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Tooth autotransplantation: review of the relevant procedural aspects for the clinical success

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Abstract

Background. Tooth autotransplantation may be considered as valuable treatment option to overcome adverse effects of tooth loss and prevent implant-related complications. The essence of such manipulation based on removing targeted (donor) tooth from its present location with its further placement at some other tooth position within the oral cavity of the same patient in the least traumatic way.

Objective. To systematize and analyze relevant procedural aspects of tooth autotransplantation associated with its' clinical success.

Materials and Methods. A comprehensive search strategy was realized through databases PubMed (https://pubmed.ncbi.nlm.nih.gov/) and Cochrane Library (https://www.cochranelibrary.com/), and also via Google Scholar (https://scholar.google.com/) search engine to expand possibilities for targeted publications identification. Primary extraction of the targeted studies was provided by their title and abstract. The criteria for eligibility included publications with described original practical and theoretical aspects regarding tooth autotransplantation procedure, while publications with repetitive information or non-sufficiently argumented/non evidence based statements were excluded from further analysis.

Results. The final number of eligible studies for analysis was 82 publications with adequate reporting of outcomes associated with present research objective. Out of this number 8 were presented in the form of systematic reviews, 3 in the form of literature reviews, while all others were presented in forms of case reports, case series, protocols, recommendations, follow-ups, experimental and clinical studies.

Conclusion. Correct surgical manipulations, which should be as atraumatic as possible to preserve the periodontal ligament of the transplanted tooth, is a key of autotransplantation successful outcome. The success of the treatment is also related with the stage of root development. In cases of transplanting the teeth with complete root development endodontic treatment should be performed approximately in 2 weeks after primary intervention.

Introduction

Tooth extraction associated not only with further dentition deformation, chewing efficiency reduction and disbalance of masticatory system in general, but also with decrease within the stimulation of cerebral cortex caused by the loss of proprioceptive function at the periodontal ligament level [2, 3, 4]. Replacement of the lost tooth with the implant-supported prosthetics seem to be efficient treatment method for partial aedentia cases, nevertheless in past decades increasing trend of implant-associated complications prevalence has been observed. The latter are mostly related with improperly performed prosthetic treatment phase and peri-implantitis pathology [1, 5, 6].

Also, while planning dental implantation dentists should consider continuous alveolar growth in the frontal region of maxilla, which does not stop after puberty period and continuing throughout the patient's life. Due to the above-mentioned fact placement of dental implants within the frontal maxilla may be related with aesthetic issues in future caused by the development of implant infraposition effect. Such effect related with progressive growth of the alveolar process at the area of the teeth adjacent to the placed implant and the absence of periodontal ligament in the area of installed intraosseous screw. Mostly such kind of situations may occur among teenagers, especially those with an elongated face type [7-10], therefore dental implants placement among this patients' category is not recommended [11, 12].

To overcome above mentioned adverse effects of tooth loss and prevent implant-related complications, autotransplantation of teeth may be considered as valuable treatment option. The essence of such manipulation based on removing targeted tooth from its present location with its further placement at some other tooth position within the oral cavity of the same patient in the least traumatic way.

A transplanted tooth has a number of advantages compare to dental implant. It helps to preserve periodontal ligament and proprioceptive sensitivity, maintain the initial alveolar bone volume and prevent alterations of the maxillofacial system development. Due to the previous research results pulp regeneration and continued root formation are seems to be highly possible when transplanting a donor tooth with incomplete root development and vital pulp [13].

Due to the recent developments of technologies and techniques

in dentistry, and a number of clinical and experimental studies published over the past 40 years, it has been proven that tooth autotransplantation procedure can be clinically predictable with successful results in the long-term perspective [22-24].

The most common indications for tooth autotransplantation are: non-restorable molars and frontal teeth, absence of frontal teeth due to agenesis (aedentia) or avulsion, retained or ectopic frontal teeth, as well as teeth that cannot be extruded orthodontically. The most frequently transplanted are premolars, canines, incisors and third molars [28].

