 and 13) were held by the assistant. In three cases (cases 11, 12, and 13), observation alone was sufficient, and in one case (case 20), the tumor could be removed by suction, which was performed by the surgeon using one hand.

Postoperative cerebrospinal fluid rhinorrhea was observed in one patient (case 2) as a surgical complication due to incomplete blockage of the opened air cells, and surgical repair was performed. No complications associated with endoscopic insertion were observed.

Illustrative cases

[Figure 1] and [Video 1] show the operation of a 63-year-old patient with tentorium meningioma (case 16). The patient visited our hospital complaining of discomfort in the right eye and paresthesia in the face. MRI showed a neoplastic lesion of approximately 15 mm in the notch of the right cerebellar tentorium [Figure 1a]. The patient was placed in the supine-lateral position, and a right temporal craniotomy, 3 cm in size, was performed. Under the ORBEYE monitor, the tumor was mostly resected using the subtemporal approach. As the tumor was suspected to extend beyond the edge of the cerebellar tentorium, the endoscope was inserted. Although ORBEYE could not capture the area directly beyond the tentorium, the endoscopic screen showed the tumor attachment and the compressed trochlear nerve. The tumor was removed endoscopically with both hands to avoid damage to the trochlear nerve. The symptoms disappeared after the operation, and no residual tumor was found on postoperative MRI [Figure 1b].

[Figure 2] and [Video 2] are a case of 73-year-old patient with the right trigeminal neuralgia (case 10). The patient was placed in the supine-lateral position, and a curved skin incision was performed in the right retroauricular space. A lateral suboccipital craniotomy of 2.5 cm size was performed under the ORBEYE monitor. The superior cerebellar artery compressing the root entry zone of the trigeminal nerve rostrally was transposed to the cerebellar tentorium. The large vein in contact with the caudal side was also detached and moved to the pyramidal bone side. As the contact of vessels around Meckel's cave could not be confirmed from the exoscopic view, an endoscope was inserted [Figure 2a]. Adhesion between the trigeminal nerve, the vein, and arachnoid was confirmed at the entrance of Meckel's cave from the endoscopic screen [Figure 2b]. Although the instrument tip could not be visualized under the ORBEYE screen, the arachnoid membrane was removed using suction and a dissector while observing through the endoscopic screen, and finally, the nerve was freed. The entire circumference, including the caudal and cranial sides of the trigeminal nerve, was observed by moving the endoscopic axis [Video 2]. Postoperatively, the trigeminal neuralgia disappeared completely.

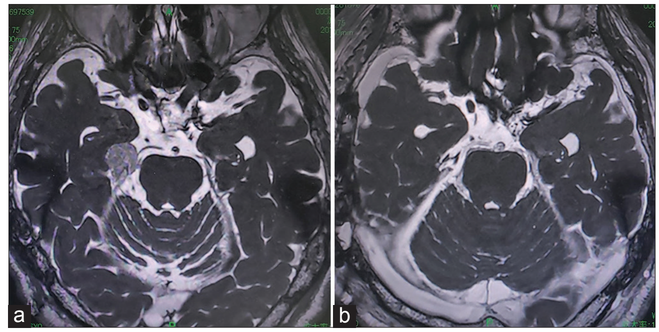

Figure 1: Pre- and post-operative MRI of illustrative case of a 63-year-old patient with tentorium meningioma. (a) Preoperative MRI thin slice T2-weighted image: a tumor (arrow) is found at the edge of the cerebellar tentorium. (b) Postoperative MRI thin slice T2-weighted image: tumor has been completely resected.

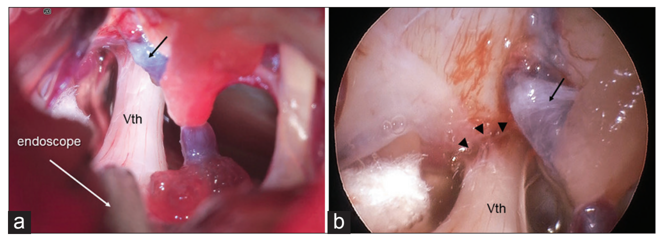

Figure 2: Intraoperative images of a 73-year-old patient with the right trigeminal neuralgia. (a) Exoscopic image when the endoscope was inserted in the surgical field. As the Meckel's cave was not able be seen directly, it was difficult to determine whether there was enough space between the Meckel's cave and vein (arrow). (b) Endoscopic image at the same time as a. The Meckel's cave (arrow heads) was observed directly and it was confirmed that the adhesions of the arachnoid and the vein (arrow) were released around the Meckel cave of the trigeminal nerve (Vth).

DISCUSSION

In recent years, the usefulness of exoscopic surgery in the field of neurosurgery has been reported.[1,8,10-13,15,20] According to a review comparing the three 3D exoscopes currently available for clinical use[9] and a report comparing them to the microscope,[18] the image quality, illumination, and depth perception are all as high as those of a microscope. The surgeon is also reported to experience less fatigue due to the surgery being performed in the head-up position.

