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CASE REPORT

Foreign body removal assisted by an intraoral ultrasound probe

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Abstract
Ultrasonography has recently been applied to the field of oral and maxillofacial surgery because of its noninvasiveness and ease of use. However, traditional transducers are not used in the intraoral area because of their large size. A novel intraoral transducer was introduced with size, volume, and axis modifications. This new transducer allows the surgeon to approach the intraoral region during dental procedures. This report describes a case of successful removal of a foreign body using the newly developed intraoral ultrasound probe. Precise localization and minimally invasive removal of the foreign body using the intraoral transducer were simultaneously conducted. Because of its many advantages, this intraoral ultrasound transducer has the potential to be applied in oral and maxillofacial surgery.

Keywords Foreign body · Ultrasound · Intraoral probe · Transducer · Ultrasonography

Introduction

The use of ultrasonography in the oral and maxillofacial regions has recently increased because of concern regarding the radiation dose of existing radiography systems and the high usability of ultrasonography during the operation [1]. Ultrasonography is beneficial because it is noninvasive and facilitates detection in both hard and soft tissues in the oral and maxillofacial regions [2]. Ultrasonography is used to aid oral surgery in various ways, including identification and measurement of tongue cancers, detection of sialolithiasis, detection of abscess formation, and performance of ultrasound-guided fine-needle aspiration [1–3]. It is useful for evaluation of bone fractures in the dentomaxillofacial region, diagnosis of temporomandibular joint disease or salivary gland disease, examination of cervical lymph nodes, and measurement of the muscle thickness or blood flow in cervical vessels [1, 4, 5]. Diagnostic ultrasound transmits high-frequency waves of more than 20 kHz through a piezoelectric transducer and provides an image by detecting the echo returned from the tissue interface. The ultrasonography transducer currently in use has been applied to the abdomen, heart, and vagina, which have relatively broad surfaces. In the oral and maxillofacial regions, this type of transducer can only be applied to the surface of the extraoral region. However, the size and volume of this transducer interfere with adaptation in intraoral regions such as the floor of the mouth, palatal gingiva, and buccal gingiva in the molar area and near the mylohyoid ridge [6]. The size and shape of more recently developed intraoral transducers have been modified compared with existing transducers, allowing for free use in various intraoral regions. We herein present an experimental case involving a foreign body in the intraoral region in which we used a recently developed intraoral transducer before and during surgery to diagnose, confirm, and remove the foreign body.

Case report

A 71-year-old woman visited the Advanced General Dentistry Department of Yonsei University Dental Hospital because of a 1-month history of discomfort and irritation under the right tongue area. The patient had previously visited the ear–nose–throat department at a local clinic for the same condition. She was prescribed an antibiotic and analgesic but experienced no improvement. During her visit to that clinic, she was told that no other abnormal findings were present on ear–nose–throat fiberscope examination.

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Fig. 1 Preoperative panoramic radiograph. A vertically oriented linear foreign body was observed between the first and second right mandibular molars

At our hospital, intraoral clinical examination revealed no other abnormal findings except for reduced salivary secretion via the right Wharton's duct. On a panoramic radiograph, we found an approximately 2.0-cm linear radiopaque foreign body in the right mandibular molar area (Fig. 1). However, the foreign body was not visible on a periapical view. During the course of obtaining the periapical view, the film was located between the mandible and the tongue. Therefore, we concluded that a linear foreign body was located in the soft tissue near the tongue and submandibular space, not in the mandible or buccal vestibule. Computed tomography (CT) of the neck was performed for more accurate localization of the foreign body. On the axial view, the foreign body had a round shape, and its position and direction were analyzed in three dimensions (Fig. 2a, b). This made it possible to assess the relationship of the foreign body with Wharton's duct and the inferior alveolar nerve canal, which are key anatomical landmarks in the mandible. The foreign body was positioned vertical to Wharton's duct and the inferior alveolar nerve canal, and rod-shaped high-attenuation material was present in the right submandibular space (Fig. 2c). We also used ultrasonography to measure the thickness of the soft tissue and determine the depth of the foreign body. For this purpose, we used an intraoral transducer (IO8-17; Alpinion, Seoul, Korea) that can operate at 3 to 12 MHz and was designed for use in various intraoral areas. The intraoral transducer is equipped with an ultrasound imaging device (E-cube 9; Alpinion) approximately 10 mm in width and 30 mm in length. We obtained the image by placing the intraoral transducer close to the mucosa of the right mandibular body area and dorsal tongue (Fig. 3a). The foreign body appeared as a line in the image when we placed the intraoral transducer parallel to the axis of the teeth (Fig. 3b). Conversely, the foreign body appeared as a dot when we placed the intraoral transducer vertical to the axis of the teeth. These images provided us with an opportunity to determine the approximate position and direction of the foreign body as well as its size and shape during the operation. Based on

