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Digitally Guided Flapless Atraumatic Extraction (DSG-FARE) of a Soft-Tissue–Impacted Palatal Root Fragment: A Case Report

Ahmed Z Rajab[1]*, Moftah Alsharif[1], Shahd Tushani[1]

[1] Dental Implantology Department, Faculty of Dentistry, Attahadi University, Tripoli, Libya

* Corresponding author e-mail: Ahmed_zirra@hotmail.com

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Abstract:

Background: Extraction of impacted or retained root fragments in the posterior maxilla may be surgically challenging due to limited access and close proximity to critical anatomical structures. Conventional flap-based approaches may increase morbidity and the risk of iatrogenic injury. **Case Presentation:** A 20-year-old healthy female presented with a soft-tissue–impacted palatal root fragment of a previously extracted maxillary first molar. Cone-beam computed tomography (CBCT), initially obtained for comprehensive digital implant planning, revealed an extremely close proximity of the fragment to the adjacent second molar root and the maxillary sinus floor. **Technique:** A digitally guided flapless atraumatic extraction technique was planned to use merged CBCT and intraoral scan data. A surgical guide was designed to allow controlled access, guided drilling, and traction-based extraction through a minimally invasive approach. **Outcome:** The root fragment was removed successfully without flap elevation or damage to adjacent structures. Postoperative healing was uneventful, with minimal discomfort and favorable soft tissue outcomes. **Clinical Significance:** This report describes a novel application of established digital planning and guided traction based atraumatic extraction techniques to enable minimally invasive removal of a retained palatal root fragment in an anatomically sensitive region.

Keywords: *Digitally guided surgery; Flapless extraction; Impacted root fragment; Atraumatic extraction; Cone-beam computed tomography; Digital dentistry; Surgical guide*.

1. Introduction

Management of impacted or retained root fragments in the posterior maxilla remains a common clinical challenge, particularly when fragments are located in close proximity to vital anatomical structures such as the maxillary sinus, adjacent tooth roots, and the greater palatine neurovascular bundle. Traditional surgical management typically involves

flap elevation, bone removal, and freehand instrumentation, which may increase operative time, postoperative discomfort, and the risk of complications [1].

The integration of cone-beam computed tomography (CBCT) and intraoral scanning into clinical workflows has transformed surgical planning in implant dentistry and guided endodontic procedures. These technologies allow precise three-dimensional visualization of anatomical relationships and enable guided surgical execution with enhanced accuracy. However, their application in guided extraction of impacted root remnants has been only sparsely reported [2].

Flapless surgical approaches have demonstrated advantages in preserving vascular supply, minimizing tissue trauma, and improving patient comfort. Nevertheless, flapless access in anatomically constrained regions is often avoided due to concerns regarding safety and control when performed without guidance [3].

This case report presents a Digitally Guided Flapless Atraumatic Extraction (DSG-FARE) technique, representing a case-selective digital adaptation of established surgical principles for the removal of a soft-tissue–impacted palatal root fragment located in extremely close proximity to adjacent vital structures.

2. Case Presentation:

A 20-year-old healthy female patient was referred for evaluation of a retained root fragment in the maxillary left posterior region. The patient's medical history was non-contributory. Dental history revealed previous extraction of the maxillary left second premolar and first molar. Clinical examination showed healed palatal mucosa with no signs of acute infection or sinus involvement.

Cone-beam computed tomography (CBCT) imaging was originally obtained as part of comprehensive digital implant planning for the replacement of teeth 25–26, 15–14, and 36. Review of the same dataset revealed the presence of a soft-tissue–impacted palatal root fragment of the maxillary first molar, requiring further clinical management.

CBCT assessment demonstrated the following critical measurements:

Axial CBCT view:
The coronal portion of the palatal root fragment was located at a distance of 0.42 mm from the mesial surface of the adjacent maxillary second molar root.

Sliced panoramic reconstruction:
A radiolucency consistent with chronic periapical inflammation was present around the apical portion of the root fragment. The minimum distance between the root tip and the cortical floor of the maxillary sinus measured 1.14 mm.

Soft tissue assessment:

Palatal soft tissue thickness covering the coronal surface of the impacted root fragment ranged between 3.0 and 3.33 mm, indicating a thick palatal mucosal phenotype.

Given the extremely limited anatomical clearances and the thick palatal soft tissue, a digitally guided flapless approach was selected to minimize surgical morbidity and reduce the risk of iatrogenic injury.

