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Third Molar Autotransplantation: Clinical Indications, Outcomes, and Future Perspectives

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Abstract

Tooth autotransplantation has emerged as a biologically based treatment modality for the replacement of missing teeth. Owing to the preservation of the periodontal ligament and the potential for continued functional adaptation, this approach has gained renewed interest as an alternative to conventional prosthetic rehabilitation and dental implant therapy. Third molars are among the most frequently utilized donor teeth, particularly for the replacement of missing first molars.

Objective. To review current evidence regarding the clinical indications, biological principles, treatment outcomes, complications, and digital workflow associated with third molar autotransplantation.

Materials and Methods. A literature review was conducted using the PubMed, Scopus, Web of Science, and Google Scholar databases, covering studies published between 2010 and 2025.

Results. Contemporary studies demonstrate survival rates exceeding 90% for autotransplanted teeth. Favorable outcomes are associated with preservation of periodontal ligament vitality, appropriate root development, minimal extra-alveolar time, and adequate primary stability. Third molar autotransplantation may be considered a particularly valuable treatment option for the replacement of missing first molars, especially in young patients and in situations where implant therapy is not feasible. The most frequently reported complications include inflammatory root resorption, ankylosis, replacement resorption, and pulp necrosis. The integration of digital technologies into clinical workflows has facilitated more precise surgical planning and improved procedural predictability.

Conclusion. Current evidence supports third molar autotransplantation as a reliable treatment option for the replacement of missing first molars. When appropriate biological and surgical principles are followed, the procedure can provide favorable long-term outcomes and may represent an effective alternative to implant therapy in selected patients.

Keywords: tooth autotransplantation; third molars; donor teeth; periodontal ligament; treatment outcomes; complications; CBCT; digital workflow; 3D printing.

Introduction

Tooth autotransplantation is a surgical procedure involving the transfer of a donor tooth from one location to another within the same individual, with the aim of replacing a missing or non-restorable tooth [1–4]. Although the technique has been described for several decades, interest in autotransplantation has increased considerably in recent years owing to advances in diagnostic imaging, surgical protocols, and digital technologies. Growing clinical evidence demonstrating favorable long-term outcomes has further contributed to the renewed interest in this treatment modality [9–16].

Unlike dental implants, autotransplanted teeth retain a functional periodontal ligament, allowing physiological mobility, proprioceptive feedback, and continuous remodeling of the surrounding alveolar bone [6,7]. These characteristics enable preservation of periodontal function and maintenance of alveolar bone volume, making autotransplantation particularly attractive in young patients and in clinical situations where preservation of biological tissues is desirable. In addition, autotransplantation may represent a cost-effective alternative to implant-supported rehabilitation and can be performed in patients for whom implant therapy is contraindicated or needs to be deferred [5,6].

Third molars are among the most frequently utilized donor teeth in autotransplantation procedures. Their widespread availability, frequent impaction, and limited functional significance in many patients have made them a common source of donor teeth for autotransplantation procedures. Consequently, transplantation of third

molars into sites of missing first molars has become one of the most extensively investigated applications of tooth autotransplantation [5,9].

The aim of this review was to summarize current evidence regarding the use of third molars as donor teeth in autotransplantation procedures, with particular emphasis on clinical indications, biological principles, treatment outcomes, complications, and recent technological developments.

Clinical Indications for Third Molar Autotransplantation

Third molars are among the most frequently used donor teeth in autotransplantation procedures. Their clinical value is largely related to the common occurrence of impacted, malpositioned, or nonfunctional third molars, which may serve as suitable donor teeth for the replacement of missing posterior teeth [5,9]. At the same time, first molars are among the teeth most frequently lost because of extensive caries, endodontic complications, periodontal destruction, and root fractures, creating a common indication for autotransplantation [12,13].

One of the principal indications for third molar autotransplantation is the replacement of a non-restorable or a recently extracted first molar. In such situations, autotransplantation provides an opportunity to restore masticatory function while preserving the biological advantages of a natural tooth and its periodontal ligament. Unlike implant-supported restorations, transplanted teeth retain proprioceptive function and the capacity for physiological adaptation to functional loading [6,7].

The procedure may be particularly advantageous in adolescents and young adults. Since osseointegrated implants do not participate in craniofacial growth, implant placement is often postponed until skeletal development has been completed. In contrast, autotransplanted teeth maintain a functional periodontal ligament and may continue to adapt to changes occurring within the dentoalveolar complex during growth [6,8].

Appropriate case selection is essential for successful treatment. Factors that should be considered include the availability of a suitable donor tooth, root morphology, stage of root development, periodontal status, and the condition of the recipient site. Donor teeth with incomplete root formation are generally more likely to

regain pulpal vitality and continue root development after transplantation [11,15]. However, favorable outcomes have also been reported for third molars with complete root formation when appropriate endodontic protocols are followed [9,16].

