

Case Report

A Case of Ear Canal Cancer with a High Venous Arch That Benefited from an Intraoperative Navigation System

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Keywords

Intraoperative navigation system · Lateral temporal bone resection · Cancers of the external auditory canal · Adenoid cystic carcinoma

Abstract

Introduction: Cancers of the external auditory canal are rare. Surgery may be the treatment of choice for localized cases. Lateral temporal bone resection is one surgical treatment option. It is rarely performed by skilled surgeons and requires caudal and anterior cutting of the tympanic chamber bone, which is not usually performed in ear surgery. It is imperative to ensure that the internal jugular vein and important nerves are present. **Case Presentation:** In this report, we describe a case of adenoid cystic carcinoma of the external auditory canal in which lateral temporal bone resection was safely performed using intraoperative navigation. A 33-year-old woman was diagnosed with an adenoid cystic carcinoma of the right external auditory canal by another physician and presented to our department. After close examination, she was diagnosed with T3N0M0 cancer of the external auditory canal and was referred to our department for lateral temporal bone resection. Although the patient had a high venous arch, intraoperative navigation enabled unblocked resection without exposing the tumor or damaging the vital tissues. **Conclusion:** Intraoperative navigation is considered a safer lateral temporal bone resection approach.

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Introduction

Intraoperative navigation systems are widely used in several fields, including otorhinolaryngology, head and neck surgery, oral and maxillofacial surgery, and neurosurgery [1]. In otorhinolaryngology, they are generally used in nasal sinus surgery but can also be used in ear-related procedures. Image-based navigation using computed tomography (CT), magnetic resonance imaging (MRI), and other technologies supports the surgeon's knowledge and skills in cases that require advanced surgical techniques performed by skilled personnel, thereby enabling safer and more accurate surgery. There is also an educational aspect to the visualization and sharing of information [2].

External auditory canal cancer is rare, accounting for less than 1% of all head and neck cancers [3]. The most common carcinoma arising in the external auditory canal is SCC, which may be treated with radiotherapy or heavy ion radiation because of its high radiosensitivity when locally arising. On the other hand, adenoid cystic carcinoma of the external auditory canal is rare, but its low radiosensitivity makes surgical resection an option for localized disease. Lateral and subtotal temporal bone resections are widely used in surgeries for ear canal cancer. Although it is crucial to remove the tumor in one piece within a safety zone, the number of cancer cases is small, and drilling may be necessary in areas that are typically avoided, such as near important blood vessels. In this report, we describe a case in which lateral temporal bone resection was safely performed while confirming the location of the tumor and important tissues using intraoperative navigation.

Case Presentation

A 33-year-old female presented with the chief complaint of right ear pain. Current medical history: the patient had a history of repeated right otitis externa since about 2 years prior to her first visit to her previous doctor. The patient visited her previous doctor because she gradually developed right otorrhea and earaches. Upon close examination, she was diagnosed with right adenoid cystic carcinoma of the external auditory canal and was referred to our department 2 months after her previous visit. History: she had a history of childhood asthma. Allergy: she was allergic to mackerel.

Findings at presentation: the right external auditory canal was narrowed and difficult to observe (Fig. 1). Examination showed no facial nerve palsy, 40/40 by Yanagihara's method. Pathological diagnosis (reevaluation of premedical biopsy specimens): atypical epithelium forms tubular and cord-like structures and proliferates with fibrosis in the interstitium from the dermal equivalent to the vicinity of the cartilage, and the atypical epithelium has small, darkly stained nuclei. Immunohistochemically, atypical cells were CK5/6 (partially positive), p40 (positive in the lateral portion of the foci), SMA (positive in some areas, mainly in the lateral portion of the foci), calponin (partially positive), S100 (few and weakly positive), and Ki-67 labeling rate (about 20–30%). The pathological diagnosis was malignancy. The pathological diagnosis was malignant tumor, suspicious of adenoid cystic carcinoma.

