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Case Report

Digitally Guided Immediate Autotransplantation of a Closed-Apex Third Molar for Management of a Hopeless Tooth: A Case Report

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Abbreviations

DAT: dental Autotransplantation; PDL: Periodontal Ligament; CBCT: Cone-Beam Computed Tomography; CARP: Computer-Aided Rapid Prototyping; AAE: American Association of Endodontists; CAD/CAM: Computer-Aided Design/Computer-Aided Manufacturing; ESE: European Society of Endodontology; L-PRF: Leukocyte- and Platelet-Rich Fibrin

Introduction

In contemporary dental practice, the management of teeth categorized as hopeless teeth represents a significant clinical challenge. These are defined as dental organs with an unfavorable prognosis in which conventional therapies cannot guarantee long-term functional stability, typically leading to extraction [1]. Similarly, the literature describes them as non-restorable teeth due to extensive destruction caused by caries, trauma, or severe periodontal disease that irreversibly compromises their functional integrity [1]. Traditionally, therapeutic alternatives for these cases have consisted of tooth extraction followed by rehabilitation using fixed partial prostheses, removable prostheses, or, more commonly, implant-supported restorations [2].

In this context, dental autotransplantation (DAT) has re-emerged as a biological and innovative therapeutic alternative. This procedure is defined as the surgical repositioning of an erupted or impacted tooth from its original location to another site, known as the recipient socket, within the same individual [3]. Third molars are considered the most frequent donor teeth due to their availability and the morphological compatibility of their roots with recipient sites, particularly for the replacement of compromised molars [7]. The biological success of autotransplantation primarily depends on the preservation of viable periodontal ligament (PDL) cells attached to the root surface, which enable regeneration of cementum and surrounding alveolar bone [5].

Historically, autotransplantation of teeth with closed apex has been considered a technique with high operator sensitivity due to the potential risk of complications such as inflammatory root resorption or ankylosis [4]. However, current evidence demonstrates that, when appropriate surgical and endodontic protocols are followed, these teeth can achieve highly favorable survival rates [4].

In recent years, the incorporation of digital workflows has significantly improved the predictability of this procedure. Planning through cone-beam computed tomography (CBCT) combined with computer-aided rapid prototyping (CARP) technologies enables the fabrication of three-dimensional replicas of the donor tooth using 3D printing. These replicas facilitate precise preparation of the recipient socket and significantly reduce the extraoral time of the transplanted tooth, a critical factor for preserving periodontal ligament cell viability [6]. Consequently, digitally guided surgery enhances surgical accuracy, improves adaptation of the tooth within the recipient alveolus, and contributes to more predictable clinical outcomes.

Compared with dental implants, autotransplantation offers notable biological advantages, including preservation of the periodontal ligament, maintenance of proprioception, continuous alveolar bone remodeling, and the intrinsic regenerative potential of supporting tissues [5,7]. These characteristics position autotransplantation as a particularly valuable therapeutic alternative for patients presenting teeth with unfavorable prognosis. Therefore, the purpose of the present case report is to describe a digitally guided immediate autotransplantation of a closed-apex third molar as treatment for a first molar categorized as hopeless. This case aims to highlight the clinical relevance of digital planning in optimizing surgical precision, preserving periodontal health, and providing a conservative biological and functionally superior solution for the rehabilitation of compromised teeth [7].

Case Report (Figure 1)

A 27-year-old female patient with no relevant medical history was referred from the Oral and Maxillofacial Implantology Specialization Program at the Pontificia Universidad Católica de Chile for endodontic evaluation and assessment of the feasibility of dental autotransplantation as a therapeutic alternative for replacement of tooth 14 (26), affected by extensive occlusomesial caries.

During anamnesis, the patient reported a previous history of endodontic treatment on the affected tooth. Clinical examination revealed that tooth 14 (26) presented a provisional coronal seal and was sensitive to percussion. Palpation findings and the surrounding soft tissues were within normal clinical parameters.

