Article published online: 2024-11-08

Case Report

CBCT Guidance for Removing Foreign Object from the Jawbone: A Case Study

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Abstract

Foreign objects lodged in the mandibular bone often result from trauma or dental procedures. Accurate localization of these foreign objects is crucial for guided surgical removal, especially when patients present with persistent pain. Conventional imaging modalities like periapical and panoramic radiographs may not provide sufficient detail for precise localization. Cone beam computed tomography (CBCT) has emerged as a valuable tool for guided surgical interventions owing to its superior imaging capabilities. We present two cases of foreign objects lodged in the mandible, where patients complained of prolonged pain, soreness, and numbness in the right mandible extending to the head and behind the ear. Both patients had undergone previous right mandibular tooth extractions and received treatment from a neurologist without resolution of symptoms. Both cases showed the control improvement in complaints, and no paresthesia or postoperative complications were found. CBCT-guided surgical removal was performed in both cases, revealing a metal specimen measuring $6 \times 3 \times 1$ mm^3 in the first patient and a remaining root measuring $5 \times 3 \times 2\,mm^3$ in the second patient. Diagnosing foreign objects in the mandible poses challenges due to their varied size, composition, and proximity to vital structures. CBCT offers superior imaging resolution, enabling precise localization and assessment of anatomical relationships, such as the distance to the inferior alveolar nerve and surrounding boundaries. CBCT emerges as the preferred imaging modality for diagnosing and guiding the surgical removal of foreign objects in the mandible. Its advantages include accurate localization, low radiation exposure, and cost-effectiveness. Compared with CT scans, CBCT also offers faster scanning times, making it a valuable tool in clinical practice for managing such cases

Keywords
- CBCT
- foreign objects
- mandible
- medicine
- medical care

DOI https://doi.org/10.1055/s-0044-1791557.
ISSN 2320-4753.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

Foreign objects in the head and neck region, often resulting from trauma or iatrogenic causes, present a significant clinical challenge. Retained fragments of surgical instruments or teeth postsurgery can lead to severe complications if not accurately identified and removed.[1,2] The detection and precise localization of these foreign objects are crucial for effective management and minimizing patient morbidity.[3] However, traditional imaging modalities such as radiographs are limited by their two-dimensional nature, which can obscure the exact position of these objects.[4]

Accidental displacement of a tooth fragment or a complete tooth into an adjacent anatomical space (e.g., maxillary sinus, infratemporal fossa, buccal space, submandibular space, pterygomandibular space, and lateral pharyngeal space) can be considered a foreign object and is a rare occurrence that requires special treatment in each case.[5]

Computed tomography (CT) has long been regarded as the gold standard for detecting foreign objects due to its high resolution and ability to provide detailed images. However, the high radiation dose and prolonged scanning times associated with CT present significant drawbacks, especially in sensitive head and neck areas.[6] Magnetic resonance imaging (MRI) and ultrasound (US) are useful alternatives for detecting foreign objects in soft tissues, but MRI is ineffective for metallic objects, and both modalities have limitations in visualizing bony structures.[7,8]

The urgency of accurately locating foreign objects is underscored by the potential complications they can cause, including pain, swelling, intracranial abscesses, and wound dehiscence.[9] These complications not only prolong patient recovery but can also lead to more severe health issues if not addressed promptly. In particular, foreign objects located near critical structures such as blood vessels and nerves pose a high risk, necessitating precise and minimally invasive removal techniques.[9] In edentulous patients, the challenge is further compounded by the increased risk of bone loss and difficulty in maintaining anatomical orientation.[10]

Cone beam computed tomography (CBCT) has emerged as a crucial tool in this context, offering several advantages over traditional imaging methods. CBCT provides three-dimensional (3D) visualization of the maxillofacial skeletal structure, enabling more accurate and efficient surgical planning and intervention.[11] The lower radiation dose and shorter scanning times make CBCT a safer option for patients, while its high-resolution images facilitate the precise localization of foreign objects, even in complex anatomical regions.[12]

In 2014, Kaviani et al[2] evaluated the diagnostic accuracy of CT and CBCT for detection of foreign bodies (FBs), namely, metal, tooth, wood, plastic, glass stone, and graphite. They reported that except for wood, all FBs were visible on both CT and CBCT scans.

