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*Case Report*

# Awake surgery for a deaf patient using sign language: A case report

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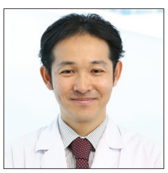

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## ABSTRACT

**Background:** Although awake surgery is the gold standard for resecting brain tumors in eloquent regions, patients with hearing impairment require special consideration during intraoperative tasks.

**Case Description:** We present a case of awake surgery using sign language in a 45-year-old right-handed native male patient with hearing impairment and a neoplastic lesion in the left frontal lobe, pars triangularis (suspected to be a low-grade glioma). The patient primarily communicated through sign language and writing but was able to speak at a sufficiently audible level through childhood training. Although the patient remained asymptomatic, the tumors gradually grew in size. Awake surgery was performed for tumors resection. After the craniotomy, the patient was awake, and brain function mapping was performed using tasks such as counting, picture naming, and reading. A sign language-proficient nurse facilitated communication using sign language and the patient vocally responded. Intraoperative tasks proceeded smoothly without speech arrest or verbal comprehension difficulties during electrical stimulation of the tumor-adjacent areas. Gross total tumor resection was achieved, and the patient exhibited no apparent complications. Pathological examination revealed a World Health Organization grade II oligodendroglioma with an isocitrate dehydrogenase one mutant and 1p 19q codeletion.

**Conclusion:** Since the patient in this case had no dysphonia due to training from childhood, the task was presented in sign language, and the patient responded vocally, which enabled a safe operation. Regarding awake surgery in patients with hearing impairment, safe tumor resection can be achieved by performing intraoperative tasks depending on the degree of hearing impairment and dysphonia.

**Keywords:** Awake surgery, Deaf patient, Low-grade glioma

## INTRODUCTION

Awake craniotomy for brain tumor resection is the gold standard for resecting low-grade gliomas located in eloquent areas.[3,5,13,17] Patients with hearing impairment require special consideration when performing intraoperative tasks during awake craniotomies.

Hearing impairment is divided into two categories: pre- and postlingual. Prelingual hearing impairment is either present at birth or begins before language is acquired, usually around five years of age. Postlingual hearing impairment occurs after speech development. Hereditary and environmental factors cause hearing impairment. [6] The incidence of hereditary hearing impairment is approximately 0.2%[6,15], and the degree of hearing impairment and language function varies from person to person.[14,16] Therefore, examining intraoperative tasks during awake craniotomy according to the degree of hearing impairment and language function of each patient is necessary. Herein, we discuss a case of awake craniotomy using sign language in a patient with hearing impairment with low-grade glioma.

## CASE DESCRIPTION

The patient was a 45-year-old right-handed native man with deafness. The patient presented with a mild headache seven years before being referred to our institution. Magnetic resonance imaging (MRI) revealed a non-enhanced, homogeneous lesion with a 25 mm diameter in the left frontal lobe (pars triangularis) [Figure 1]. The tumor was suspected to be a low-grade glioma and was regularly followed up. The patient remained asymptomatic. When the tumor grew to a 45 mm diameter, the patient was referred to our hospital for surgical treatment. MRI indicated that the lesion was confined to the pars triangularis and pars opercularis and that the posterior part was in contact with the precentral gyrus [Figure 2]. Contrast-enhanced agents were not used due to the patient's allergies to them. The patient was neurologically asymptomatic, and his physical examination results were normal. The mini-mental state examination score was 26. The patient was employed as an officer; his activities of daily living were independent. The patient could not answer questions about the town or state in which he resided. In addition, the patient obtained three points for calculating serial 7 s. Although the patient was prelingually deaf, he was able to speak at a sufficiently audible level through childhood training. The patient primarily communicated using sign language and writing.

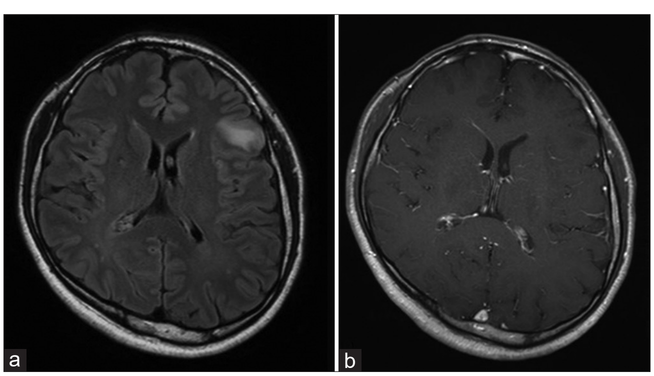


**Figure 1:** Magnetic resonance imaging, performed during the patient's previous visit, showed (a) a T2 fluid-attenuated inversion recovery high homogeneous lesion with a 25 mm diameter in the left frontal lobe (pars triangularis), (b) The lesion was non-enhanced , suggesting a low-grade glioma.

