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# REPLANTATION AND AUTOTRANSPLANTATION AS A METHOD OF SURGICAL TREATMENT FOR MISSING AND SEVERELY DAMAGED TEETH

**Shanygina Diana Vladimirovna[1], Kalinkina Valentina Alexandrovna[2], Ksenofontov Maxim Sergeevich[3], Korovin Oleg Leonidovich[4]**

[1]Candidate of Medical Sciences, Associate Professor, Department of Dentistry, Moscow Medical University "Reaviz", ORCID: https://orcid.org/0009-0002-2621-8705, E-mail: Disha1Disha@mail.ru
[2]Dental Hygienist, StatusKVO Dentistry LLC, Student, Moscow Medical University "Reaviz", Email: alya.lelya@yandex.ru, ORCID: 0009-0009-3444-9889
[3]Dental Practitioner, Foderis Dental Center LLC, Student, Moscow Medical University "Reaviz", Email: m.s.ksenofontov@mail.ru, ORCID: 0009-0002-3738-0337
[4]Author's Dentistry LLC, Serpukhov, Moscow Region, Student, Moscow Medical University "Reaviz", Email: Olegtheman@yandex.ru, ORCID: 0009-0004-6718-469X

## ABSTRACT

In modern oral surgery, the treatment of patients with missing, traumatically lost, or severely damaged teeth is more often associated with prosthetic rehabilitation and dental implantation. However, replantation and autotransplantation retain their clinical significance as biological methods of tooth preservation and replacement. Their effectiveness is determined not only by surgical technique, but also by molecular and cellular processes: preservation of periodontal ligament viability, remodeling of alveolar bone, pulp revascularization, and reduction of the risk of inflammatory or replacement root resorption. The aim of this article is to review current concepts of tooth replantation and autotransplantation, taking into account their biological prerequisites, indications, limitations, clinical stages, and complications. Particular attention is paid to the stage of root formation, the condition of the recipient site, and postoperative follow-up. It is shown that autotransplantation should not be regarded as an outdated alternative to implantation, but may serve as an independent organ-preserving method when the patient is properly selected, a donor tooth is available, and the surgical protocol is followed.

**KEYWORDS:** tooth replantation; tooth autotransplantation; avulsion; third molar; periodontal ligament; root resorption; oral surgery; dental implantation; clinical guidelines.

## INTRODUCTION

Tooth loss or the impossibility of tooth restoration remains one of the most common clinical situations in dental practice. It may be caused by complicated caries, vertical root fracture, trauma, unsuccessful endodontic treatment, severe destruction of the crown, inflammatory and destructive processes in the periapical tissues, as well as congenital absence of individual teeth. In everyday clinical practice, such cases often result in tooth extraction followed by prosthetic treatment or dental implantation. This approach is justified in many situations, but it is not always the only possible option, especially when the patient has their own teeth that can be used as a biological graft.

When restoration and prosthetic treatment of a severely damaged tooth are impossible, clinicians often choose standard implantation, even when suitable wisdom teeth are available. Autotransplantation is used much less frequently than implantation because of the lack of protocols for this specific procedure and the absence of necessary guidance on this method in clinical recommendations. As a result, a method that has a strong biological rationale and confirmed clinical outcomes is applied only to a limited extent in real practice and often depends on the personal experience of the oral surgeon, the level of interdisciplinary training, and the technical capabilities of the clinic [5, 6, 11].

Tooth replantation and autotransplantation are surgical procedures based on preserving the viability of the periodontal ligament and the ability of the tooth to reintegrate into bone tissue. Replantation involves returning a tooth to its own alveolus after traumatic luxation or after controlled extraction, for example, in cases of intentional replantation. Autotransplantation, in turn, involves moving the patient's own tooth from one position to another, most often to the area of a dental arch defect or into the socket of an extracted severely damaged tooth [2, 5, 6].

The most extensively developed area is replantation of a permanent tooth in cases of complete avulsion. The International Association of Dental Traumatology and clinical guidelines on dental trauma describe the main principles of managing such patients: the urgency of replantation, the importance of extra-alveolar time, the choice of storage medium, splinting features, and subsequent endodontic treatment [1, 2, 3]. With regard to autotransplantation, the situation is less clearly defined. Despite the availability of systematic reviews, clinical studies, and expert recommendations, unified indications and a standard protocol have not yet become as widespread as those for traumatic replantation [5, 6, 10, 11].

