CASE REPORT



PET-CT-based resection guide for treatment of auricular squamous cell carcinoma: an innovative clinical management of soft tissue tumors: a case report

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Abstract

Purpose To describe the successful use of a PET-CT-based resection guide for the treatment of auricular squamous cell carcinoma.

Case presentation A 69-year-old male presented with a painless growing mass in his left ear helix that had been unsuccessfully treated conservatively by another surgeon. An incisional biopsy revealed moderately differentiated squamous cell carcinoma, and the patient was referred to the department for further management. A PET/CT was performed, which showed uptake of FDG in the ear with a SUV max value and T3N0M0 status. The treatment plan was based on a multidisciplinary team discussion and a thorough evaluation of the PET/CT imaging findings. A decision was made to proceed with excision of the mass with a wide safety margin, using a PET/CT-based resection guide for ear resection. Additionally, partial temporal bone resection, selective neck dissection, and superficial parotidectomy were planned. The patient opted for reconstruction with a scalp rotational flap. The patient's treatment plan was successful, and at follow-up visits, he remained disease-free. This case report highlights the importance of using a PET-CT-based resection guide for the treatment of soft tissue tumors, specifically auricular squamous cell carcinoma. It also demonstrates the importance of a multidisciplinary team approach and thorough evaluation of imaging findings in determining an effective treatment plan for patients.

Conclusions The use of PET-CT-based resection guide can be an effective tool in the treatment of auricular squamous cell carcinoma. It can provide more precise and accurate information about the extent of the tumor, leading to a more effective treatment plan. Multidisciplinary team approach and thorough evaluation of imaging findings are crucial in determining the best course of treatment for patients.

Keywords PET-CT, Resection guide, Auricular squamous cell carcinoma, Soft tissue tumors, Multidisciplinary team, Partial temporal bone resection, Safety margin, Case report

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Introduction

Primary malignant tumors of the external ear are rare, accounting for less than 1% of all head and neck tumors [1]. These tumors can arise from various structures within the ear, including the skin, cartilage, and bone [2]. Due to the complex anatomy of the external ear, treatment options can vary depending on the location and extent of the tumor [1, 2].

Surgical excision is often the preferred method of treatment for these tumors, particularly when the tumors are small and localized. In some cases, micrographic surgery may be used by dermatologists to remove the tumor while preserving as much healthy tissue as possible [3]. Radiotherapy may also be used as a primary treatment option, particularly for tumors that are difficult to remove surgically [4].

In recent years, there has been growing interest in the use of chemoradiotherapy following surgery as a way to improve outcomes for patients with primary malignant tumors of the external ear [5]. While this approach has been shown to be effective in improving local tumor control, it can also result in significant side effects and complications and is generally reserved for patients with more advanced tumors or who are at high risk for recurrence [4, 5].

The main aim in treating head and neck cancers is to achieve intraoperative tumor free margin. This is the only prognostic factor in oncology that is controlled by the surgeon. Many trials were done to achieve this goal. Using computer-assisted surgery (CAS) is a rising modality to reach this aim. Several studies used the CT imaging modality for CAS. In this study, PET/CT was used to perform CAS, in order to achieve tumor-free surgical margin (R_0) [6, 7]. It is not common to fabricate resection guides for soft tissue cancers. There is a case report done by Wu et al. for fabrication of resection guide based on MRI for breast-conserving surgery in breast cancer. He obtained free surgical margins with that resection guide design [8].

Overall, the prognosis for patients with primary malignant tumors of the external ear is generally good, particularly when the tumors are diagnosed and treated early. However, the rarity and complexity of these tumors highlight the importance of seeking care from experienced specialists who can develop an individualized treatment plan based on the specific characteristics of the tumor and the needs of the patient.

Case presentation

The patient is a 69-year-old male with controlled hypertension, who presented with a painless growing mass in his left ear helix that had been present for 8 months. The mass had been unsuccessfully treated conservatively by another surgeon, and an incisional biopsy was taken, revealing moderately differentiated squamous cell carcinoma. The patient was subsequently referred to the oral and maxillofacial department for further management.

At presentation, the mass had grown to approximately 5×5 cm, involving almost the entire ear and with areas of fungation. The neck examination revealed a palpable jugulodigastric lymph node. A PET/CT was performed to stage the tumor, which showed uptake of FDG in the ear with a SUV max value of 6.8 and T3N0M0 status (Fig. 1).

There was also slight uptake of the parotid lymph nodes, which were provisionally considered to be inflammatory. A PET/CT scans of the head and neck and lymph node study with a less than 1-mm pitch are done. The obtained digital imaging in the sort of DICOM files (Digital Imaging and Communications in Medicine) is imported into Mimics Medical 21.0 software (Materialise NV Technologielaan 15 3001 Leuven, Belgium) and is 3-dimensionally rendered into models of the tumoraffected part, which are transferred to 3-matic Medical 13.0 (Materialise NV Technologielaan 15 3001 Leuven, Belgium) to be virtually analyzed and surgically planned

Fig. 1 Depicting a medical imaging scan of the left auricle of a patient with squamous cell carcinoma (SCC) using a combination of positron emission tomography (PET) and computed tomography (CT)



using the various tools provided by this software. Virtual tumor resection with safety margin is carried out based on the planned resection margins which will be determined by the PET/CT and operator. According to it, a patient-specific resection guides are fabricated by fusion deposition modeling 3D-printing technique (Figs. 2 and 3).