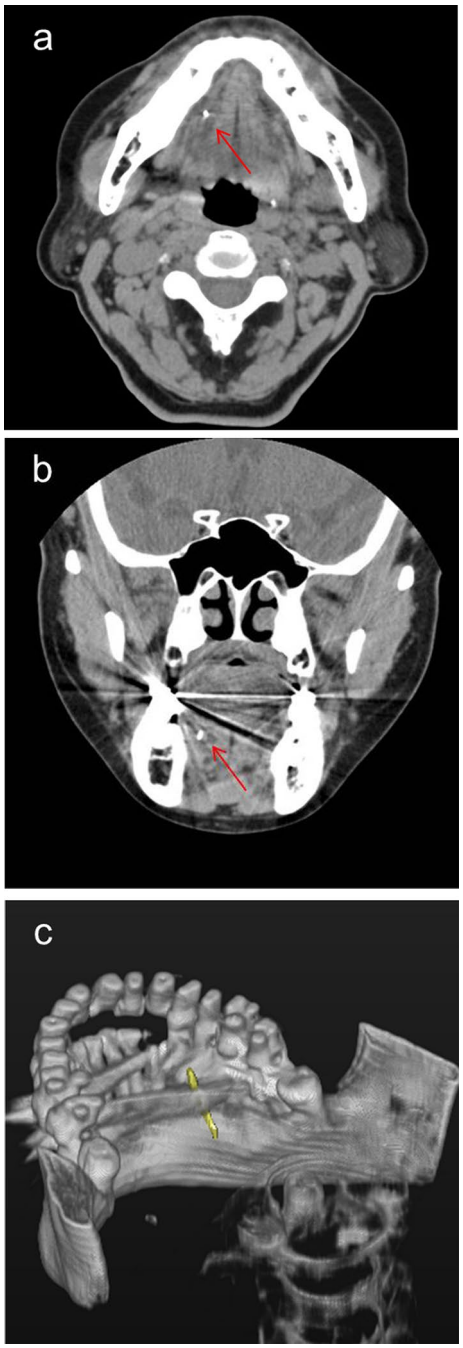

Fig. 2 Preoperative computed tomography. **a** Axial view. **b** Coronal view. A round radiopaque foreign body was found in the right submandibular area. **c** Three-dimensional reconstruction using Simplant® dental planning software (Dentsply Sirona, York, PA, USA)

the information obtained from the images, we determined that the foreign body was located between the right side of the tongue and the ipsilateral submandibular space.

We planned to remove the foreign body under local anesthesia and use an intraoral transducer during surgery to obtain a real-time image of the soft tissue. First, we retracted

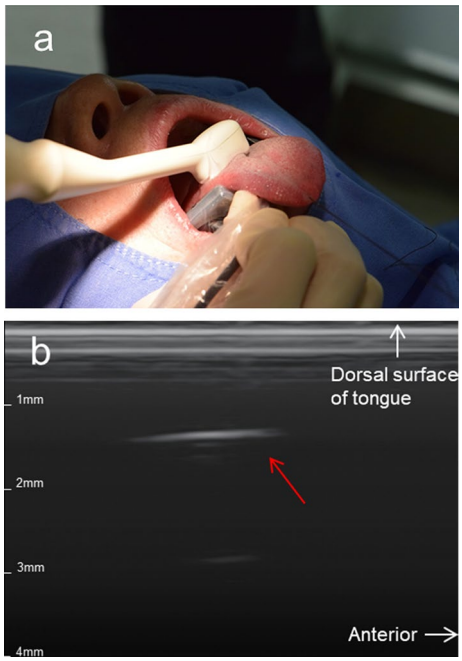

Fig. 3 **a** The intraoral transducer and X-ray film were applied below and above the tongue, respectively. The intraoral transducer was placed transversely on the tongue. **b** Ultrasound image of the foreign body (red arrow) when the intraoral transducer was applied longitudinally on the tongue

the tongue forward using 3–0 silk to prevent the tongue from interfering with the surgeon's field of view and approach. Next, we localized the area where we expected to find the foreign body using a periodontal probe and portable X-ray system. For areas where the X-ray film could not reach (e.g., under the tongue or on the floor of the mouth), we freely used an intraoral transducer without inducing a gag reflex, pain, or discomfort for the patient during surgery. The incision was minimal with the help of X-ray and ultrasonography, and close attention was given to avoid damaging Wharton's duct and the lingual nerve during incision and dissection. Because the patient was locally anesthetized in the intraoral region, she could express her feelings and communicate with the dentist during surgery. She reported discomfort when we approached the foreign body and felt movement of the foreign body. Finally, we found the foreign body and removed it from where it was encircled by the lingual area of the right mandibular first molar and lateral side of the right tongue and mouth floor. The foreign body was a wire-like material of about 21 mm in length (Fig. 4). After removal of the foreign body, sufficient irrigation was conducted using saline and chlorhexidine around the area where the foreign body had been located. The wound was closed layer by layer using 3–0 absorbable suture material. No linear high-attenuation material was present on a postoperative panoramic radiograph. The day after the operation,