The relevance of this topic is determined by the fact that dental implantation, although a highly effective method of restoring dental arches, does not reproduce the biological properties of a natural tooth. An implant has no periodontal ligament, does not possess physiological proprioception, does not participate in alveolar bone remodeling in the same way as a natural tooth, and has limitations in patients with incomplete jaw growth [16]. By contrast, an autotransplanted tooth, in the event of a favorable outcome, preserves the periodontal ligament, can participate in occlusal adaptation, support bone tissue, and subsequently function as a complete functional unit [11, 12, 13]

The aim of this review is to analyze current data on tooth replantation and autotransplantation as methods of surgical treatment for missing and severely damaged teeth, to determine their clinical significance, limitations, and possible place in the algorithm of clinical decision-making.

**Research objectives:**

1. To examine the biological basis of the engraftment of replanted and autotransplanted teeth;
2. To compare the indications for replantation, intentional replantation, and autotransplantation;
3. To assess the factors influencing treatment prognosis;
4. To determine the practical significance of autotransplantation under conditions of widespread dental implantation.

## MATERIALS AND METHODS

This study was conducted as a review analysis of scientific literature. The search for sources was carried out among publications devoted to replantation of permanent teeth, intentional replantation, tooth autotransplantation, traumatic avulsion, surgical treatment of severely damaged teeth, and comparison of biological methods of tooth replacement with dental implantation.

The review included clinical guidelines, systematic reviews, meta-analyses, expert consensus statements, retrospective studies, controlled clinical studies, and review publications, mainly for the period from 2021 to 2026. Earlier sources were used only in cases where they were of fundamental importance for understanding the limitations of implantation in patients with ongoing jaw growth or for analyzing the outcomes of intentional replantation.

The search was conducted using the following keywords: tooth replantation, dental avulsion, intentional replantation, tooth autotransplantation, third molar autotransplantation, periodontal ligament, root resorption, ankylosis, dental trauma, clinical guidelines.

The inclusion criteria were as follows: the presence of clinically significant data on indications, technique, outcomes, or complications; publication in a peer-reviewed journal or in the form of official clinical guidelines; and the possibility of correlating the source conclusions with dental practice. Isolated clinical cases were used to a limited extent and were not considered the main level of evidence.

The literature analysis was conducted across several thematic blocks: terminology and biological basis of the methods; indications and contraindications; surgical protocol; prognosis and complications; and the practical role of replantation and autotransplantation in modern dentistry.

## RESULTS AND DISCUSSION

### Biological Basis of Replantation and Autotransplantation

A common biological condition for successful replantation and autotransplantation is the preservation of viable periodontal ligament cells on the root surface. It is the periodontal ligament that ensures the reattachment of the tooth to the alveolar bone, the formation of a functional periodontium, and a reduction in the risk of replacement resorption. In cases of traumatic extraction, prolonged drying of the root, mechanical damage to the cementum, or overheating of the bone bed, the probability of an unfavorable outcome increases significantly [2, 3, 6].

Replantation in cases of complete tooth avulsion is most often an emergency procedure. In this case, the prognosis depends on the time elapsed between the injury and the return of the tooth to the socket, as well as on the storage conditions of the tooth. The longer the tooth remains outside the oral cavity in a dry environment, the higher the risk of periodontal ligament cell necrosis, inflammatory root resorption, and ankylosis [2, 4]. Therefore, clinical guidelines place particular emphasis on the urgency of care and the correct management of the patient after replantation [1, 2].

Intentional replantation differs from traumatic replantation in that the tooth is extracted in a controlled manner, after which the clinician performs extraoral therapeutic procedures: root inspection, apical resection, retrograde filling, defect correction, or other interventions, and then returns the tooth to its own socket [5, 6, 10]. This method is not a way of replacing a missing tooth, but it may be considered an option for tooth preservation when conventional endodontic or surgical treatment is difficult or impossible.

Autotransplantation has a different clinical purpose. Its essence lies in transferring the patient's own tooth to the area of a dental arch defect or into the socket of an extracted tooth. Third molars, premolars, or teeth planned for extraction for orthodontic reasons are most often considered as donor teeth [11, 12, 13]. Unlike an implant, a successfully transplanted tooth preserves its biological connection with the surrounding tissues, which is especially important in adolescents and young patients.