Radiographic examination showed that the temporary restoration extended to the floor of the pulp chamber and the entrance of the palatal canal, along with a partially filled root canal obturation in length. Additionally, a periapical radiolucent lesion associated with the mesiobuccal and palatal roots was observed, suggestive of persistent apical pathology.

Based on the clinical and radiographic findings, a diagnosis of symptomatic apical periodontitis in a previously treated tooth was established according to the diagnostic criteria of the American Association of Endodontists (AAE). During the endodontic evaluation, the provisional restoration was removed to assess the remaining structural condition and restorative prognosis of the tooth. Following comprehensive clinical and radiographic assessment, the tooth was classified as a hopeless tooth due to its unfavorable long-term functional prognosis, primarily associated with insufficient remaining dental structure to allow a predictable restorative rehabilitation. Consequently, replacement through dental autotransplantation was indicated as the therapeutic alternative.

Cone-beam computed tomography (CBCT) was prescribed to evaluate potential donor teeth, corresponding to teeth 1 (18) and 16 (28), and to analyze their suitability for a dental autotransplantation procedure.

CBCT images were acquired using a CBCT unit (Morita Veraview X800; J. Morita Corp., Kyoto, Japan) with a field of view of 90 × 50 mm, voxel size of 0.12 mm, 91 kV, and 4.6 mA. Three-dimensional analysis allowed evaluation of root morphology, root divergence, root volume dimensions, and their relationship with the recipient site.

Following radiographic evaluation, tooth 16 (28) was selected as the donor tooth despite the presence of two enamel pearls associated with the palatal and distobuccal roots, as it exhibited a more favorable root morphology and anatomical configuration comparable to the recipient site compared with tooth 1 (18), allowing improved three-dimensional adaptation and reducing the need for surgical modification of the recipient alveolus.

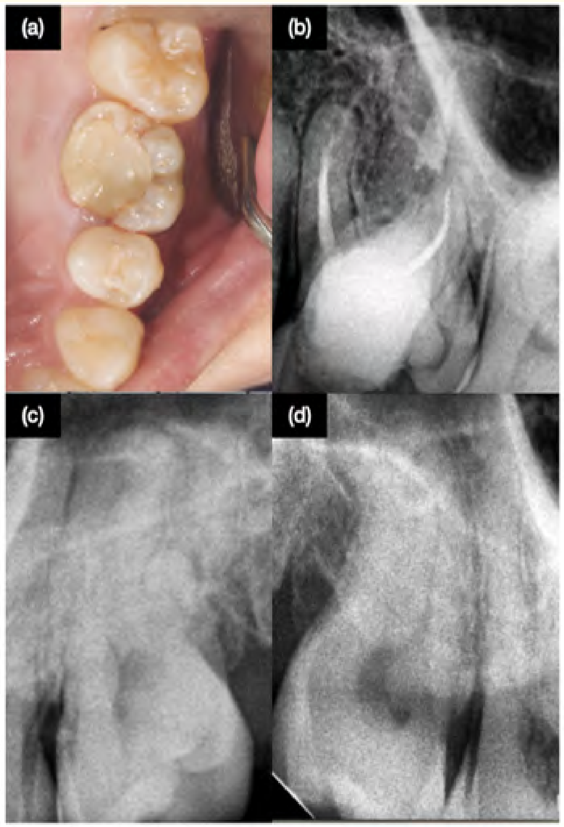

Figure 1: *(a) Clinical image of tooth 14 (26); (b) Periapical retroalveolar x ray of tooth 14 (26); (c) Periapical retroalveolar x ray of tooth 16 (28); (d) Periapical retroalveolar x ray of tooth 1 (18).*

Digital planning (Figure 2)

A digitally guided immediate dental autotransplantation was planned using a CAD/CAM digital workflow.

Following acquisition of the intraoral scan using a Virtuo Vivo scanner (Dental Wings, Germany) and CBCT tomographic imaging, the digital files were imported into coDiagnostiX v10.9 software (Dental Wings, Germany) for virtual planning. During this stage, anatomical segmentations were performed, and a digital design of the anatomical replica model of the donor tooth (CARP) was created. Additionally, a surgical guide for preparation of the recipient socket compatible with a guided drilling system (BioHorizons, USA), and a guide for three-dimensional positioning and splinting of the donor tooth were designed.