The integration of CBCT in surgical procedures for the removal of foreign objects represents a significant advancement in maxillofacial surgery. By improving the accuracy and safety of these interventions, CBCT not only enhances patient outcomes but also reduces the risk of complications and the need for multiple surgeries.[13] This case study highlights the effective use of CBCT guidance in the removal of foreign objects from the jawbone, demonstrating its potential to become a standard practice in similar clinical scenarios.

CBCT is particularly useful in cross-sectional imaging for implant placement, assessment of dental trauma, and evaluation of cleft lip and palate cases due to its lower radiation dose and high-resolution images.[14] It also aids in orthognathic surgery planning by providing detailed 3D datasets of the craniofacial skeleton. In situations where panoramic radiographs suggest a direct relationship between the third mandibular molar and the mandibular canal, CBCT is recommended for precise surgical planning and to ensure safe and effective removal of foreign objects.[15]

Case Report

Case 1

A 39-year-old female patient (►**Fig. 1**) who agreed to be made into a case report came to Dental Hospital Universitas Airlangga Surabaya with complaints of pain, discomfort, and numbness in the lower right jaw, spreading to the head and back of the ear. The patient had previously been treated by neurology, but had not improved. There were no complaints of leg pain, and there had never been a complaint of salty fluid leak. She had a 21-year-old lower jaw tooth extraction history. History of hypertension, diabetes, and drug allergy was suspected.

In a general status examination within normal limits, an extraoral maxillofacial examination did not find edema and hyperemia, and an intraoral examination did not find edema, hyperemia, or pain. Edentulous ridges were found in regions 37, 38, 46, 47, and 48. Laboratory and chest X-ray results were within normal limits.

The panoramic radiograph showed the presence of a radiopaque image in region 48 near the mandibular canal (►**Fig. 2**).

We use the CBCT scan (Instrumentarium OP300, PaloDEx Group Oy, Finland) to determine the correct position and as a guide for surgery during the removal of foreign objects. The result of the CBCT scan is shown in ►**Fig. 3**. From the CBCT, we could determine that the length of the foreign objects was approximately 7 to 8 mm^3.

Case Management

Our patient was diagnosed with a foreign object in the right mandibular region and we treated them with exploration and extraction of the foreign object under general anesthesia. Before the operation, a surgical guide *dental gutta percha point* was used to determine the position of the incision (►**Fig. 4**). During the operation, we first marked the area using a CBCT guide, as a guide for bone reduction. ►**Fig. 5** shows the steps of the operation. Exploration was done carefully with a low-speed burr until a sufficient bone window was obtained. Then, extraction of the foreign object was performed. We obtained a $6 \times 3 \times 1$ mm^3 metal specimen (►**Fig. 6**). Then, we performed the closure of the surgical area with an interrupted suture (►**Fig. 7**). On the first postoperative day, we performed panoramic and periapical radiographs for evaluation and no FB residue, fracture, or minimal pain were found (►**Fig. 8**). At