After discussing treatment options with the patient, the surgical team made a decision to proceed with excision of the mass with a wide safety margin, using a PET/CT-based resection guide for ear resection. Additionally, partial temporal bone resection, selective neck dissection from levels II–V, and superficial parotidectomy were planned (Fig. 4). A reconstruction with a scalp transposition flap was chosen by the patient rather than an ALT free flap. Overall, the patient's treatment plan was based on a multidisciplinary team discussion and a thorough evaluation of the PET/CT imaging findings (Fig. 5). Intraoperative frozen section confirmed the negative and adequate surgical margins. It was further confirmed in the final pathology.

Discussion

Squamous cell carcinoma (SCC) of the auricle can extend into the external auditory canal (EAC), rendering the treatment to be more complex and mutilating. Resection



Fig. 2 Demonstrating the virtual planning of the tumor segmentation, tumor wrapping with a safety margin, and guide designing. The image illustrates the importance of using advanced imaging techniques such as PET/CT to visualize the tumor and surrounding structures accurately. The red outline indicates the tumor segmentation, and a safety margin is added to ensure complete removal of the tumor (R0). The guide is designed based on these measurements to provide a precise outline for the surgeon during the resection procedure. This virtual planning can help improve the accuracy and effectiveness of the surgical procedure, resulting in better patient outcomes



Fig. 3 Showing the preoperative guide trial for fitting. The image demonstrates the use of a PET/CT-based resection guide during the preoperative planning phase to ensure accurate placement and fitting. The guide is designed to provide a precise outline for the surgeon during the resection procedure and is customized to fit the unique anatomy of the patient. This preoperative guide trial for fitting can help improve the accuracy and effectiveness of the surgical procedure, resulting in better patient outcomes

of the tumor with free surgical margin is the main cornerstone for better overall survival. Prophylactic neck dissection and superficial parotidectomy in tumors from T3 and T4 need to be done. To achieve this aim, a multidisciplinary team approach is needed [9].



Fig. 4 a Surgical wound after ear resection. **b** Partial temporal bone resection. **c** Selective neck dissection + superficial parotidectomy. **d** Wound closure with transposition scalp flap and split thickness skin graft for the donor site healing



Fig. 5 Healing after 1 year and 3 months postoperative and 1 year post radiation

The team is composed of maxillofacial, otology, and plastic surgeons. The soft tissue free surgical margin was achieved by using PET/CT-based resection guide and confirmed with frozen section and final pathology, intraoperative and postoperative, respectively. The EAC extension was managed by partial temporal bone resection. This is because the Resection guides lack the controlling for the depth of resection, which is a limitation for their usage. The judgment of the surgical margin in large-sized tumors is difficult. To confirm the adequacy of clinical-based surgical margin, the surgeon confirms with a frozen section [10].

Another modality to aid the surgeon in deciding the surgical margin is usage of resection guides. Computerassisted surgery is used widely in the field of maxillofacial surgery. The main usage of the resection guides is for bone tumor resection rather than soft tissue resection [6]. Ear resection guide is new to be done in the field of oncological resection. To overcome the nature that the ear is a compressible structure and also the landmarks around it are mainly soft tissue, we decided to fabricate the guide to have support on the skin over mastoid and zygoma and lateral orbital wall areas. The skin in these areas are thin, less mobile as in the mastoid area, and the bone is near the skin.

The other alternative to make a guided resection is to use the navigation system which is not available in our setting. Previously, a soft tissue resection guide was successfully created and used by Wu Z. Y. et al. for breastconserving surgery in breast cancer patients who had undergone neoadjuvant chemotherapy [8]. However, there is currently no literature on the use of PET/CT-based resection guides for squamous cell carcinoma of the ear pinna. PET/CT was utilized to stage and segment the tumor for imaging purposes.

The segmentation was based on PET/CT rather than a single modality such as CT or MRI. The localization and delineation of the primary tumor are important in management of head and neck cancer patients. PET/CT provides both the biological behavior of the tumor beside the anatomy obtained by CT or MRI. It makes the delineation of gross tumor volume (GTV) better and decreases the interobserver variability compared to a single imaging modality. This is why PET/CT is used to customize the radiotherapy plan according to the tumor's metabolic behavior [11]. Also, it makes the manual tumor segmentation easier and subject the process to less interobserver variation [12].

Conclusion and future recommendations

PET/CT-based resection guides show promise in helping achieve safe and effective resection of squamous cell carcinoma of the auricle. Resection with adequate free surgical margins is essential for improving survival outcomes in this type of cancer. However, complete resection can be difficult due to the extension of tumors into nearby structures like the external auditory canal. Resection guides fabricated based on PET/CT segmentations may help surgeons to achieve adequate margins while minimizing unnecessary tissue removal.

The PET/CT provides both anatomical and metabolic information that can improve the delineation of tumor volume and margins. While resection guides have been used commonly for bone tumors, ear resection guides are relatively new and represent an innovative approach that may help overcome challenges posed by the ear's compressible and soft tissue-dominated anatomy. Further studies are needed to validate the effectiveness and safety of PET/CT-based ear resection guides to guide surgical management of squamous cell carcinoma of the auricle.

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Authors' contributions

MM, MN, and HS were responsible for writing the main manuscript text. MM, MN, AN, MA, and AG conducted the required procedures. HS provided supervision throughout the entire project and contributed to the clinical debate in the discussion section. All authors reviewed the manuscript.

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Availability of data and materials

Any data is available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of Ain Shams Faculty of Dentistry Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Consent for publication

Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Competing interests

The authors declare that they have no competing interests.

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