The surgical guides were fabricated using 3D printing with a Pro 55s printer (SprintRay, USA) and autoclavable Surgical Guide 3 resin (SprintRay, USA). Post-processing included automated washing using Pro Wash/Dry (SprintRay, USA), followed by final curing in ProCure 2 (SprintRay, USA), according to the manufacturer's recommendations.

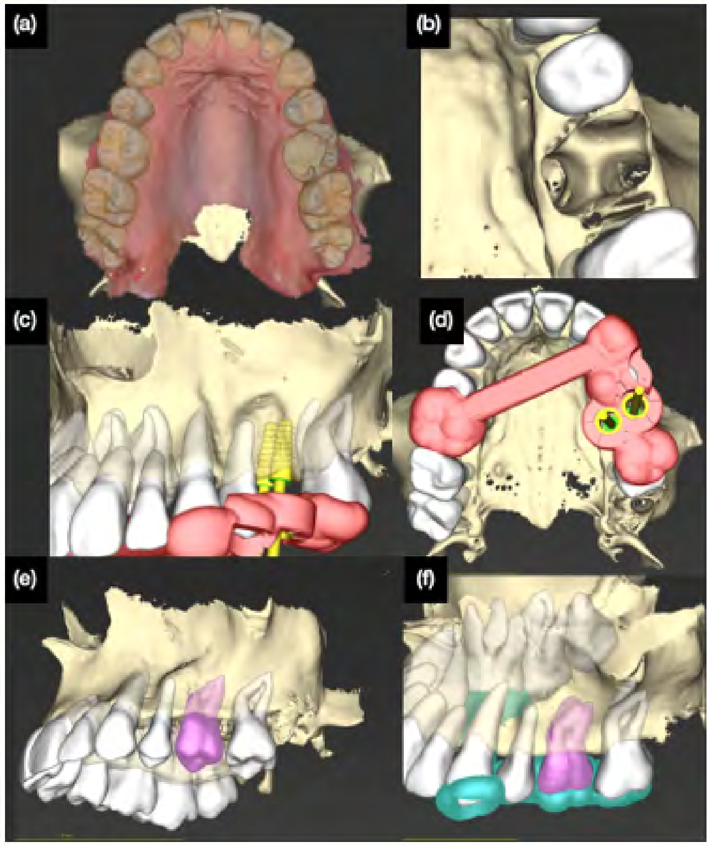

Figure 2: *(a) Aligned DICOM segmentation and intraoral scan; (b) Virtual extraction of tooth 14 (26); (c) Implant positioning for recipient socket drilling; (d) Drilling guide; (e) Virtual autotransplantation of donor tooth 16 (28) into the recipient site of tooth 14 (26); (f) Donor tooth positioning guide.*

Surgical planning (Figure 3a and 3b)

The clinical procedure followed the recommendations of the European Society of Endodontology (ESE, 2021) [8]. Supportive periodontal therapy was performed two weeks prior to the procedure, informed consent was obtained from the patient, and antibiotic premedication with amoxicillin/clavulanic acid (875/125 mg) was prescribed. The surgical technique was planned to include leukocyte- and platelet-rich fibrin (L-PRF) to promote healing of the recipient site.

Under 3% local anesthesia, both the recipient site and the donor tooth were anesthetized simultaneously. A minimally traumatic extraction of tooth 14 (26) was first performed. Subsequently, using the drilling splint, the recipient socket was enlarged with a guided drilling system (BioHorizons, USA) to allow atraumatic and passive accommodation of the donor tooth.

Once the replica achieved the digitally planned position, tooth 16 (28) was atraumatically extracted and immediately positioned into the recipient socket of tooth 14 (26). L-PRF was applied around the donor tooth to promote regeneration of periodontal ligament cells and alveolar bone. Finally, a semi-rigid splint was placed extending from tooth 12 (23) to tooth 15 (27) using a braided orthodontic wire (0,3 mm).