Although tooth autotransplantation demonstrates long-term successful results, patients should be informed about the potential complications associated with the procedure of removing the donor tooth. Also, patients should be aware regarding impact of alveolar bone deficiency at the recipient area on the final outcome of autotransplantation [25]. The most prevalent complications include inflammatory or replacement resorption, pulp necrosis, lack of healing or impaired healing of the periodontal ligament, as well as reduction of root length [26]. Tooth autotransplantation procedure is also contraindicated for children and adolescents due to the continued growth of the alveolar process [8, 9].

The success of tooth autotransplantation linked with the following factors: stage of root development, morphology of the tooth, methodology of used surgical procedure, duration of extraoral manipulations with the tooth, form of the recipient socket, vascularization of the recipient site, and the viability of the periodontal ligament [12, 18].

Objective

To systematize and analyze relevant procedural aspects of tooth autotransplantation associated with its' clinical success.

Materials and Methods

Literature search

A comprehensive search strategy was realized through databases PubMed (https://pubmed.ncbi.nlm.nih.gov/) and Cochrane Library (https://www.cochranelibrary.com/), and also via Google Scholar (https://scholar.google.com/) search engine to expand possibilities for targeted publications identification.

Search within PubMed database was provided by the following Mesh-terms algorithm: ("tooth"[MeSH Terms] OR "tooth"[All Fields]) AND ("transplantation, autologous"[MeSH Terms] OR ("transplantation"[All Fields] AND "autologous"[All Fields]) OR "autologous transplantation"[All Fields] OR "autotransplantation"[All Fields]) [27]. Search via Google Scholar engine was realized by the following keywords "tooth" and "autotransplantation".

No restrictions regarding terms of publication were applied during literature search, while only publications written in English or at least with English abstract were considered to be included into the study sample. The search was performed on 1st of May 2022. The literature search was done according to PRISMA (Preferred Reporting Item for Systematic Reviews and Meta-Analysis) recommendations [28].

Primary extraction of the targeted studies was provided by their title and abstract. The criteria for eligibility included publications with described original practical and theoretical aspects regarding tooth autotransplantation procedure, while publications with repetitive information or non-sufficiently argumented/non evidence based statements were excluded from the further analysis.

Quality assessment of selected publication

Publications retrieved after the search were assessed by the specific criteria regarding their quality and potential to undergo in-detail content analysis. Quality of selected case-studies and case-series were evaluated with criteria proposed by Murad et al [29]. Proposed tool for evaluating the methodological quality of case reports and case series included four domains: selection, ascertainment, causality, and reporting [29].

Quality assessment of selected systematic reviews was provided with AMSTAR 2 tool, which is eligible for systematic reviews that include randomized or non-randomized studies of healthcare interventions [30]. AMSTAR 2 critical domains include following: protocol registration info, adequacy of provided literature search, argumentation for excluding individual studies, presented risk of bias from analyzed individual studies, usage of correct and argumented meta-analytical methods, consideration of risk of bias when interpreting the results of the review, evaluation of potential impact of publication bias [30].

SANRA scale was used to assess the quality of narrative review articles [31]. Present scale helps to measure quality of review articles based on the following aspects: argumentation of article's importance for the readership, statement of specifically formulated objective or questions, description of literature search algorithm, referencing, scientific reasoning and appropriate representation of the data [31].

Data extraction

The following information was extracted from each publication during content analysis of articles' full texts: success of tooth autotransplantation, procedural and clinically-relevant aspects of tooth autotransplantation procedure, complications associated with tooth autotransplantation procedure, histological and morphological features linked with the clinical success of tooth autotransplantation procedure.

Statistical analysis

The descriptive statistics were performed regarding parameters of tooth autotransplantation success and frequency of complications reported within the previously published studies. The statistical analysis and data categorization were provided within the Microsoft Excel 2019 spreadsheet software (Microsoft, United States).