The tumor was located in the left frontal lobe; we decided to perform an awake craniotomy to preserve verbal function. A few days before the awake craniotomy, we presented the patient with an intraoperative task, including number counting, picture naming, reading Japanese characters, bending, and stretching the right elbow. A nurse with sign language skills confirmed that the patient could vocally complete these tasks. On the day of the awake craniotomy, the patient was placed in the right lateral position with his head fixed with a Mayfield pin holder after induction of general anesthesia. We performed a left frontotemporal craniotomy under general anesthesia. The patient was awakened after the brain surface was exposed, wherein bipolar stimulation (NIM Eclipse, Medtronic, Dublin, Ireland) was performed for cortical mapping. Brain function mapping was performed using tasks such as number counting, picture naming, and reading Japanese characters. The nurse with sign language skills presented tasks and asked questions in sign language that the patient vocally answered. We ensured that the patient's comfort and pain were adequately controlled by frequent communication using sign language during intraoperative mapping and tumor removal because the patient had difficulty expressing his discomfort; the patient's face was hidden behind the drapes. Figure 3 illustrates the patient's position and the layout of the operating room. No speech arrest, verbal comprehension difficulties, or motor deficits were observed with electrical stimulation of the cortical and subcortical areas where the tumor was located [Figure 4a]. Gross total tumor resection was achieved, and the patient exhibited no apparent complications [Figure 4b].

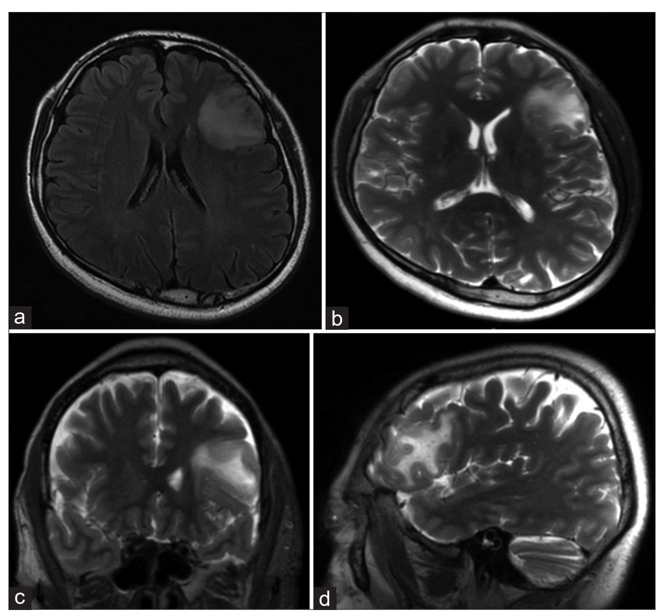


**Figure 2:** Preoperative magnetic resonance imaging (MRI) showing (a) the tumor was confined to pars triangularis and pars opercularis , (b) Preoperative axial, (c)coronal , (d) sagittal and T2 MRI scan showing the posterior part was in contact with the central gyrus.