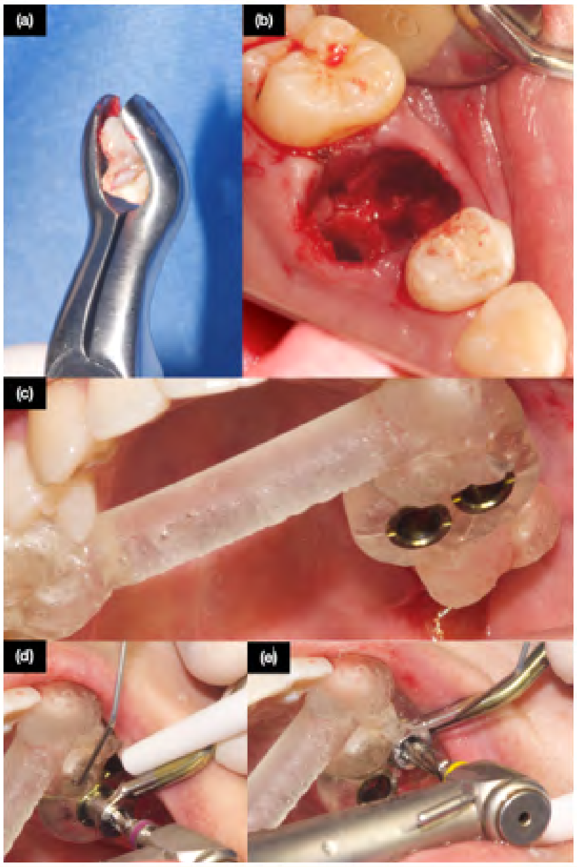

Figure 3a: *(a) Extraction of tooth 14 (26); (b) Recipient socket of the donor tooth; (c) Drilling guide; (d) Recipient socket drilling.*

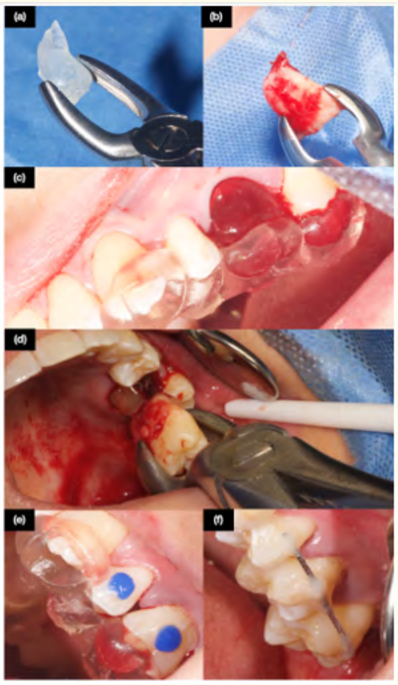

Figure 3b: *(a) CARP model or replica; (b) Tooth 16 (28 – donor tooth); (c) Replica stabilization splint; (d) Positioning of the donor tooth in the recipient socket; (e) Adhesive protocol for flexible splinting of the donor tooth; (f) Semi-rigid splint.*

Endodontic planning (Figure 4a and 4b)

In the present case, since the donor tooth corresponded to a third molar with a fully formed apex, endodontic treatment was initiated 7 days after autotransplantation. During the first session, initial instrumentation of the root canal system was performed under magnification using a reciprocating mechanized system (Reciproc Blue; VDW, Munich, Germany). Irrigation was carried out following strict disinfection protocols and was activated using a sonic activation system (EndoActivator; Dentsply Sirona, Ballaigues, Switzerland) to optimize penetration and effectiveness of the irrigating solutions within the root canal system.

Subsequently, calcium hydroxide–based intracanal medication was placed as a temporary dressing. The use of this material is supported by its antimicrobial properties and high pH, which promote disinfection of the root canal system and contribute to the prevention of external inflammatory root resorption. The use of magnification, together with rigorous irrigation and activation protocols, is particularly relevant in third molars due to the frequent anatomical complexity of their root canal systems, especially in the apical third, where adequate cleaning and three-dimensional sealing are critical determinants of treatment success.