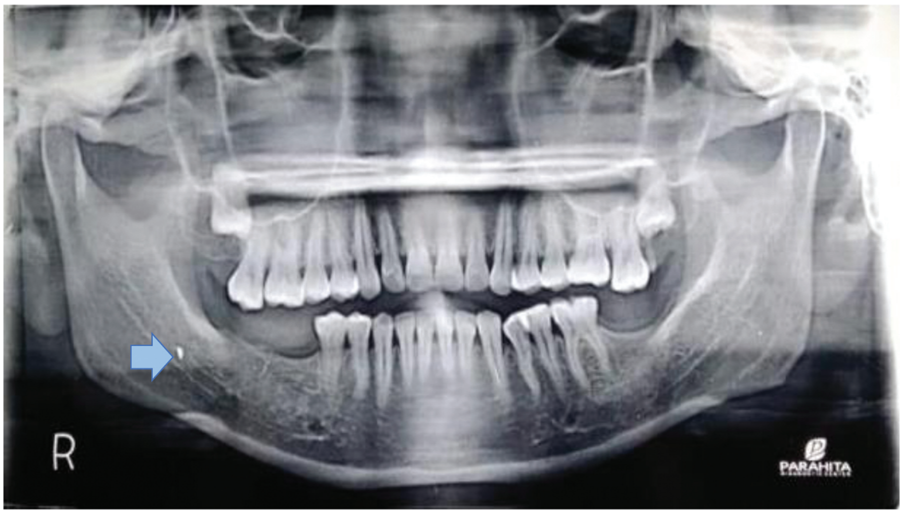

Fig. 1 Panoramic radiograph.

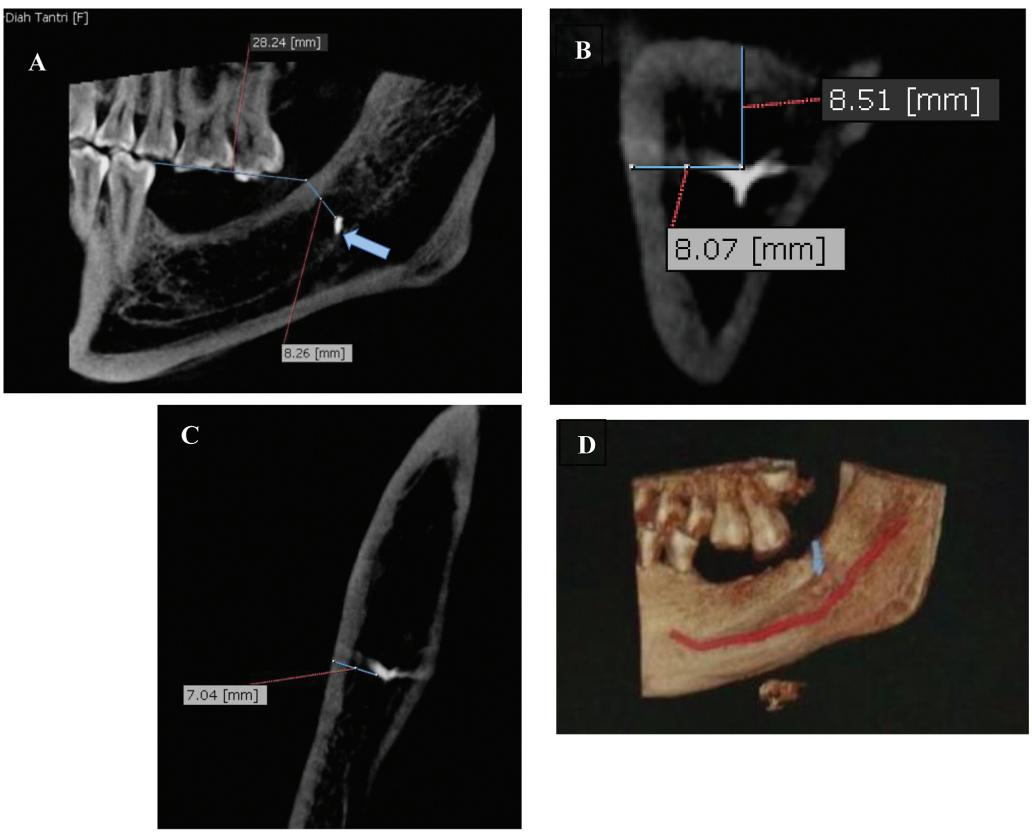

Fig. 2 Result of cone beam computed tomography (CBCT) scan. (**A**) Sagittal view. (**B**) Coronal view. (**C**) Axial view. (**D**) Three-dimensional (3D) reconstruction buccal view.

the 1-week postoperative control, the patient's symptoms improved, and the sensation of pain had disappeared. Then, 3 months after the surgery, an evaluation was performed and the patient no longer had any complaints regarding the surgical wound.