**Indications for Replantation**

The most obvious indication for replantation is complete avulsion of a permanent tooth. At the same time, replantation of primary teeth is generally not performed because of the risk of damaging the permanent tooth germ. For permanent teeth, replantation is considered the treatment of choice provided that the tooth is suitable for reinsertion into the socket, there are no absolute contraindications, and the patient can remain under dynamic follow-up [1, 2].

The clinical purpose of replantation in cases of avulsion is not limited to restoring the tooth as an aesthetic and functional unit, but also includes preservation of the alveolar process, especially in the anterior region. Even in cases with an unfavorable long-term prognosis, a replanted tooth may temporarily preserve bone volume and postpone the need for implantation or complex bone augmentation procedures [2, 4].

Intentional replantation may be considered in cases of persistent apical periodontitis, impossibility of orthograde root canal retreatment, difficult access to the pathological focus, instrumental complications, perforations, or root defects that can technically be corrected outside the oral cavity [5, 6, 8, 10]. However, this method requires strict patient selection. Unfavorable factors include pronounced tooth mobility, deep periodontal pockets, vertical fractures with poor prognosis, unfavorable root anatomy, impossibility of atraumatic extraction, and low patient motivation for follow-up.

Systematic reviews show that intentional replantation may provide acceptable clinical outcomes when the technique is properly followed. According to a meta-analysis, the overall healing rate after intentional replantation of teeth with periapical pathology was approximately 80%; however, the complication rate remained clinically significant [9]. Another review reported survival and success rates of approximately 85.9% and 77.2%, respectively, with minimal extra-alveolar time, atraumatic root handling, and adequate apical sealing identified as key prognostic factors [8].

**Indications for Autotransplantation**

Tooth autotransplantation is most justified in cases where the patient has a dental arch defect or a tooth requiring extraction, while also having a suitable donor tooth. A classic clinical situation is the destruction of the first or second molar in the presence of a third molar with a favorable root shape. In such cases, the wisdom tooth may not be removed as a “supernumerary” or unnecessary tooth, but instead used to restore masticatory function [11, 13, 15].

Other indications may include congenital absence of teeth, early loss of permanent teeth in adolescents, traumatic loss of an anterior tooth, the need for tooth replacement in a patient with incomplete jaw growth, as well as the impossibility or undesirability of implantation. Particularly important is the fact that an implant in a growing patient behaves as an ankylosed structure and does not follow the growth of the alveolar process, which may lead to infraocclusion and aesthetic disturbances [16].

Teeth with incomplete root formation are considered the most favorable donor material. With an open root apex, the probability of pulp revascularization and further root development is higher. However, mature teeth may also be used if timely endodontic treatment is planned and the surgical protocol is followed [11, 12].

Criteria for a favorable prognosis include good oral hygiene, absence of active uncontrolled inflammation, sufficient bone volume in the recipient site, simple or moderately complex root morphology of the donor tooth, the possibility of atraumatic extraction, minimal extra-alveolar time, absence of excessive compression of the periodontal ligament, and subsequent regular follow-up [11, 13, 15].

Contraindications or significant limitations include severe systemic conditions, advanced periodontitis, poor oral hygiene, absence of a suitable donor tooth, unfavorable root anatomy, inability to prepare the recipient site without trauma, and lack of conditions for dynamic monitoring. A relative contraindication may be a pronounced infectious process in the transplantation area if it cannot be adequately controlled before or during surgery.

**Surgical Protocol and Prognostic Factors**

Planning for replantation and autotransplantation begins with diagnosis. In traumatic replantation, the time available for examination is limited, but the clinician must assess the condition of the socket, the degree of tooth contamination, the stage of root formation, and the presence of associated injuries to the soft tissues and alveolar bone [1, 2]. In planned autotransplantation, diagnostic possibilities are broader and include clinical examination, occlusion assessment, analysis of orthopantomography, and, if necessary, cone-beam computed tomography.