After 14 days, the patient was re-evaluated and remained asymptomatic; therefore, the splint was removed, and a 6-month follow-up appointment was scheduled, including a new CBCT examination.

In the cervical and middle thirds, intimate proximity between the roots and the surrounding bone tissue was observed, with preservation of the alveolar cortical plate and maintenance of the periodontal ligament space. At the apical third, radiographic signs of partial bone healing surrounding the roots were identified, consistent with the six-month interval between the surgical procedure and CBCT acquisition.

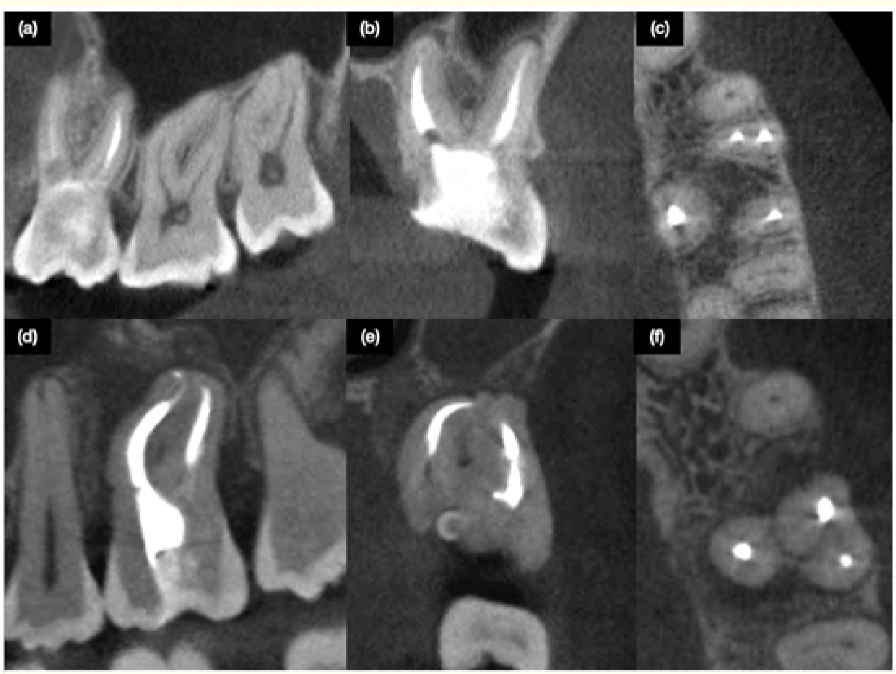

Figure 4a: *Pre-autotransplantation CBCT images: (a) Sagittal view of teeth 26 and 28, (b) Coronal view of tooth 26, and (c) Axial view of the roots of tooth 26. CBCT images of the donor tooth 6 months after autotransplantation: (d) Sagittal view, (e) Coronal view, and (f) Axial view.*