ORBEYE is a product specifically developed for exoscope and its imaging quality is no less than conventional microscope, and its small size allows effortless handling.[18] In addition, it is the only exoscope that incorporates a picture-in-picture view,[9] useful for capturing navigation and endoscopic images. In our hospital, ORBEYE was introduced in November 2018 and used in 216 (89.6%) of 241 craniotomies by December 2020. A total of 12 surgeons have completed a surgical intervention with ORBEYE alone, while one surgeon used ORBEYE for the 1st time and changed to a microscope during the surgery. After trying it once, a surgeon tended to use ORBEYE again because of the high image quality and ease of posture, securing the field of view, and handling. It is now the first choice for all cases requiring craniotomy in our hospital. This result is consistent with the previous reports,[13] suggesting that the exoscope is becoming preferred over microscope.

Endoscopic-assisted craniotomy has been reported in many cases, such as clipping,[7,8,15] additional resection of skull base tumors,[1,2,20] and compression of blood vessels in MVD.[3,5,10] Although it has been reported to be useful in confirmation,[11,12] inserting an endoscope under a microscope poses a risk of tissue damage in the superficial surgical field. Because it is difficult to observe the entire surgical field with a normal microscope, it is necessary to insert the endoscope with the scope the microscope far away from the surgical field when inserting the endoscope. Furthermore, to perform surgical operations under the endoscope, it is necessary to take your eyes off the microscope and concentrate only on the field of view of the endoscope. Therefore, it has been reported that it is difficult to simultaneously observe two screens with the current microscope.[4,11,16]

In this respect, exoscopic surgery has a high degree of freedom because a wide operating space can be visualized near the surgical field. Since exoscopic surgery is designed as a head-up surgery, the surgeon can see two screens without moving their head from the scope if the endoscopic screens are arranged in parallel. Therefore, safer endoscopic insertion during operation is possible.

There are various tools for holding an endoscope. EndoArm® (Olympus, Tokyo, Japan), which we used in our study, is an endoscope holder dedicated to neurosurgery.[6] This device can be fixed in any position by gas control and operated with both hands while using the endoscope. The 2.7 mm small-diameter endoscope we used did not obstruct the visual field and had excellent operability [Figure 3a]. Furthermore, the provision of 4K images has improved the conventional narrow angle of view. The 4K camera head used in this study can be separated from the EndoArm and connected to the

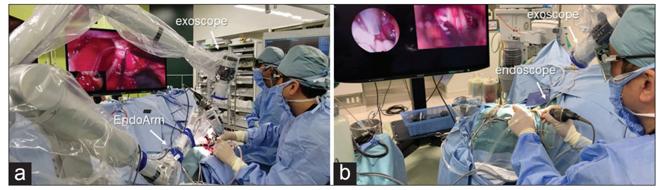

Figure 3: Methods of holding the endoscope under the exoscope as adopted in this report. (a) The endoscope is attached to the EndoArm and inserted from the left-hand side of the operator. (b) The operator holds the endoscope with his right hand.

scope to be held manually, when necessary [Figure 3b]. While the exoscope is 3D, the endoscope we used is 2D, but there was no inconvenience in the visibility of the endoscope screen even when wearing goggles for 3D screen observation. Of course, it would be even more useful if a 3D endoscope could be equipped.

In our experience, the ease of two-handed operations while using an endoscope depends on the space between the endoscope and the target structure for the two-handed instrument. It is relatively easy in cases where a large space can be obtained after removal, such as tumor removal, but there are restrictions in narrow range operations, as in the case experienced with MVD, although the most one hand operation was sufficient. In fact, when the EndoArm was held (Case 8), two-handed operation was not possible. The space around the trigeminal nerve was considered to be narrow and the craniotomy opening was small; hence, when the endoscope was inserted from the left, the space for the left hand could not be secured.

In the last four cases (cases 11, 12, and 13), the endoscope was held by hand. When the surgeon becomes accustomed to holding the endoscope, this procedure is effective enough for observation only, and it does not take up much space like EndoArm, and it takes less time to prepare. In one of these cases (case 20), the tumor remaining in the internal auditory meatus could be removed by suction; hence, the operator held the endoscope by the one hand and operated it using the other hand. However, in the case of complicated operations such as dissection and incision, two-handed operation is indispensable, and in that case, we have to fix the endoscope to the EndoArm.

Because it is better to hold the endoscope by hand for fine adjustment during operation, handling of endoscope by a skilled "scopist" like an assistant doing four hands approach during endonasal endoscopic surgery[19,21] is the most ideal. Therefore, educating surgeons regarding manual holding the endoscope are important. Alternatively, it would be ideal if the position of the endoscope could be adjusted during operation with a foot switch.

Since skull base surgery requires deep manipulation, it is expected that blind spots will be created more frequently than surgery at other sites. For such situations, it is important that the endoscope is always available in the operating room. In exoscopic surgery, the endoscope can be inserted safely without stress, so the combined use of both is considered to be extremely useful.

CONCLUSION

Exoscopic surgery provides excellent surgical view that is not inferior to conventional microsurgery. As a large space can be secured between the scope and the surgical field, it is safer and easier to manipulate the endoscope under the exoscope.