Successful outcomes depend largely on careful assessment of both donor and recipient site characteristics. Appropriate case selection has consistently been recognized as a key factor influencing long-term survival and complication rates following autotransplantation [10,12,14].

Biological Principles and Determinants of Success

The biological success of tooth autotransplantation depends on the capacity of the transplanted tooth and surrounding tissues to undergo functional healing after surgery. Unlike dental implants, which achieve stability through osseointegration, autotransplanted teeth retain living periodontal tissues that play a central role in post-transplant healing and long-term function [6,7].

The periodontal ligament is widely recognized as the most critical structure influencing treatment outcomes. Viable periodontal ligament cells facilitate regeneration of the attachment apparatus, restore physiological tooth mobility, and contribute to the maintenance of normal functional relationships between the root surface and alveolar bone. Conversely, extensive damage to the periodontal ligament may result in inflammatory root resorption, ankylosis, or eventual loss of the transplant [3,6,14].

In addition to providing functional attachment, the periodontal ligament plays an important role in maintaining the structural and functional integrity of the surrounding alveolar bone. The presence of viable periodontal tissues enables ongoing bone remodeling and contributes to preservation of alveolar bone volume following transplantation [7,8]. This biological advantage is particularly relevant in younger patients and in clinical situations where preservation of the alveolar ridge is a treatment objective.

The stage of root development is another major determinant of treatment success. Immature teeth with open apices are more likely to regain pulpal vitality and continue root development following transplantation [11,15]. Consequently, donor teeth with

approximately one-half to two-thirds root development are generally considered ideal candidates for the procedure. However, successful transplantation of teeth with complete root formation has also been reported, especially when appropriate endodontic treatment is performed during follow-up [9,16].

Extra-alveolar time represents a critical procedural factor affecting biological healing. Prolonged exposure of the donor tooth outside the oral environment reduces periodontal ligament cell viability and may compromise subsequent healing. As a result, current surgical approaches focus on preserving periodontal ligament cell viability by reducing extra-alveolar time and limiting unnecessary handling of the donor tooth [14,17].

Finally, successful healing depends on the relationship between donor tooth morphology and recipient site anatomy. Adequate adaptation of the transplant within the recipient socket is essential for achieving primary stability while avoiding excessive compression of periodontal tissues. Both insufficient stability and excessive pressure may negatively influence periodontal healing and long-term prognosis [3,14]. These observations underscore the multifactorial nature of successful autotransplantation, in which preservation of periodontal ligament vitality, favorable root development, atraumatic surgical handling, and proper donor-recipient adaptation collectively determine treatment outcomes.

Complications and Risk Factors

Although tooth autotransplantation is associated with high survival rates, complications may still occur and can adversely affect long-term outcomes. Most reported complications are directly related to injury of the periodontal ligament, impaired pulp healing, or inadequate adaptation of the transplanted tooth within the recipient site [11,14,16].

Inflammatory root resorption is one of the most serious biological complications following autotransplantation. It is generally associated with damage to the periodontal ligament combined with bacterial contamination of the root canal system. The condition may remain clinically asymptomatic during its early stages and is often detected only through radiographic examination. If not diagnosed and treated

promptly, progressive root destruction may eventually lead to transplant failure. According to Rohof et al. [7], the incidence of root resorption in teeth with incomplete root formation is approximately 2.9%.

Ankylosis and replacement resorption represent another group of complications associated with severe injury to periodontal ligament cells. In these cases, normal periodontal healing is replaced by direct contact between the root surface and alveolar bone, resulting in gradual replacement of dental tissues by bone. Ankylosed teeth lose physiological mobility and may exhibit unfavorable long-term behavior, particularly in younger patients. Although the reported incidence of ankylosis is relatively low, the risk increases significantly when extraction is traumatic or when excessive manipulation of the donor tooth occurs during surgery [11,14].

Pulp necrosis remains a major concern, especially when donor teeth with complete root formation are used. Immature teeth with open apices possess a greater capacity for pulp revascularization, whereas mature teeth demonstrate a substantially lower potential for spontaneous healing [15]. Consequently, several authors have emphasized the importance of endodontic treatment in teeth with closed apices to reduce the risk of inflammatory complications and improve long-term prognosis [9,16].

In addition to biological factors, technical factors may also influence treatment outcomes. Excessive extra-alveolar time, inadequate preparation of the recipient site, poor primary stability, and inappropriate splinting protocols have all been associated with increased complication rates [14,17]. Likewise, complex root morphology and unfavorable recipient site conditions may increase surgical difficulty and negatively affect healing.

Current evidence suggests that many complications share common underlying mechanisms. Therefore, prevention strategies should focus on preservation of periodontal ligament vitality, atraumatic surgical techniques, minimization of extra-alveolar time, careful case selection, and appropriate postoperative monitoring. Adherence to these principles remains essential for achieving predictable long-term outcomes following tooth autotransplantation [9,11,14,16].