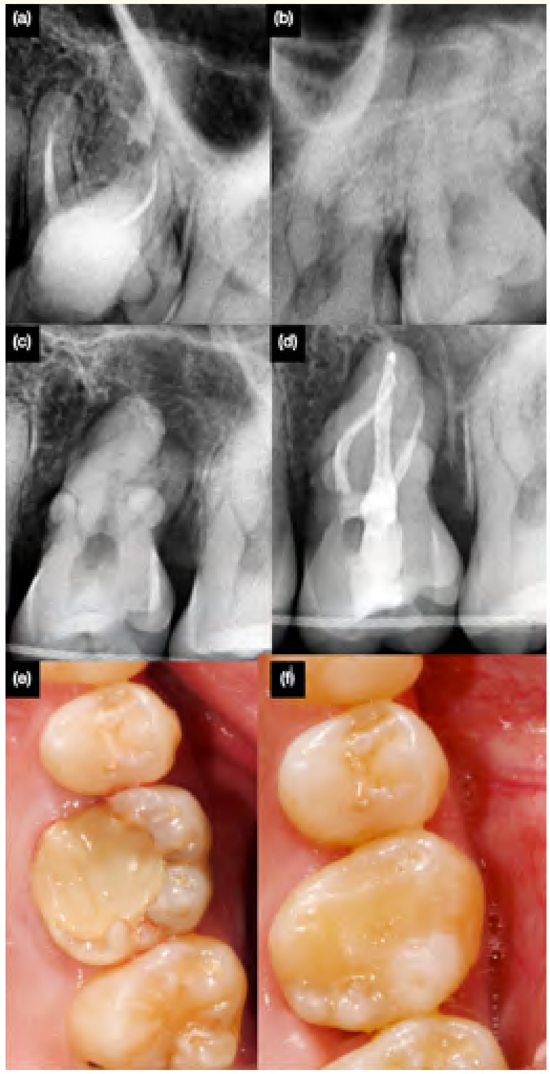

Figure 4b: *(a) Pre-autotransplantation radiograph; (b) Donor tooth radiograph; (c) Immediate postoperative radiograph; (d) Necro-pulpectomy performed after 7 days; (e) Preoperative clinical image; (f) 6-month follow-up image.*

Discussion

The present clinical case demonstrates the feasibility of immediate transplantation of a closed-apex third molar planned through a digital workflow as a therapeutic alternative for teeth categorized as hopeless teeth. The clinical and radiographic outcomes observed showed adequate functional integration of the transplanted tooth, with periodontal stability and absence of early complications. These findings are consistent with the existing literature, which describes dental autotransplantation as a predictable technique when the biological and surgical principles of the procedure are respected [9,10]. In this context, the present case supports the potential of autotransplantation as a biological and conservative therapeutic alternative compared with other rehabilitative options.

The predictability of dental autotransplantation has been widely documented in clinical studies and systematic reviews. Several investigations have reported survival rates exceeding 90% when the procedure is performed under controlled surgical conditions with appropriate case selection [11]. A recent systematic review evaluating more than 2,800 autotransplanted teeth reported survival rates of 93.8% for teeth with open apices and 92.6% for teeth with closed apices, with success rates of 84.0% and 86.7%, respectively [12]. These results support the clinical reliability of the procedure and suggest that autotransplantation may be considered a predictable therapeutic alternative for replacing teeth with unfavorable prognosis. A key biological factor in this process is the preservation of periodontal ligament viability, which plays a fundamental role in root cementum regeneration and alveolar bone remodeling following transplantation [11].

The stage of root development of the donor tooth has traditionally been considered one of the most important prognostic factors in dental autotransplantation. Teeth with immature apices exhibit greater potential for pulp revascularization due to the wider apical foramen diameter, which favors pulp regeneration and reduces the incidence of postoperative pulp necrosis [12]. For this reason, teeth with incomplete root development have historically been considered to yield superior biological outcomes after autotransplantation. However, their availability is limited, as they must be identified during a specific stage of root development to meet the biological criteria required for the procedure. Consequently, recent studies have demonstrated that teeth with fully formed apices may also achieve favorable clinical outcomes when the procedure is performed under appropriate protocols and precise surgical planning [12]. In this regard, third molars are considered ideal donor teeth for dental autotransplantation due to their high biological potential, population availability, and anatomical characteristics throughout their developmental stages. These conditions facilitate surgical manipulation and increase the probability of procedural success [1,3].

In teeth with mature apices, pulp revascularization is less likely, increasing the incidence of postoperative pulp necrosis. Therefore, endodontic treatment becomes necessary as part of postoperative management to prevent infectious or inflammatory complications [15]. Root canal treatment is preferably initiated between 7 and 14 days after transplantation to prevent pulp necrosis and the risk of external inflammatory root resorption. Since spontaneous revascularization is not expected in mature teeth, early pulp removal is critical to prevent periapical infections that may compromise periodontal ligament integrity [1,3]. Despite this biological limitation, several longitudinal studies have demonstrated that teeth with closed apices can achieve survival rates comparable to those observed in teeth with open apices when the biological principles of the procedure are respected [12].