Imaging findings (Fig. 2–4): CT showed a mass in the right obstructed external auditory canal, mastoid apical infiltration, and no middle ear infiltration. A high venous arch was present, with no facial nerve course problems. MRI showed a mass with contrast effect in the same area as the CT, with no facial nerve involvement. PET-CT showed accumulation of the primary tumor only, with no distant metastasis. Diagnosis: she was diagnosed with right cancer of the external auditory canal (adenoid cystic carcinoma, tubular type), T3N0M0.



Fig. 1. Preoperative findings. The external auditory canal was narrowed, and internal observation was difficult.

Progress

After explaining the surgery and heavy ion therapy to the patient, a plan was made for lateral temporal bone resection. One month after her visit to our department, right lateral temporal bone resection, temporal myocutaneous flap reconstruction, and skin grafting were performed.

At postoperative day 14, the patient was discharged with good progress. Intraoperative neural integrity monitor (NIM) showed good response, and postoperative examination revealed no evidence of paralysis due to surgery, 40/40 by Yanagihara's method. The patient is currently under observation and has had no recurrence (Fig. 5).

Surgical Findings

The Stryker ENT navigation system and NIM were used as surgical support equipment. An incision was made around the entrance of the external auditory canal using an electrocautery scalpel until it hit the temporal bone and the canal was closed in a width-like manner to prevent seeding.

The posterior ear was incised, the entire auricle was dissected in the layer above the temporal fascia until the entire auricle rotated, and the periauricular incision was passed. Mastoidectomy was performed, and the posterior tympanic chamber was opened after the vertical part of the facial nerve became transparent. The incus was removed, and the tensor tympani muscle tendon was identified on the malleus and separated. The head side was shaved anteriorly, and the temporomandibular joint capsule was traversed undamaged. Subsequently, the facial nerve up to the foramen magnum was identified during translation. The tympanic nerve was transected as the opening of the posterior tympanic chamber was extended caudally. The high venous arch beyond the tympanic chamber was confirmed using CT; therefore, a navigator was used to make the incision. The anterior incision was made caudally, and the tumor was removed by traversing the caudal incision. Tumor extension to the mastoid, facial nerve, high venous arch, internal carotid artery in the anterior tympanic chamber, and inner ear was identified by navigation, and the procedure was performed without damaging critical tissues (Fig. 6). Pathology: the tumor was resected and a diagnosis of adenoid cystic carcinoma was made.

Discussion

Surgical navigation systems are mainly used in neurosurgery, oral surgery, and otorhinolaryngology for the head and neck region, with image-based navigation displaying the surgical location on images, such as CT and MRI. This navigation has been introduced in multiple fields and is useful for understanding complex anatomical structures near the skull

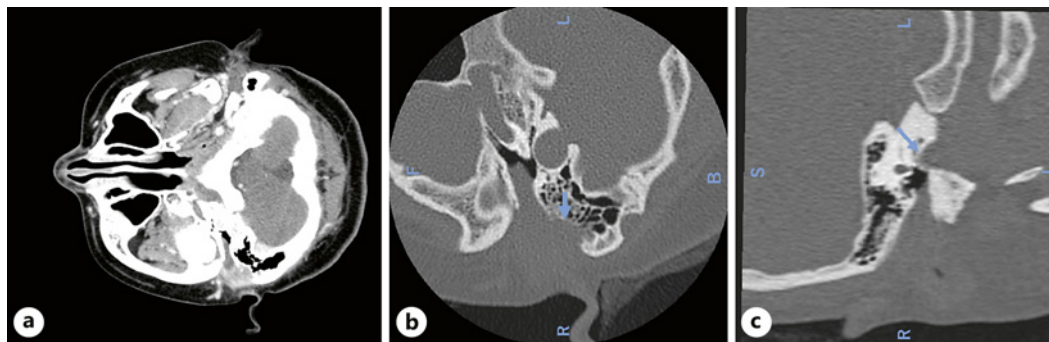


Fig. 2. a, b The tumor, with contrast enhancement in the right external auditory canal, which had invaded the mastoid cells. c A high venous arch was observed.