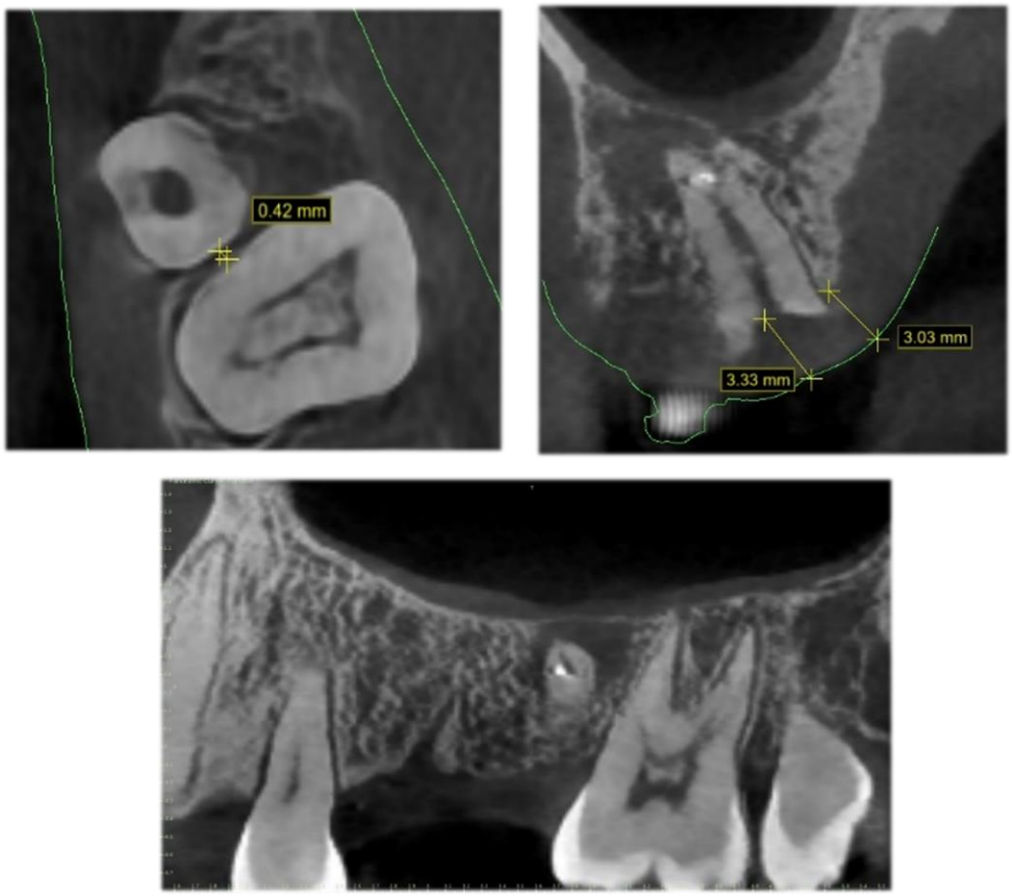


Figure 1. Preoperative CBCT demonstrating proximity of the palatal root fragment to the adjacent second molar and maxillary sinus floor.

Digital Planning and Surgical Guide Design

CBCT and intraoral scan (IOS) data were merged using digital planning software (exoplan, exocad GmbH, Germany).

Virtual planning focused on:

- Identification of the fracture surface of the palatal root fragment.
- Establishment of a safe access trajectory avoiding the adjacent second molar root and maxillary sinus floor.

- Control of drilling angulation and depth.

A tooth-supported surgical guide was designed incorporating a titanium sleeve with a 4-mm height and 5-mm internal diameter.
The guide was fabricated using a three-dimensional printing workflow. The guide was manufactured using a biocompatible photopolymer resin suitable for intraoral surgical use (Senertek-Turkey). The guide was then verified intraorally for stability and accuracy prior to surgery.

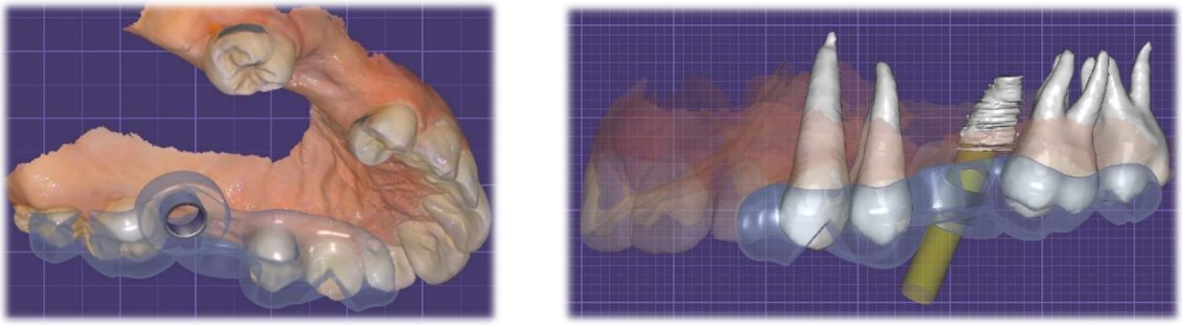


Figure 2. Digital planning and trajectory design for guided access.

Surgical Technique: DSG-FARE Technique

Guided access was performed using a tooth-supported surgical guide incorporating a titanium sleeve and tissue punch (MODE Dental Implant System, Turkey). Guided drilling was carried out using a 1.5-mm tapered reamer derived from a commercial fiber post system, followed by insertion of a threaded attachment. Controlled axial traction was then achieved using a specialized traction device.