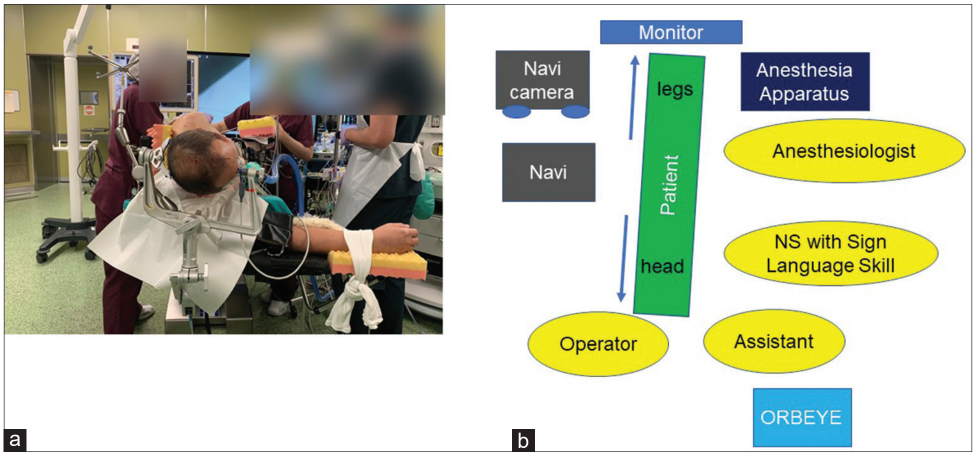


**Figure 3:** (a) Intraoperative patient's position and (b) operative room setup.

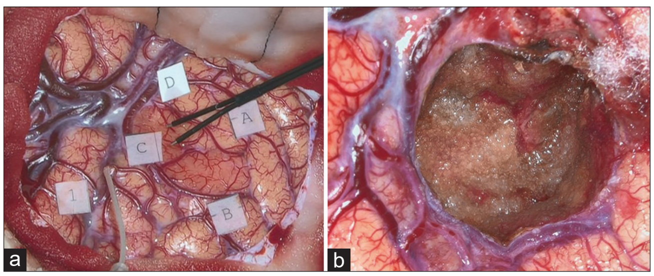


**Figure 4:** Intraoperative pictures (a) before and (b) after tumor resection. The brain surface directly above the tumor, surrounded by "A," "B," "C," and "D" markers, was edematous and had a color different from that of the surrounding area. No speech arrest or motor deficit was observed with electrical stimulation to the tumor surface and premotor area ("1" marker).

After tumor removal, the patient we re-intubated the patient during dural closure, bone flap fixation, and skin suturing. Postoperative MRI revealed no apparent residual tumors [Figure 5]. Pathological examination revealed a World Health Organization grade II oligodendroglioma with an isocitrate dehydrogenase 1 ( IDH1) mutation and 1p 19q codeletion. The patient's neuropsychological status remained unchanged, and he was discharged on postoperative day 9. After one year of follow-up, no significant change or recurrence was observed on imaging.

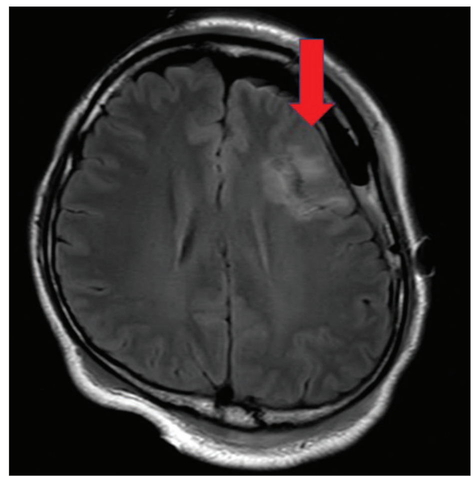

**Figure 5:** Postoperative magnetic resonance imaging showing total tumor removal. T2 fluid-attenuated inversion recovery high signal intensity area remained, which has been suggested as brain edema (arrow).

## DISCUSSION

Here, we describe a case of awake craniotomy using sign language in a patient with hearing impairment with oligodendroglioma. Four previous studies have reported cases of awake craniotomy using sign language in patients with hearing impairment for glioma resection.[1,8,11,12] All these studies reported that awake craniotomies and intraoperative tasks were safely performed with the help of a sign language interpreter. Moreover, these patients did not present any new postoperative neurological deficits. Awake craniotomies for prelingual[1,12] and postlingual deaf patients[8,11] were performed in these reports, during which number counting,[1,11,12] visual object naming,[1,8,11,12] continuous motor function testing,[1] text reading,[12] repetition,[12] and the N back memory test[11] were used as intraoperative tasks.

Our case is different from these previous reports in that the patient learned to speak from childhood, whereas the case reported by Lau *et al.* is similar to our case in that the patient learned to speak vocally.[8] Intraoperative tasks during awake craniotomy were easier to perform because the patient could speak the language. Recent advances in managing prelingual deaf signers enable patients to learn signs and speak.[14] Thus, the number of patients with prelingual deafness who learn to speak will increase in the future. Although awake craniotomy is easier in patients with prelingual deafness who learn to speak than for prelingual deaf signers, patients with hearing disabilities have more difficulty expressing discomfort and pain during awake craniotomy compared with those without disabilities. Special attention should be paid to ensure that discomfort, pain, and anxiety are adequately relieved through frequent communication using sign language. In addition, preoperative simulation of intraoperative tasks is necessary because whether patients with hearing impairment could successfully undergo intraoperative tasks during awake craniotomy remains uncertain.

Our patient did not exhibit any neurological signs on electrical stimulation during awake craniotomy, whether this was because the tumor had already replaced language function or if the patient had a different language pathway from their childhood, which is unclear.