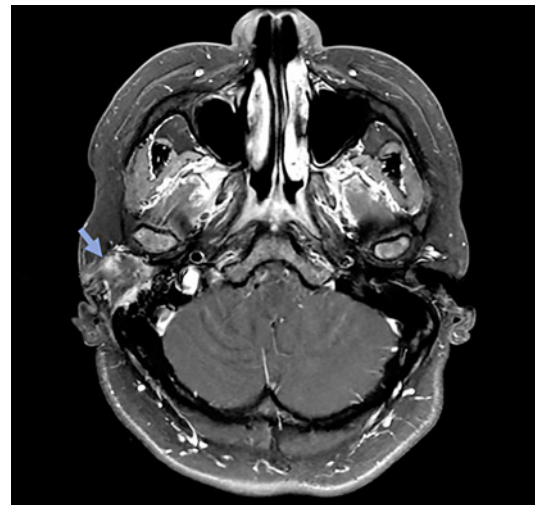


Fig. 3. Mass with contrast effect in the same area as CT, with no facial nerve involvement.

base during surgery [4]. It has also been reported to be useful in mandibular odontogenic keratocysts [5]. In otorhinolaryngology, it is generally used in nasal sinus surgery and for evaluation of the nasal sinus region [6–8], pterygopalatine fossa [9], and parotid calculus [10].

Navigation can be optical or magnetic. In optical navigation, a dedicated tracker is attached to the instrument and the patient is recognized by an infrared camera to determine their location. The instruments must always be operated in accordance with the orientation of the infrared camera; if the path is blocked by a person or another instrument between the infrared camera and the tracker, this can lead to poor recognition by the navigation system. In contrast, magnetic navigation generates a low-energy magnetic field in the surgical field and tracks the patient's position and the movement of the instruments by placing the patient and instruments to which a dedicated tracker is attached within the magnetic field area. There is no need to manipulate instruments in accordance with the orientation of the camera, and navigation is rarely affected by the intrusion of a person or another instrument between the magnetic field generator and the tracker. Therefore, the magnetic field type is considered easier to use in surgery, where free manipulation of instruments is required, compared to the optical type, as it allows for continuous navigation with normal instrument manipulation. In addition, the tracker is approximately thumb-sized and is lightweight; therefore, it is thought to reduce the stress on the surgeon. The Stryker ENT navigation system used in this study is a magnetic field-type navigation system that is useful in otorhinolaryngological surgery. The

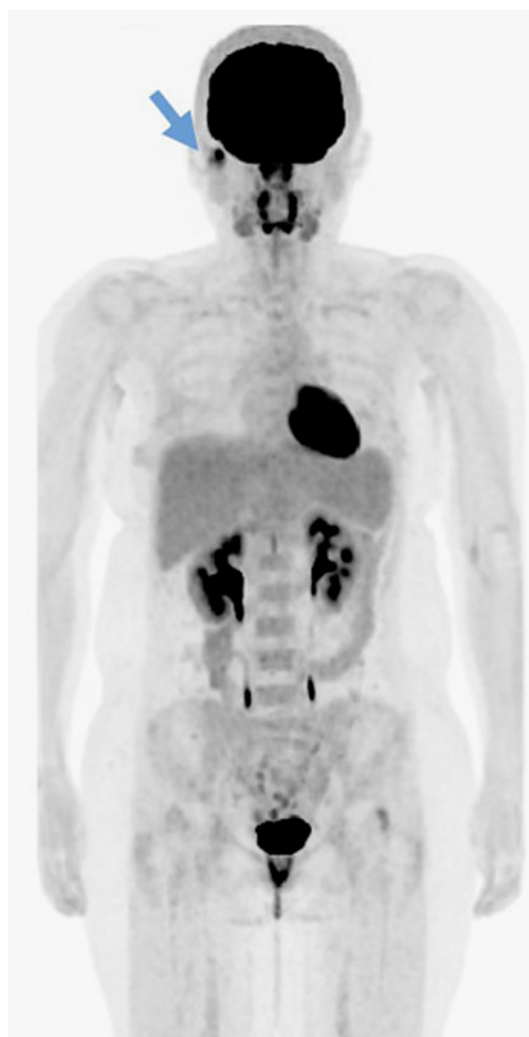


Fig. 4. PET-CT findings. There were no other findings suggestive of distant metastasis.