Case 2

The patient was a 60-year-old woman who had agreed to be made into a case report presented to Dental Hospital Universitas Airlangga Surabaya with a 1-year history of persistent pain in the right lower jaw region, radiating to the face, neck, and back, accompanied by numbness. She had undergone right lower jaw extraction 20 years ago. She had a history of hypertension, diabetes, and drug allergy. We performed panoramic (►**Fig. 9**) and CBCT imaging. The results of the CBCT imaging are shown in ►**Fig. 10**.

Case Management

An exploratory procedure was performed with caution following CBCT guidelines until a sufficient bone window was

Fig. 3 Marking preoperation with gutta percha.

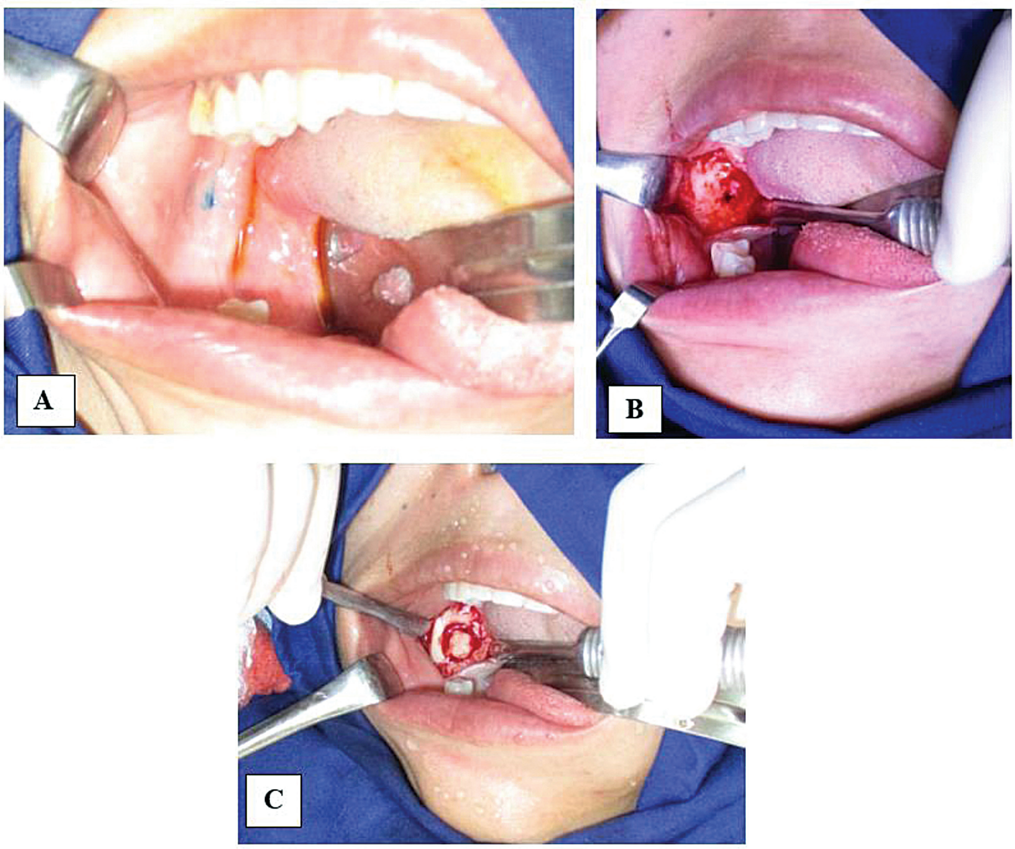

Fig. 4 Steps of removing the foreign object. (**A**) Marking intraoral area. (**B**) Marking bone area. (**C**) Bone window.

obtained (►**Fig. 11**). Then, an odontectomy of tooth 48 was performed. We were able to obtain a tooth root specimen with dimensions of $5 \times 3 \times 2\,mm^3$. Control shows improvement in complaints and no paresthesia or postoperative complications were found. After 3 months of surgery, regular checkups revealed no signs of paresthesia or other complaints.