CBCT is of particular importance for assessing the root morphology of the donor tooth, the thickness of the bone walls, and the relationship with the mandibular canal, maxillary sinus, and adjacent teeth. Modern digital technologies make it possible to produce 3D replicas of the donor tooth, which are used for preliminary preparation of the recipient site. This reduces the number of trial fittings of the tooth itself, shortens extra-alveolar time, and decreases trauma to the periodontal ligament [14].

A key stage of the operation is atraumatic extraction of the donor tooth. The tooth should be held mainly by the crown, avoiding contact of instruments with the root surface. Drying of the root, aggressive scraping of the cementum, and prolonged exposure of the tooth outside a moist environment are unacceptable. If necessary, the tooth should be stored in saline solution or another suitable medium, but not in a dry gauze pad [2, 6].

The recipient site must correspond to the size and shape of the root, while avoiding excessive pressure on the periodontal ligament. A fit that is too tight increases the risk of damage to periodontal cells, whereas excessive mobility may impair primary stabilization. After tooth placement, gentle fixation is usually performed using

sutures, flexible splinting, or a combination of both. Rigid long-term fixation is undesirable, as it may contribute to ankylosis [2, 6, 13].
Occlusal relief is an essential element of postoperative management. The transplanted or replanted tooth should not be in premature contact. The patient is instructed on the need for a sparing regimen, oral hygiene, monitoring of inflammatory symptoms, and regular follow-up visits. Dynamic follow-up includes clinical assessment of mobility, percussion response, gingival condition, periodontal attachment, as well as radiographic monitoring for signs of resorption, ankylosis, periapical changes, and root formation [1, 2, 13].
Endodontic management depends on the stage of root formation. In teeth with incomplete root formation, preservation of pulp vitality and further root development are possible. In teeth with a closed apex, the risk of pulp necrosis is higher; therefore, planned endodontic treatment is often required. A common mistake is that the clinician may technically perform the transplantation successfully but fail to organize subsequent endodontic and radiographic follow-up, which increases the risk of delayed detection of inflammatory resorption [2, 6, 12].

**Clinical Outcomes and Complications**
The outcome of replantation after avulsion largely depends on extra-alveolar time. A retrospective analysis of replanted permanent teeth showed that some teeth remain preserved after several years of follow-up, whereas a significant proportion are lost due to external root resorption. One of the key factors associated with a favorable prognosis is returning the tooth to the socket within the first hour after trauma or storing it in an appropriate moist medium [4].
For intentional replantation, the most common complications include inflammatory resorption, replacement resorption, ankylosis, persistent periapical lesion, pathological mobility, and reinfection of the root canal. Nevertheless, with proper tooth selection, this method may be justified as a final opportunity to preserve the patient's own tooth before extraction [7, 8, 9, 10, 17].
Autotransplantation is associated with similar biological risks: pulp necrosis, arrest of root development, inflammatory resorption, ankylosis, periodontal defects, lack of stabilization, and graft loss. However, current reviews show that, with proper selection of the donor tooth, especially one with incomplete root formation, survival rates may be high. An umbrella review on tooth autotransplantation reported high five-year and ten-year survival rates for teeth with open apices, although the authors emphasized heterogeneity among studies and differences in success criteria [11].
A systematic review and meta-analysis of autotransplantation of teeth with incomplete root formation also confirms that such grafts have a favorable prognosis when selection criteria and surgical technique are properly followed [12]. This is especially important for young patients, in whom implantation may be postponed until growth is complete, while removable or adhesive prosthetic constructions do not always provide full function and tissue stability.

**Comparison with Dental Implantation**
The comparison between autotransplantation and implantation should not be based on complete opposition between the two methods. Dental implantation remains a predictable and widely used treatment option in adult patients with sufficient bone volume and no contraindications. However, an implant is an artificial structure, whereas an autotransplanted tooth is a biological organ with its own periodontium.
Autotransplantation has several advantages: preservation of the periodontal ligament, the possibility of physiological adaptation, maintenance of alveolar bone, potential for orthodontic movement, and better biological integration in young patients. In addition, the method may be more economically accessible if the donor tooth is already present and would otherwise be extracted [13, 15].
The limitations of autotransplantation are also significant. The method is impossible without a suitable donor tooth. It is technically sensitive and requires surgical experience, precise planning, control of extra-alveolar time, and subsequent follow-up. Unlike implantation, the outcome depends not only on osseointegration, but also on the condition of the periodontal ligament, pulp, root cementum, and recipient site [6, 11, 13].
For this reason, autotransplantation should be considered not as a universal replacement for implantation, but as a separate clinical option. In practice, this means that when planning extraction of a severely damaged molar in a young patient, the clinician should assess not only the possibility of future implantation, but also the presence of a third molar, its anatomy, the stage of root formation, and the feasibility of transplantation. This approach broadens clinical thinking and helps avoid premature rejection of a biological treatment option.