Fig. 5. Postoperative findings.

navigation system supports the surgeon's knowledge and technique, enabling safer and more accurate surgery, and is useful for educational purposes through image sharing. However, one disadvantage of navigation systems is that intraoperative manipulation can cause misalignments [11]. The accuracy of navigation in clinical use is said to be 1–2 mm [12, 13], but in temporal bone

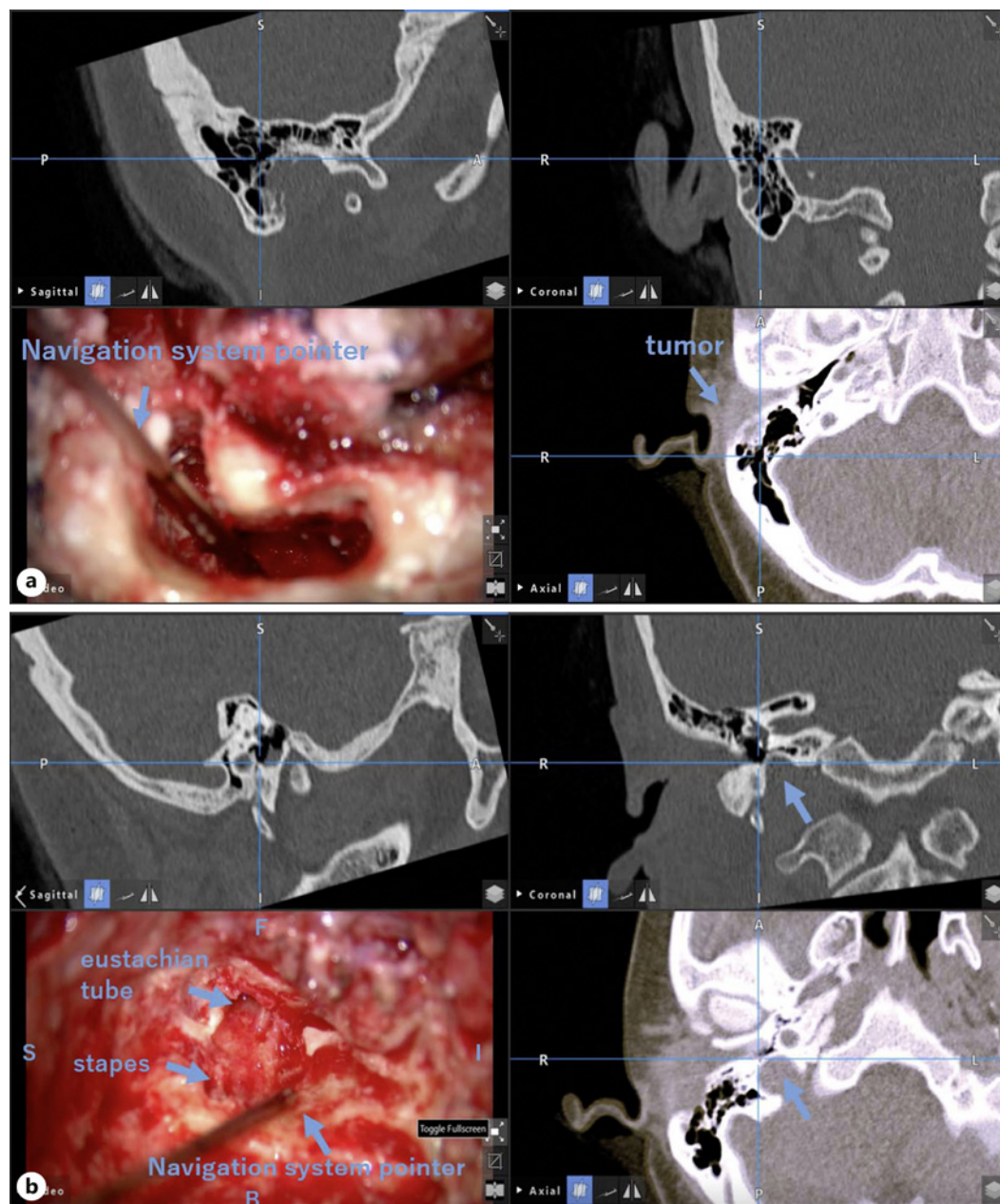


Fig. 6. **a** Determining the area of tumor infiltration into the mastoid cells during surgery. **b** After removal, it was confirmed that the bony wall of the high venous arch was preserved.