Discussion

Foreign objects trapped in the mandibular and submandibular regions can cause significant clinical challenges, including neuropathic pain, infection, and granuloma formation. These complications are often the result of trauma or iatrogenic factors during dental procedures, such as amalgam fillings, endodontic treatments, or broken dental instruments left behind.[8,12] Specifically, intraosseous foreign objects located near the mandibular canal pose a high risk of causing inflammation or injury to the inferior alveolar nerve (IAN), leading to severe neuropathic pain.[6,7]

CT is a standard imaging modality for detection of foreign objects because the shape and size of objects are accurately reconstructed in this method. CT also determines the exact position of the foreign object and enhances its surgical removal. However, metal artifacts can cause errors in

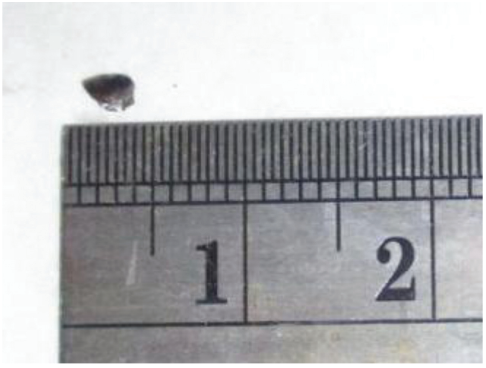

Fig. 5 Foreign object specimen.

Fig. 6 Interrupted suture in the surgical area.

detection of foreign objects on CT scans. MRI is also used for detection of foreign objects. If the composition of the foreign objects is not known, MRI cannot be used as the first diagnostic modality because artifacts of iron, glass, graphite, asphalt, stone, and plastic impede accurate visualization of these objects by MRI. Moreover, MRI can cause displacement of ferromagnetic objects and damage the adjacent tissues. In the head and neck region, CBCT has advantages over CT. CBCT is more affordable and has a lower patient radiation dose than CT. US is another imaging modality that can be used to detect foreign objects. It is easily accessible and available chairside; therefore, it is suitable for use in trauma patients. It is affordable and does not employ X-ray beams and the obtained images are readily available for evaluation. However, this modality is not suitable for detection of objects in deep tissues or air-filled cavities.[16]

The current study showed that CT was efficient for detection of glass, iron, stone, asphalt, and tooth but not for wood (low radiopacity). In other words, materials with high radiopacity are detectable on CT scans. However, metal objects cause artifacts and interfere with accurate localization of foreign objects. In such cases, the presence or absence of foreign objects can only be confirmed by CT scan. According to the results of this study, CT has higher sensitivity than other modalities evaluated in the current study. Also, CT can provide a clear depiction of the outline and accurate size of a foreign object. The results of this study show that the environment in which the foreign object is located had no significant effect on its visibility on CT scans. In other words, the diagnostic accuracy of this modality was not affected by the environment in which the foreign object was located.

In the current study, CBCT and CT yielded similar results. CBCT detected glass, iron, stone, asphalt, and tooth in the three environments studied although metal caused significant artifacts. The visibility of wood in the tongue and at the bone–soft tissue interface on CBCT scans was similar to that on CT scans. In the nose (air-filled cavity), wood often had bad visibility on CBCT scans, while it was not visible at all on CT scans. Wood had a significantly lower density than other materials tested in the current study. It had a density close to that of the adjacent soft tissue. This explains its invisibility on some scans because close density of wood and soft tissue can result in masking of wood on CBCT scans when it is located adjacent to soft tissue.