Ethical approval

This study has been approved by the appropriate ethics committee and has, therefore, been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Declaration of patient consent

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

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Abolfotoh M, Bi WL, Hong CK, Almefty KK, Boskovitz A, Dunn IF, *et al*. The combined microscopic-endoscopic technique for radical resection of cerebellopontine angle tumors. J Neurosurg 2015;123:1301-11.
2. Almeida JP, de Albuquerque LA, Dal Fabbro M, Sampaio M, Medina R, Chacon M, *et al*. Endoscopic skull base surgery: Evaluation of current clinical outcomes. J Neurosurg Sci 2019;63:88-95.
3. Broggi M, Acerbi F, Ferroli P, Tringali G, Schiariti M, Broggi G. Microvascular decompression for neurovascular conflicts in the cerebello-pontine angle: Which role for endoscopy? Acta Neurochirurg 2013;155:1709-16.
4. Cheng WY, Chao SC, Shen CC. Endoscopic microvascular decompression of the hemifacial spasm. Surg Neurol 2008;70 Suppl 1:40-6.
5. El Refaee E, Langner S, Marx S, Rosenstengel C, Baldauf J, Schroeder HW. Endoscope-assisted microvascular decompression for the management of hemifacial spasm caused by vertebrobasilar dolichoectasia. World Neurosurg 2019;121:e566-75.
6. Eskandari R, Amini A, Yonemura KS, Couldwell WT. The use of the Olympus EndoArm for spinal and skull-based transsphenoidal neurosurgery. Minim Invasive Neurosurg 2008;51:370-2.
7. Fischer G, Oertel J, Perneczky A. Endoscopy in aneurysm surgery. Neurosurgery 2012;70 Suppl 2:184-90; discussion 90-1.
8. Gallieni M, Del Maestro M, Luzzi S, Trovarelli D, Ricci A, Galzio R. Endoscope-assisted microneurosurgery for intracranial aneurysms: Operative technique, reliability, and feasibility based on 14 years of personal experience. Acta Neurochirurg Suppl 2018;129:19-24.
9. Langer DJ, White TG, Schulder M, Boockvar JA, Labib M, Lawton MT. Advances in intraoperative optics: A brief review of current exoscope platforms. Oper Neurosurg (Hagerstown) 2020;19:84-93.
10. Liu JK, Dodson VN. Endoscopic-assisted microvascular decompression of ectatic vertebral artery for hemifacial spasm: Operative video and technical nuances. J Neurol Surg B Skull Base 2019;80 Suppl 3:S312-S3.
11. Luzzi S, Gallieni M, Del Maestro M, Trovarelli D, Ricci A, Galzio R. Giant and very large intracranial aneurysms: Surgical strategies and special issues. Acta Neurochir Suppl 2018;129:25-31.
12. Magnan J. Endoscope-assisted decompression of facial nerve for treatment of hemifacial spasm. Neurochirurgie 2018;64:144-52.
13. Murai Y, Sato S, Yui K, Morimoto D, Ozeki T, Yamaguchi M, *et al*. Preliminary clinical microneurosurgical experience with the 4K3-dimensional microvideoscope (ORBEYE) system for microneurological surgery: Observation study. Oper Neurosurg (Hagerstown) 2019;16:707-16.
14. Oertel JM, Burkhardt BW. Vitom-3D for exoscopic neurosurgery: Initial experience in cranial and spinal procedures. World Neurosurg 2017;105:153-62.
15. Peris-Celda M, Da Roz L, Monroy-Sosa A, Morishita T, Rhoton AL Jr. Surgical anatomy of endoscope-assisted approaches to common aneurysm sites. Neurosurgery 2014;10 Suppl 1:121-44; discussion 44.
16. Rak R, Sekhar LN, Stimac D, Hechl P. Endoscope-assisted microsurgery for microvascular compression syndromes. Neurosurgery 2004;54:876-81; discussion 81-3.
17. Rossini Z, Cardia A, Milani D, Lasio GB, Fornari M, D'Angelo V. VITOM 3D: Preliminary experience in cranial surgery. World Neurosurg 2017;107:663-8.
18. Sack J, Steinberg JA, Rennert RC, Hatefi D, Pannell JS, Levy M, *et al*. Initial experience using a high-definition 3-dimensional exoscope system for microneurosurgery. Oper Neurosurg (Hagerstown) 2018;14:395-401.
19. Todeschini AB, Montaser AS, Shahein M, Revuelta JM, Otto BA, Carrau RL, *et al*. Endoscopic endonasal approach to a suprasellar craniopharyngioma. J Neurol Surg B Skull Base 2018;79 Suppl 3:S237-8.
20. Tuchman A, Platt A, Winer J, Pham M, Giannotta S, Zada G. Endoscopic-assisted resection of intracranial epidermoid tumors. World Neurosurg 2014;82:450-4.
21. Yousaf J, Afshari FT, Ahmed SK, Chavda SV, Sanghera P, Paluzzi A. Endoscopic endonasal surgery for clival chordomas a single institution experience and short term outcomes. Br J Neurosurg 2019;33:388-93.

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