Results

The literature search of identified terms in PubMed, Cochrane Library and via Google Scholar engine yielded a total of 1431 articles. After reviewing each article's title and abstract, 1349 studies were excluded due to non-relevance issues, unavailability of abstracts and/or full texts, containment of repetitive information, presentation of non-sufficiently argumented/non evidence based statements, and because of non-compliance with used quality assessment criteria (Murad's et al. for case studies and case series [29], AMSTAR 2 for systematic review [30], and SANRA for narrative review [31]).

The final number of eligible studies for analysis was 82 publications with adequate reporting of outcomes associated with present research objective. Out of this number 8 were presented in the form of systematic reviews, 3 in the form of literature reviews, while all others were presented in forms of case reports, case series, protocols, recommendations, follow ups, experimental and clinical studies.

Discussion

Surgical protocol of the tooth autotransplantation

The operation starts with local anesthesia in the projection of the inferior alveolar nerve (for the mandible) or in the projection for the posterior superior alveolar nerve (for the maxilla). In the case of complete third molar retention or impaction triangular flap is formed and separated to gain needed access within the operative field [18, 19, 21]. If the donor third molar is fully erupted intrasulcular incision is used in order to preserve the periodontal ligament. Extraction of the tooth should be provided in the most atraumatic way.

The extracted tooth should be stored within the Hanks' balanced salt solution or within the pasteurized milk [32]. Preparation of recipient area provided using low-speed surgical burs with constant saline cooling [13]. After that donor tooth is placed within prepared recipient socket. Transplanted tooth should be out of occlusion

to eliminate impact of destabilizing loads through the occlusal contacts with antagonist tooth. It is preferably to use more flexible splint for transplanted tooth fixation, rather than rigid one. Flexible splint fixation supports further pulp revascularization [33]. The surrounding soft tissues could be sutured with absorbable or non-absorbable sutures.

Postoperative care includes oral rinses with 0.12% chlorhexidine gluconate solution, liquid-type diet with only soft food intake, antibacterial therapy and, if necessary, anti-inflammatory drugs prescription [34].

Usually sutures could be removed in a week, while the splint should stay in place for 2-4 weeks [18, 19, 21, 36].

In the case of autotransplantation of tooth with completely formed roots endodontic treatment should be performed after 2-3 weeks to prevent pulp infection and potential inflammatory resorption of the roots [35]. Patients with provided tooth autotransplantation should undergo control dental examination at the period of 1, 3, 6, 9, and 12 months during which doctor should evaluate mobility of the tooth, its response to percussion, depth of periodontal probing, and perform X-ray for potential identification of periodontal lesions, signs of resorption and destruction of surrounding bone tissue.

Impact of root development stage on the tooth autotransplantation outcome

Root development stage plays an important role within the prognosis of tooth autotransplantation. Teeth with incomplete root development characterized with 96% probability of successful pulp healing, while teeth with completed root development associated only with 15% of such probability.

Also, some other types of complications related with root development stage of the tooth during its autotransplantation. The most common include pulp necrosis, ankylosis, and root resorption [38]. These complications are directly related to the stage of root development and the ability of pulp to revascularize. The development of the root up to 75% of its length demonstrates one of the greatest tendencies for revascularization after autotransplantation [39-41]. The vitality of the tooth after autotransplantation directly related with the regeneration of the vascular tissue of the pulp. Such regeneration provided by the growth of capillaries from the area of not yet fully formed root apex [44]. Previously different authors had mentioned various radiological indicators of root development, which potentially could be linked with successful results of tooth autotransplantation (regarding apex width in the range from 2-3 mm to 3-5 mm) [42, 43].