Diagnosing these cases can be particularly challenging due to atypical clinical presentations that often mimic trigeminal neuralgia. High doses of medication to manage neuropathic pain can be harmful in the long term if the underlying cause—such as a lodged FB—is not addressed.[8] Routine radiological examinations, like panoramic X-rays,

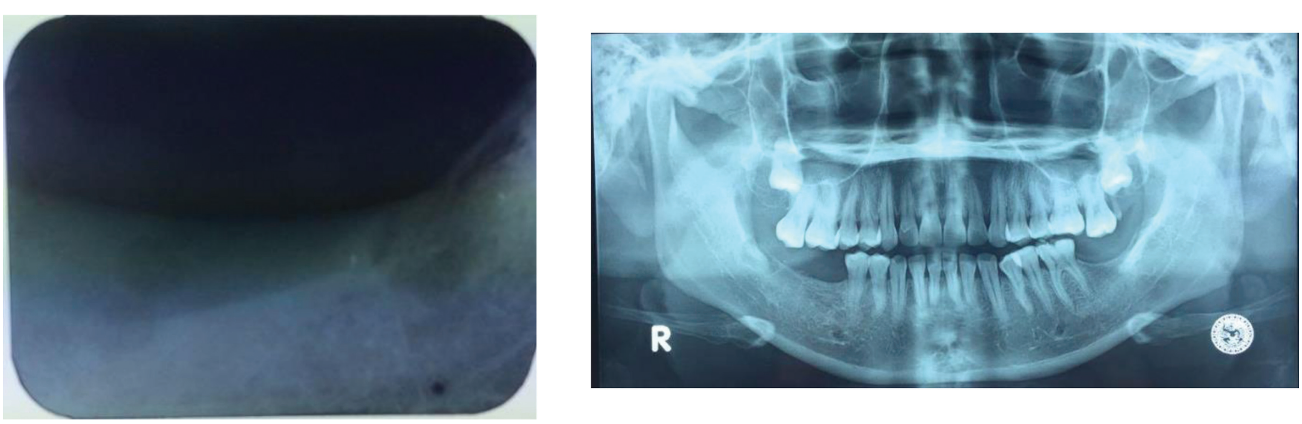

Fig. 7 Postoperative evaluation. Periapical radiograph (left). Panoramic radiograph (right).

Fig. 8 Panoramic radiograph.