**The Problem of Clinical Guidelines and Practical Implementation**
The main problem of autotransplantation in everyday dental practice lies not only in the technical complexity of the method, but also in the absence of its stable position within clinical algorithms. For replantation in cases of complete tooth avulsion, clinical guidelines are available, and the clinician can follow clear stages: replantation, splinting, medication support, endodontic management, and dynamic follow-up [1, 2]. For tooth autotransplantation, a comparable level of standardization is still insufficient in domestic practice.
For this reason, clinicians more often choose a more familiar pathway: extraction of the severely damaged tooth, socket preservation, bone augmentation if necessary, and subsequent implantation. This approach is understandable, but it does not always take into account the biological potential of the patient's own teeth. This is

especially relevant to third molars, which are often removed as impacted or dystopic teeth, although in selected cases they may be used to restore a dental arch defect.

To expand the use of autotransplantation, not only publications of individual clinical cases are needed, but also the development of clear criteria: which tooth should be considered a suitable donor, which stages of root formation are optimal, when transplantation should be performed simultaneously with extraction of a severely damaged tooth, when preliminary preparation of the recipient site is required, how endodontic treatment of mature transplants should be carried out, and how long the patient should be monitored.

A practical algorithm may include several sequential questions. Does the patient have a tooth that cannot be preserved? Is there a suitable donor tooth? Has jaw growth been completed? Does the anatomy of the donor tooth allow atraumatic extraction? Can the recipient site be prepared without excessive trauma? Is the patient ready for follow-up? If the answers are favorable, autotransplantation should be discussed as one of the treatment options along with implantation and prosthetic constructions.

## CONCLUSION

Tooth replantation and autotransplantation are biologically oriented surgical methods whose effectiveness is determined not only by the surgical technique, but also by the preservation of molecular and cellular conditions required for tissue repair. The viability of periodontal ligament cells is of key importance, since it ensures reattachment of the tooth to the alveolar bone, formation of a functional periodontium, and reduction of the risk of inflammatory or replacement root resorption.

Replantation of a permanent tooth in cases of complete avulsion is a more standardized approach, as its main stages are reflected in clinical guidelines and international protocols. In such cases, the prognosis largely depends on extra-alveolar time, tooth storage conditions, preservation of the root cementum, proper splinting, endodontic management, and subsequent follow-up.

Tooth autotransplantation has independent clinical significance in the treatment of missing and severely damaged teeth, especially in young patients, when a suitable donor tooth and sufficient bone volume are available. Unlike implantation, this method makes it possible to preserve the biological properties of a natural tooth: the periodontal ligament, proprioception, the ability to adapt to occlusion, and participation in alveolar bone remodeling.

From a molecular and biological perspective, the most favorable conditions are created when teeth with incomplete root formation are used, since an open apex increases the likelihood of pulp revascularization and further root development. In the transplantation of mature teeth, the prognosis depends to a greater extent on timely endodontic treatment, atraumatic extraction, minimal extra-alveolar time, and the quality of postoperative follow-up.

Autotransplantation should not be regarded as a direct competitor to dental implantation. It is more appropriate to consider it as an additional organ-preserving and organ-replacing method that may be selected before a final decision on implantation is made. This is especially important in cases where the patient has a third molar or another donor tooth potentially suitable for restoring a dental arch defect.

The main limitation to the practical use of autotransplantation remains the insufficient standardization of indications and clinical algorithms. Therefore, further development of the method should be associated with clarifying patient selection criteria, assessing the stage of root formation, and developing protocols for recipient site preparation, endodontic support, and dynamic follow-up. This approach will allow replantation and autotransplantation to be considered not merely as surgical procedures, but as methods based on preserving the regenerative potential of the patient’s own tissues.

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