Third molars with not completely developed roots characterized with a good blood supply and a rich depo of stem cells, so their further root development after transplantation procedure depends on the preserved activity of the epithelial Hertwig's sheath [46]. Its preservation not only leads to complete root development, but also affects periodontal healing [11, 45]. Considering these factors, teeth with root development quantified as late stage 2 (formed to the half of their length) to stage 4 (formed to the three-quarters of their length or almost fully formed) seems to be the best choice for autotransplantation. Preservation of tooth viability is important for proper development of the alveolar ridge and prevention of ankylosis or root resorption side effects [39, 47, 48]. Following classification could be used for categorization of molar root development [49]: 1st stage – roots are formed to the one quarter of their length; 2nd stage – roots are formed to the half of their length; 3rd stage – roots are formed to the three quarters of their length; 4th stage – roots are formed along the entire length with open apex; 5th stage – the roots apexes are half closed by a wide periodontal ligament; 6th stage – roots apexes are fully closed.

Phase of atraumatic tooth extraction

One of the important factors, which is greatly contributes to the success of tooth autotransplantation, is minimal traumatization of the root surface during extraction [50-52]. Damage of the periodontal ligament should be avoided and prevented as much as possible. Before extraction, an intrasulcular incision is made to preserve the periodontal ligament, while extraction should be provided in the slow and atraumatic manner. Piezosurgical approach could be used to facilitate the extraction of retained third molars and to minimize damage to the periodontal fibers, which further helps to minimize risk of ankylosis or root resorption development [53]. During preparation of the recipient site, extracted donor tooth should be preserved within Hanks' balanced salt solution [32]. This solution is the most suitable for maintaining the viability of periodontal ligament cells. As an alternative, pasteurized milk could be used due to its physiologically compatible pH, osmolality relative to the cells on the root surface, and presence of nutrients and growth factors [18, 19, 21, 32].

The longer the time interval between the extraction phase and transplantation, the more unfavorable the overall prognosis. The optimal period of donor tooth extraoral storage is 18 minutes. This time period is important to preserve the vitality of the cells of the periodontal ligament. After 18 minutes of extraoral storage periodontal cells are exposed to hypoxia, which can subsequently lead to necrosis and inflammatory resorption of the root [54].

The preparation of the recipient area takes some time, because the donor tooth needs to be adjusted to obtain maximally correct position. Thus, there is a risk that the donor tooth will remain outside the oral cavity for a longer than 18 minutes.

In order to shorten this period, it has been proposed to use a 3D printed replica of the donor tooth. This way recipient site could be prepared to the form of replica, which allows to avoid a long stay of the transplanted tooth outside the oral cavity and reduces the number of attempts to position the donor tooth correctly within the bone socket. Before the operation, patient can undergo CBCT examination to collect all necessary data about the donor tooth, which is further needed for its replica manufacturing [55].

Impact of the periodontal ligament on the tooth autotransplantation outcome

The periodontal ligament condition is one of the most important factors for the success of tooth autotransplantation [56]. Reattachment between the connective tissue of the periodontal ligament and the wall of the recipient alveolar socket occurs approximately in the period of two weeks after the procedure. Periodontal ligament contains cells that genetically have the ability to differentiate into fibroblasts, osteoblasts and cementoblasts. Presumably, cells of the periodontal ligament at the outer apical surface of the tooth differentiate into cementoblasts and stimulate dentin deposition, while cells facing the surface of the alveolar socket differentiate into osteoblasts, thereby stimulating formation of the bone tissue.

Careful extraction of the donor tooth is very important to preserve the periodontal ligament [63]. Bone regeneration in the recipient area occurs when periodontal ligament cells are preserved [64-65]. The healing of the root surface depends on the degree of its damage. Cement healing can occur at small areas of the damaged periodontal surface. However, large defects of the root surface undergo resorption and dentin replacement to the bone [13]. The periodontal ligament is sensitive to the changes under the influence of osmotic potential and acidity level, while prolonged exposure to the extraoral environment provokes fibroblasts death [63]. Moreover, overdrying of the tooth for 30 and 60 minutes can lead to the development of inflammatory root resorption and ankylosis, respectively [56]. The regenerative potential of periodontal ligament cells decreases with age, which may prevent the normal integration of the donor tooth in the recipient area [62]. Orthodontic treatment does not have a negative effect on the condition of the periodontium of transplanted third molars with incomplete root development [60].