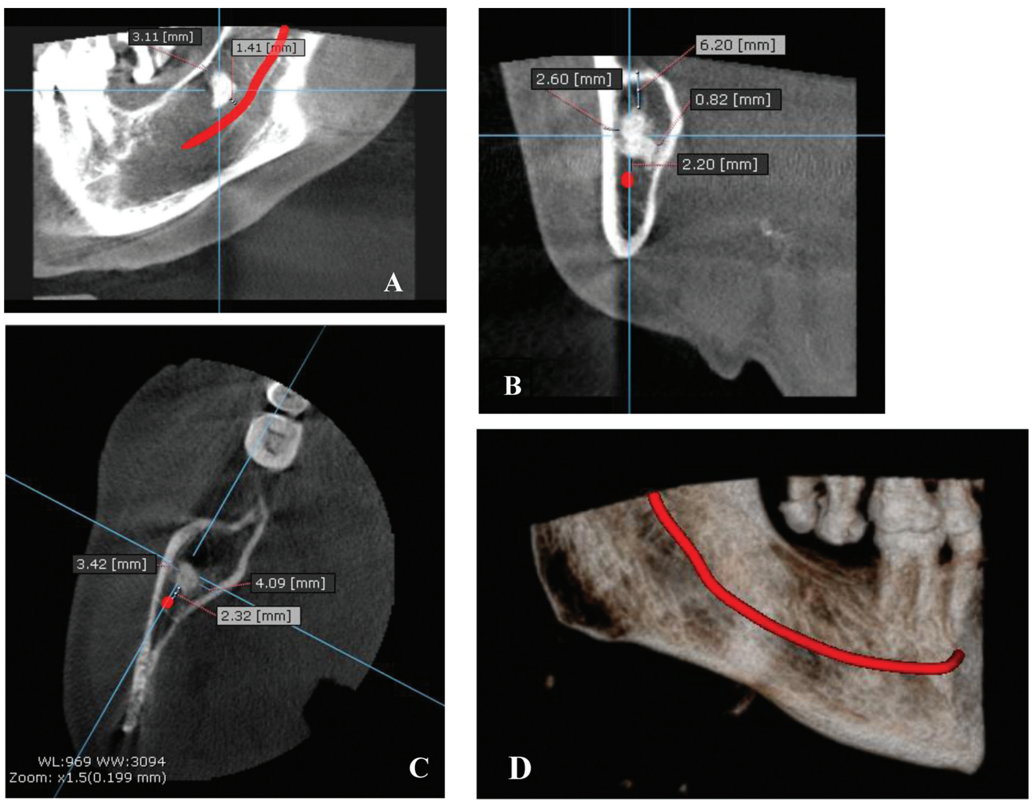

Fig. 9 Cone beam computed tomography (CBCT) result region 48. (**A**) Sagittal view. (**B**) Coronal view. (**C**) Axial view. (**D**) Three-dimensional (3D) reconstruction.

can detect foreign objects but are limited by their two-dimensional nature and associated distortion rates. Panoramic X-rays have been shown to have an average sensitivity and specificity of 66 and 74%, respectively, with 33% of images being inadequate due to factors like incorrect positioning and low contrast.[17]

CBCT offers several advantages over traditional imaging techniques, providing detailed 3D visualization of the maxillofacial skeletal structures and eliminating the complexities associated with techniques such as parallax.[13] CBCT's ability to produce accurate, real-size representations of anatomical structures makes it an invaluable tool in dental practice, particularly for surgical planning and intervention.[12] This imaging modality uses cone-shaped X-rays and flat panel detectors, allowing for a single rotation to collect comprehensive data, thereby increasing spatial resolution and often reducing radiation dose compared with conventional CT scans.[18]

In the first case, CBCT proved invaluable in precisely localizing the foreign object near the mandibular canal, overcoming the limitations of conventional panoramic radiography. Similarly, in the second case, CBCT enabled the identification of an FB despite the patient's complex medical history, contributing to targeted treatment strategies.

Fig. 10 Exploratory procedure.

Fig. 11 Specimen of 48 root.

The diagnostic complexities associated with atypical clinical presentations underscore the importance of advanced imaging techniques like CBCT in optimizing patient outcomes. By providing comprehensive visualization of the mandibular anatomy, CBCT facilitates precise localization of FBs and guides minimally invasive surgical interventions.[19]

In the cases presented, the use of CBCT was instrumental in accurately locating the foreign objects and guiding their removal, thereby improving patient outcomes. The ability to visualize the exact position of the FBs allowed for minimally invasive surgical interventions, reducing the risk of complications and enhancing postoperative recovery.

Conclusion

The use of CBCT in this case is a suitable choice with numerous benefits, such as accurately determining the location, low radiation dose, and affordable cost, with submillimeter resolution, and compared with CT scan, CBCT requires less scan time. Furthermore, using CBCT as a surgical guide for removing foreign objects makes the procedure safer and minimally invasive.

In addition, the oral and maxillofacial surgical practice has become more efficient and successful with CBCT, and will continue to benefit the oral and maxillofacial surgery offices if CBCT is used judiciously based on expected diagnostic yield, patient costs, and radiation dose.

Funding
None.

Conflict of Interest
None declared.

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