The procedure was performed under local anesthesia using a flapless approach. A soft tissue punch was used to remove the palatal mucosa overlying the fracture surface of the root fragment, providing direct access without flap elevation, using the surgical guide to ensure precise localization.

Drilling was performed using a post drill to prepare an internal channel within the coronal portion of the root fragment. A threaded traction post with an attachment mechanism was then inserted.

Using a specialized traction device, controlled axial traction was applied through the surgical guide, allowing removal of the root fragment without lateral luxation forces. The extraction was completed without sinus membrane perforation or injury to adjacent teeth.

1-Surgical Guide positioned prior to access

2 – Guided Tissue punch

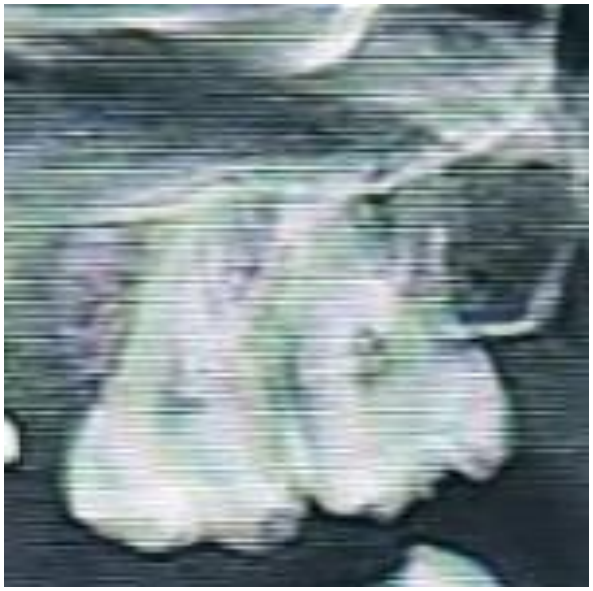
3-Preparing the root canal.

4-Securing the surgical guide with traction post in place.

5-Traction-based Extraction plier

6- Removing the Root.

7-Postoperative clinical view – after seven days.



8-Postoperative radiographic confirmation.

Figure 3. Clinical sequence of the DSG-FARE technique.

3. Postoperative Outcome:

Postoperative healing was uneventful. The patient reported minimal discomfort and no swelling, bleeding, or sinus-related symptoms. Clinical follow-up demonstrated favorable palatal soft tissue healing with preservation of mucosal contour.

Postoperative radiographic assessment confirmed complete removal of the root fragment and preservation of surrounding anatomical structures.

4. Discussion:

In the present case, CBCT analysis demonstrated critically limited anatomical clearances, with less than 0.5 mm separation from the adjacent tooth root and approximately 1 mm from the maxillary sinus floor. Such conditions render conventional freehand surgical extraction particularly hazardous [4,5].

The DSG-FARE technique illustrates how established digital surgical principles may be adapted beyond implant placement and guided endodontic access to manage complex extraction scenarios. Digital planning enabled precise trajectory control, while guided drilling and traction-based extraction minimized lateral forces on adjacent teeth and alveolar bone [6].

The flapless approach preserved palatal vascular supply and reduced the risk of injury to the greater palatine neurovascular bundle. Additionally, utilization of an existing CBCT dataset originally obtained for implant planning avoided the need for additional imaging, adhering to the ALARA principle [7].

Limitations of the technique include the requirement for advanced digital infrastructure and operator experience. Ankylosed root fragments or cases with dense cortical bone may not be suitable for traction-based removal. Further studies are required to assess reproducibility and broader clinical applicability.

This report highlights the potential of digital workflows to extend minimally invasive surgery into situations traditionally considered high risk. With appropriate planning and case selection, guided traction-based extraction may reduce morbidity while preserving anatomical integrity.

Conclusion

The DSG-FARE technique represents a digitally guided, flapless adaptation of established surgical principles for the extraction of impacted palatal root fragments in anatomically sensitive regions. Precise digital planning and guided execution enabled safe removal despite extremely limited anatomical clearances, while preserving adjacent structures and enhancing patient comfort. This report describes a novel application of established digital planning and guided traction based atraumatic extraction techniques to enable minimally invasive removal of a retained palatal root fragment in an anatomically sensitive region.

Author Contributions

Ahmed Z. Rajab conceptualized the treatment approach, performed the digital planning and surgical guide fabrication, and supervised the clinical surgical procedure.
Moftah Alsharif provided surgical supervision and validated the clinical applicability of the technique.
Shahd Tushani, Internship Dentist, participated in the surgical procedure under direct supervision and assisted during the surgical workflow when required.
All authors critically revised the manuscript and approved the final version for publication.

Ethical Statement and Patient Consent

Written informed consent was obtained from the patient for all clinical procedures and for publication of clinical and radiographic images. No additional CBCT imaging was required for the extraction procedure, as the existing dataset obtained for digital implant planning was utilized in accordance with the ALARA principle. According to institutional policy, formal ethical committee approval was not required for this anonymized case report.

Conflict of Interest

The authors declare no conflict of interest.

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