Several prognostic factors have been identified as determinants of success in autotransplantation of closed-apex teeth. Among the most important are preservation of periodontal ligament integrity during donor tooth extraction, reduction of extraoral time, atraumatic handling of the tooth, and achievement of adequate primary stability within the recipient socket [9,11]. Furthermore, appropriate case selection and timely planning of postoperative endodontic treatment are essential to reduce the risk of complications such as inflammatory root resorption or ankylosis [11]. In the present case, adherence to these surgical principles may have significantly contributed to the favorable clinical outcome observed.

In recent years, the development of digital technologies has significantly transformed the planning and execution of dental autotransplantation. The use of cone-beam computed tomography (CBCT) enables precise three-dimensional evaluation of both the donor tooth and the recipient site, facilitating procedural planning. Additionally, the use of three-dimensional printed replicas of the donor tooth allows preparation of the recipient alveolus prior to tooth extraction, significantly reducing extraoral time and improving periodontal ligament preservation [12]. These technological innovations have been shown to enhance surgical accuracy and optimize clinical outcomes in autotransplantation.

Technological evolution has also promoted the development of guided surgery and surgical navigation techniques applied to dental autotransplantation. Customized surgical guides enable more precise preparation of the recipient socket and facilitate accurate three-dimensional orientation of the transplanted tooth. More recently, dynamic surgical navigation has been proposed as a promising tool to improve intraoperative precision and increase procedural reproducibility, potentially optimizing clinical outcomes and facilitating standardization of this technique in dental practice.

From a biological perspective, dental autotransplantation offers significant advantages compared with other therapeutic alternatives such as osseointegrated dental implants. Unlike implants, autotransplantation preserves the periodontal ligament, allowing maintenance of proprioception, physiological adaptation to occlusal forces, and continuous remodeling of the alveolar bone [13]. Moreover, the presence of functional periodontal tissue contributes to preservation of alveolar bone architecture and promotes biological integration of the transplanted tooth within the stomatognathic system.

However, this study presents limitations inherent to the methodological design of case reports. Evidence derived from a single clinical case does not allow generalizable conclusions nor robust evaluation of procedural predictability. Additionally, the follow-up period may be insufficient to detect late complications such as root resorption or ankylosis. Therefore, the results should be interpreted cautiously and within the context of the available scientific evidence.

Finally, dental autotransplantation represents a promising therapeutic alternative whose potential has not yet been fully explored in contemporary dentistry. Future research should focus on prospective clinical studies and controlled clinical trials systematically evaluating the efficacy of the procedure across different clinical scenarios. Furthermore, integration of advanced digital technologies-including three-dimensional planning, 3D printing, and dynamic surgical navigation-may further enhance the predictability of autotransplantation and facilitate its implementation in routine clinical practice.

Conclusion

This clinical case highlights the feasibility of immediate autotransplantation of a closed-apex third molar planned through a digital workflow as a biological and conservative therapeutic alternative for teeth categorized as hopeless teeth. The favorable clinical and radiographic outcomes observed demonstrate adequate periodontal integration and functional stability of the transplanted tooth, supporting the predictability of the procedure when biological and surgical principles are strictly respected.

From an anatomical and periodontal perspective, third molars-particularly those deeply embedded-often present relatively well-preserved periodontal ligament tissues due to their limited exposure to the oral environment and reduced bacterial load. This condition favors preservation of periodontal ligament cell viability during extraction and transplantation, a determining factor for periodontal healing and functional reintegration of the transplanted tooth. Furthermore, their root morphology and dimensions are frequently compatible with recipient sockets of first and second molars, which are commonly indicated for replacement when classified as hopeless teeth.

The incorporation of digital technologies, including three-dimensional planning and guided surgical execution, enhances procedural accuracy, reduces extraoral time, and contributes to preservation of periodontal ligament viability, which remains a critical determinant of treatment success. Within these conditions, dental autotransplantation may be considered a predictable and biologically advantageous alternative to conventional rehabilitative options.

Further prospective clinical studies with longer follow-up periods are required to strengthen the scientific evidence and to support broader implementation of digitally guided autotransplantation in contemporary dental practice.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this publication.

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