Such factors as periodontal pocket depth of more than 4 mm at the site of donor tooth, age over 40 years, and previous endodontic treatment may be categorized as unfavorable regarding tooth autotransplantation prognosis. It is also recommended not to rotate the donor tooth during its transplantation and avoid damage of the cementum, as this can provoke resorption [57-59].

Preparation of the recipient area

One of the conditions for successful transplantation is a sufficiently large size of the recipient area [32, 66]. The mesiodistal size of the transplanted tooth should correspond to the size of the recipient socket [34]. Usually there is a sufficient amount of bone in the post-extraction recipient site. If the tooth was extracted several months ago with partial or complete bone regeneration, the recipient area is created using surgical burs [67,68]. The recipient socket should be prepared slightly larger than the donor socket, which can be provided with low-speed spherical surgical burs at constant saline cooling. Donor tooth should be placed within recipient socket with a minimal pressure. It is necessary to check the correspondence between the donor tooth and the recipient area, and all the irregularities of the socket wall should be immediately removed [13]. If the donor tooth placed within recipient socket with deficient vestibulo-oral size, root protrusion may occur due to the bone expansion effect and resorption of the alveolar crest [69].

Thus, the lack of sufficient vestibular cortical bone volume and a narrow recipient site are considered to be risk factors for tooth autotransplantation procedure [58]. The discrepancy between the size of the recipient site and donor tooth's root morphology can lead to pulp necrosis [72]. Low success rates were noted after transplantation of teeth from the maxilla to mandible, as well as after the third maxillary molars transplantation in place of the first maxillary molars [73, 74]. Such outcome was related to the differences within the morphology of the corresponding structures [73, 74]. Also, there is a direct relationship between the impaired revascularization of transplanted tooth and an increase of the distance between the root apex and the alveolar surface [75].

The periodontal ligament of transplanted teeth can induce the formation of alveolar bone [56]. However, in cases of alveolar atrophy, the use of free bone autografts should be considered [71]. Another surgical option for insufficient bone volume cases is a split osteotomy procedure. At the same time, split osteotomy characterized by a higher frequency of inflammatory root resorption and a lower success rate compare to the effect of using different types of bone grafts [70].

To ensure the stabilization of the tooth within the recipient area, the presence of inflammation-free bone support with a sufficient amount of attached keratinized soft tissue is required [77]. Therefore, despite the fact that the protocols describe autotransplantation of donor tooth into the socket of extracted tooth at the same session, such procedure should be postponed if tooth in the extraction (recipient) site demonstrates signs of periapical lesion [13]. Also, too close adjacent location of anatomical structures, such as the mandibular canal, mental foramen, or maxillary sinus, and periapical lesions can complicate the curettage procedure of the recipient site [78]. Remnants of inflamed tissue can disrupt bone and soft tissue repair after autotransplantation. In such cases, the second phase of autotransplantation should be postponed for a period of 8 to 12 weeks in order to eliminate the inflammatory process, while manipulation within the recipient area also will be more convenient due to the immaturity of the newly formed osteogenic tissue [76].

Placement, positioning and stabilization of transplanted teeth

The position of the donor tooth within the recipient area should provide a biological width similar to those at the area of naturally erupted tooth [81]. Autotransplanted tooth should also be out of occlusion, so that masticatory loads could not disturb the periodontal healing processes after transplantation [63]. Gingival flap should be correctly closed around the transplanted tooth to ensure the success of the operation. The integration of the donor tooth within recipient socket largely depends on the absence of bacterial invasion of the blood clot formed between the root and the socket. To manage this in some cases it is necessary to obtain correct position and secure soft-tissue flap before placing donor tooth into recipient site [82].