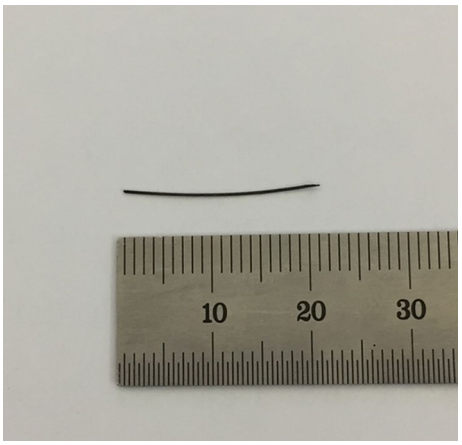

Fig. 4 Removal of the foreign body. The foreign body was a 2.1-cm-long steel wire

postoperative dressing was conducted and no lingual nerve damage was present. The sutures were removed 1 week later, and good wound healing was observed. No complications occurred during continuous follow-up appointments.

Discussion

Ultrasonography is an imaging technique with high clinical potential that can be used in the head and neck region because of its noninvasiveness, painlessness, and economic benefit. It can be adequately applied on moving material or soft tissue lesions. Because of certain characteristics of the oral and maxillofacial regions, such as limitation of access and complex anatomical structures, ultrasonography offers many benefits in the diagnosis of head and neck diseases [3]. Usefulness of intraoral ultrasonography in the head and neck region was noted in the 1980s [7]. However, an efficient intraoral transducer has not been developed for widespread use. In this case, we used ultrasonography and an intraoral transducer to visualize a foreign body in the oral soft tissue and establish a differential diagnosis. We obtained detailed information on the approximate size, shape, position, and orientation of the foreign body using an intraoral transducer, and we used this transducer constantly during surgery to facilitate successful removal of the foreign body. In particular, ultrasonography has higher sensitivity and specificity for soft tissue than other diagnostic instruments such as radiography, CT, and magnetic resonance imaging. Therefore, it is useful for the diagnosis and treatment of soft tissue-related diseases or abnormalities [8]. Similar to our case, ultrasound-guided needle biopsy has been shown to be a safe and reliable diagnostic tool because it has high diagnostic yield in detecting abnormalities of the facial and cervical regions [2]. An intraoral transducer that can be used more

freely in the intraoral region than the existing transducer was recently developed, and its small size and shape allow it to be used for diagnosis and treatment of intraoral diseases. Consequently, ultrasonography is useful and applicable to a broader oral and maxillofacial region because of the aid provided by the intraoral transducer, and it can become a powerful diagnostic tool for soft tissue.

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Compliance with ethical standards

Conflict of interest Kee-Deog Kim and Wonse Park have received research grants from the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (Grant number HI16C0822). Eun-Jung Kwak and Nan-Ju Lee declare that they have no conflict of interest.

Human rights statement All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

Informed consent Informed consent was obtained from the patient for being included in the study.

Animal rights statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

References

1. Evirgen S, Kamburoglu K. Review on the applications of ultrasonography in dentomaxillofacial region. World J Radiol. 2016;8:50–8.
2. Wakasugi-Sato N, Kodama M, Matsuo K, Yamamoto N, Oda M, Ishikawa A, et al. Advanced clinical usefulness of ultrasonography for diseases in oral and maxillofacial regions. Int J Dent. 2010;2010:639382.
3. Rama Mohan K, Koteswara Rao N, Leela Krishna G, Santosh Kumar V, Ranganath N, Vijaya Lakshmi U. Role of ultrasonography in oral and maxillofacial surgery: a review of literature. J Maxillofac Oral Surg. 2015;14:162–70.
4. Marotti J, Heger S, Tinschert J, Tortamano P, Chuembou F, Radermacher K, et al. Recent advances of ultrasound imaging in dentistry—a review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;115:819–32.
5. Karumuri SK, Rastogi T, Beeraka K, Penumatcha MR, Olepu SR. Ultrasound: a revenant therapeutic modality in dentistry. J Clin Diagn Res. 2016;10:ZE08–Z12.
6. Salmon B, Le Denmat D. Intraoral ultrasonography: development of a specific high-frequency probe and clinical pilot study. Clin Oral Investig. 2012;16:643–9.
7. Yoshida H, Akizuki H, Michi K. Intraoral ultrasonic scanning as a diagnostic aid. J Craniomaxillofac Surg. 1987;15:306–11.
8. Oikarinen KS, Nieminen TM, Makarainen H, Pyhtinen J. Visibility of foreign bodies in soft tissue in plain radiographs, computed tomography, magnetic resonance imaging, and ultrasound. An in vitro study. Int J Oral Maxillofac Surg. 1993;22:119–24.