Digital Workflow in Contemporary Autotransplantation

The incorporation of digital technologies has significantly transformed the planning and execution of tooth autotransplantation procedures. Advances in cone-beam computed tomography (CBCT), computer-assisted planning, and three-dimensional (3D) printing have improved surgical precision and contributed to more predictable clinical outcomes [17,18].

CBCT has become an essential component of the preoperative assessment. 3D imaging enables detailed evaluation of donor tooth morphology, root configuration, recipient site anatomy, available bone volume, and the relationship of adjacent anatomical structures. Such information is particularly valuable when third molars are selected as donor teeth because of their considerable anatomical variability [17,18].

A major development in contemporary autotransplantation is the use of virtual treatment planning. Digital datasets obtained from CBCT scans allow clinicians to simulate the procedure before surgery, assess the compatibility between donor and recipient sites, and determine the optimal position of the transplant. This approach facilitates more accurate surgical planning and reduces intraoperative uncertainty.

Three-dimensional printing technologies have further enhanced the digital workflow. Patient-specific replicas of donor teeth can be fabricated before surgery and used to prepare the recipient site prior to extraction of the actual donor tooth. As a result, the number of trial insertions is reduced and extra-alveolar time can be minimized, thereby improving preservation of periodontal ligament cell viability [17].

Another important development is the use of surgical guides and customized instruments. Anssari Moin et al. [18] demonstrated the feasibility of computer-assisted template-guided autotransplantation using individualized surgical tools designed from digital imaging data. These technologies enable more precise preparation of recipient sites and may improve the accuracy of transplant positioning.

Despite these advances, digital technologies should be regarded as adjunctive tools rather than independent determinants of success. Their primary value lies in reducing surgical trauma, shortening extra-alveolar time, and improving procedural accuracy. Nevertheless, successful outcomes continue to depend on fundamental

biological principles, including preservation of periodontal ligament vitality, atraumatic handling of the donor tooth, and appropriate postoperative management [14,17].

Clinical Outcomes and Future Perspectives

Evidence accumulated over the past two decades indicates that tooth autotransplantation can achieve highly favorable long-term outcomes when appropriate biological and surgical principles are followed. Numerous clinical studies and systematic reviews have reported survival rates exceeding 90%, supporting the reliability of this treatment modality in carefully selected cases [9–16].

Among the various applications of autotransplantation, the use of third molars for replacement of missing first molars appears particularly promising. This approach simultaneously addresses two common clinical challenges: the loss of strategically important posterior teeth and the presence of third molars with limited functional value. In addition to restoring masticatory function, transplantation preserves periodontal ligament function and promotes physiological remodeling of the surrounding alveolar bone [6,7].

Despite these favorable outcomes, direct comparison of published studies remains difficult because of differences in patient populations, follow-up periods, surgical protocols, and definitions of treatment success. While some authors define success primarily as long-term retention of the transplanted tooth, others additionally require the absence of root resorption, ankylosis, pulp pathology, periodontal complications, and abnormal mobility [14,16]. Greater standardization of outcome measures would facilitate comparison between studies and improve the quality of future evidence.

The increasing adoption of digital technologies has already contributed to improvements in the accuracy and predictability of autotransplantation procedures. CBCT-based planning, virtual simulation, surgical guides, and 3D-printed replicas have demonstrated their value in reducing surgical trauma and facilitating more precise treatment execution [17,18]. Future advances may include artificial intelligence-assisted treatment planning, automated assessment of donor-recipient compatibility, and increasingly individualized surgical workflows.

Further prospective clinical studies with long-term follow-up are required to clarify the influence of donor tooth morphology, root development stage, recipient site characteristics, and digital planning protocols on treatment outcomes. Continued research in these areas may help refine patient selection criteria and optimize clinical protocols for tooth autotransplantation.

Conclusion

Third molar autotransplantation represents a clinically effective treatment option for the replacement of missing teeth, particularly in cases involving the loss of first molars. By preserving functional periodontal tissues and supporting physiological adaptation of the dentoalveolar complex, autotransplantation offers biological advantages that cannot be fully replicated by artificial restorative solutions.

Current evidence indicates that favorable long-term outcomes are closely associated with careful case selection and adherence to fundamental biological principles. Preservation of periodontal ligament vitality, minimization of extra-alveolar time, adequate recipient site preparation, and proper postoperative management remain the key determinants of treatment success. Although complications such as inflammatory root resorption, ankylosis, replacement resorption, and pulp necrosis may occur, their frequency can be minimized through atraumatic surgical techniques and appropriate postoperative care.

Based on the available evidence, third molar autotransplantation should be considered a valuable treatment option within contemporary restorative and surgical dentistry. The combination of favorable long-term outcomes, preservation of periodontal function, and recent advances in digital dentistry has renewed clinical interest in this procedure and expanded its potential applications in clinical practice.

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