use, the error has been reported as approximately 0.5 mm in a cadaveric model [14]. Some reports indicate that otolaryngologists sometimes omit navigation of the middle and posterior cranial fossa because of inadequate accuracy [15]. In the present case, there were instances of misalignment even during the use of intraoperative navigation. Possible causes include the effect of the microscope's specular surface on the magnetic field, changes in morphology due to surgical maneuvers, lesion changes, intraoperative head decompression, and the use of forceps in the operative field. An evaluation of the accuracy of different registrations to reduce misalignment has also been performed [16]. However, the navigation system used in this study allowed intraoperative position correction, in which it was possible to safely perform the surgery if misalignment was detected, by

re-recognizing and adjusting the position using the stapes. Because intraoperative misalignment can occur during any surgery, this intraoperative correction function is also considered useful in other cases. In addition, although an NIM monitor was used in this case, the NIM monitor and navigation can be used together in otology because temporary, single-shot facial nerve stimulation does not affect magnetic field navigation.

In this case, the intraoperative navigation system was useful because lateral temporal bone resection is rare and because of the presence of a high venous arch. Lateral temporal bone resection requires cutting the caudal and anterior sides of the tympanic chamber bone, which is rarely performed in ear surgery. The risk of damage increases when the internal carotid artery is deep on the anterior side and there is a high venous arch on the caudal side, as in this case. For the higher venous arch, alternative methods were used to expose the internal jugular vein to confirm the critical point or to ligate or embolize the vein; however, the use of a navigation system made it possible to perform the procedure without destroying the bone wall surrounding the vein, thus being less invasive to the patient. Even in the absence of malformations, such as abnormalities in the vascular motion of the high venous arch, when performing surgery for auditory canal cancer, the canal wall-up technique differs from normal tympanoplasty in that it is performed if the cancer has invaded the mastoid, as in this case, and the surgery cannot be performed while removing the external auditory canal skin and confirming the external auditory canal motion of the bone. This may lead to a missed location, which is different from usual ear surgery and may lead to the seeding of cancer cells owing to perforation or ablation of the cancerous tumor. The advantage of using the navigation system in this case was that the procedure could be performed without intraoperative damage to vital tissues, and the tumor could be removed without incision. However, the time required for the surgery was not shortened because the surgeon had to check the navigation system while performing the surgery. In this regard, it will be necessary to devise ways to shorten the operation time and reduce the burden on the patient in combination with preoperative simulations in the future. In lateral temporal bone resections, which require cutting and other procedures that are not usually performed in tympanoplasty, navigation may be useful to confirm the location of abnormal blood vessels, even if they are not as abnormal as in this case. However, because it uses magnetism, it is necessary to confirm whether or not pacemakers, implantable cardioverter defibrillators, and other metal implants are affected by magnetism and whether or not they may not be used, so preoperative confirmation is required.

We encountered a case of adenoid cystic carcinoma of the external auditory canal, in which lateral temporal bone resection was performed using a navigation system. The navigation system is useful as a surgical aid for lateral temporal bone resection. The use of a navigation system is expected to improve surgical accuracy and safety. The navigation system is considered more useful in surgeries for rare cases and for cases with unusual structures, such as a high venous arch, as in the present case.

Statement of Ethics

Written informed consent was obtained from the patients regarding the use of their personal information, privacy protection, and publishing. Ethical approval is not required for this study in accordance with local or national guidelines. The CARE Checklist has been completed by the authors for this case report, attached as online supplementary material (for all online suppl. material, see <https://doi.org/10.1159/000542927>).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Ryota Tomioka: drafted the article and revised the article. Yusuke Aihara: conceptualization and investigation. Kiyoaki Tsukahara: supervision and writing – reviewing and editing.

Data Availability Statement

The datasets generated and/or analyzed during the current study are not publicly available due patient privacy but are available from the corresponding author on reasonable request.

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