The previous studies on deaf signers reported that language organization was similar to that in patients without deafness [2,8,10-12], whereas other studies suggest that some differences between deaf and non-deaf signers in the parietal lobules are predominantly important for sign-language processing.[7,10] In addition, a recent detailed study by Leonard *et al*. showed that the sensory-motor cortex and supramarginal gyrus exhibited neural selectivity for specific American Sign Language.[4,9] Thus, whether prelingual deaf patients who learned speaking during childhood could have similar language organization compared with patients without deafness is unclear. Thus, awake craniotomy should be considered in patients with hearing impairment when resecting brain tumors at eloquent lesions since awake craniotomy can be safely performed in such patients using sign language interpreters. In addition, intraoperative tasks should also be optimized and protocolized for patients with hearing impairment so that awake craniotomy in these patients with hearing impairment could be safely performed at different medical centers.

## CONCLUSION

Here, we report a case of awake craniotomy using sign language in a patient with hearing impairment. Awake craniotomy in patients with hearing impairment can be successfully performed through intraoperative tasks. However, each individual has a different degree of hearing impairment and dysphonia. In addition, whether patients with hearing impairment could have similar language processing pathways compared with those without deafness is unclear. Therefore, adjusting the most appropriate intraoperative tasks depending on each individual is crucial.

### Ethical approval

The research/study approved by the Institutional Review Board at Osaka University, number 22302, dated October 18, 2022.

### 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.

### Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

## REFERENCES

1. Chen PA, Chen YC, Wei KC, Chen KT. Awake craniotomy for a left pan-hippocampal diffuse low-grade glioma in a deaf and mute patient using sign language. World Neurosurg 2020;134:629-34.
2. Corina DP, McBurney SL, Dodrill C, Hinshaw K, Brinkley J, Ojemann G. Functional roles of Broca's area and SMG: Evidence from cortical stimulation mapping in a deaf signer. Neuroimage 1999;10:570-81.
3. Duffau H. Is non-awake surgery for supratentorial adult low-grade glioma treatment still feasible? Neurosurg Rev 2018;41:133-9.
4. Emmorey K. Sign language: How the brain represents phonology without sound. Curr Biol 2020;30:R1361-3.
5. Gogos AJ, Young JS, Morshed RA, Hervey-Jumper SL, Berger MS. Awake glioma surgery: Technical evolution and nuances. J Neurooncol 2020;147:515-24.
6. Ito T, Noguchi Y, Yashima T, Ohno K, Kitamura K. Hereditary hearing loss and deafness genes in Japan. J Med Dent Sci 2010;57:1-10.
7. Kassubek J, Hickok G, Erhard P. Involvement of classical anterior and posterior language areas in sign language production, as investigated by 4 T functional magnetic resonance imaging. Neurosci Lett 2004;364:168-72.
8. Lau R, Malhotra AK, McAndrews MP, Kongkham P. Subcortical language localization using sign language and awake craniotomy for dominant posterior temporal glioma resection in a hearing-impaired patient. Acta Neurochir (Wien) 2023;165:1665-9.
9. Leonard MK, Lucas B, Blau S, Corina DP, Chang EF. Cortical encoding of manual articulatory and linguistic features in American Sign Language. Curr Biol 2020;30:4342-51.
10. MacSweeney M, Capek CM, Campbell R, Woll B. The signing brain: The neurobiology of sign language. Trends Cogn Sci 2008;12:432-40.

11. Martino J, Velasquez C, Vázquez-Bourgon J, de Lucas EM, Gomez E. Cross-modal recruitment of auditory and orofacial areas during sign language in a deaf subject. World Neurosurg 2017;105:1033.e1-5.
12. Metellus P, Boussen S, Guye M, Trebuchon A. Successful insular glioma removal in a deaf signer patient during an awake craniotomy procedure. World Neurosurg 2017;98:883.e1-5.
13. Sanai N, Mirzadeh Z, Berger MS. Functional outcome after language mapping for glioma resection. N Engl J Med 2008;358:18-27.
14. Wiggin M, Sedey AL, Yoshinaga-Itano C, Mason CA, Gaffney M, Chung W. Frequency of early intervention sessions and vocabulary skills in children with hearing loss. J Clin Med 2021;10:5025.
15. Wrightson AS. Universal newborn hearing screening. Am Fam Physician 2007;75:1349-52.
16. Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early-and later-identified children with hearing loss. Pediatrics 1998;102:1161-71.
17. Zhang JJ, Lee KS, Voisin MR, Hervey-Jumper SL, Berger MS, Zadeh G. Awake craniotomy for resection of supratentorial glioblastoma: A systematic review and meta-analysis. Neurooncol Adv 2020;2:vdaa111.

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