Replaced tooth should be stabilized after placement. X-ray control of recipient site should be provided before surgery, as well as before and after splinting of donor tooth. The effect of the type of stabilization on periodontal healing remains controversial [83]. There are various methods of stabilization available for the transplanted teeth, such as fixation with orthodontic brackets, ligatures, sutures, and composite materials, among which the period of immobilization varies from 1 to 4-6 weeks [79, 80, 84, 85, 86, 87]. Initially it was hypothesized that the use of rigid splints for immobilization up to 3 months supports periodontal regeneration [67, 87]. However, later it was found that this type of splints may lead to the impaired pulp revascularization [33,90]. The formation of the new blood vessels stimulated by the small microexcursions during transplanted tooth function, while reduction of tooth micromobility with a rigid splint has a negative effect on revascularization. This explains the frequent cases of pulp necrosis during the use of hard splints for transplanted teeth immobilization [33, 90]. Due to the reduced vascularization of the transplanted tooth, there is a deficiency of nutrition for the Hertwig's epithelial root sheath, which in turn affects further development of the root. Moreover, rigid splints usually placed relatively high regarding tooth crown to prevent trauma of adjacent gingiva with a wire or composite. As a result, the greater distance between the base of the bone socket and the roots causes problems with revascularization and the development of Hertwig's sheath [89]. Rigid splints could also negatively affect oral hygiene and periodontal regeneration, leading to such complications as inflammatory root resorption or ankylosis [37, 72]. A rigid splint is recommended only if the donor tooth has poor stability [88, 91]. The splint should be carefully chosen because it plays a fundamental role in the success of the entire procedure [36].

Short-term flexible splinting is most preferred in cases of tooth autotransplantation. Stabilization of the donor tooth could be provided with sutures for a period of 7-10 days [84, 89]. There is also a technique without targeted stabilization of donor tooth, in which retention of transplanted tooth is ensured due to the close contact with neighboring teeth. At the same time, the bone socket should be prepared in a way to ensure maximum contact with the donor tooth [34, 92]. The occlusion should be checked carefully to ensure absence of any occlusal interferences. After obtaining proper stabilization doctor should consider some type of future restorations.

A surgical (periodontal) dressing can be applied to protect the area of intervention from infection and support healing of the wound surface during the first 2-4 days [81]. The patient should be informed about all needed hygienic instructions and diet in the first postoperative week. The next visit is usually scheduled 7-10 days after operation to remove the sutures [93].

Indications for endodontic treatment

In teeth with complete roots development pulp revascularization does not occur in the vast majority of cases [35, 96, 97]. Only 15% of teeth with a closed apex are revitalized after the autotransplantation procedure, while revitalization occur in 96% cases of transplanted teeth with an open apex [85]. Therefore, teeth with complete root development require endodontic treatment within 1-2 weeks after transplantation in order to prevent pulp infection, subsequent periapical inflammation and inflammatory root resorption [42]. This period is chosen to minimize traumatizing effect of endodontic treatment on the periodontal ligament during the healing phase of the primary attachment. Longer period of waiting before endodontic treatment increases the risk of inflammatory resorption due to the infection and pulp necrosis [13, 98].

If access to the donor tooth is not complicated, then the root canal treatment can be performed before its atraumatic extraction [13, 99]. Third molars often have a complex root morphology, which complicates their endodontic treatment [100, 102]. In such cases, apical resection could be performed, which helps to remove a more complex part of the root and reduce possible complications of future orthograde endodontic treatment [88]. Moreover, better disinfection, cleaning and plug formation could be achieved after root apex resection and subsequent retrograde endodontic treatment [95]. If adequate sterility is maintained during apicoectomy and retrograde root filling, then orthograde endodontic treatment can be avoided or postponed [94]. Temporary root canals fillings of calcium hydroxide may contribute to the healing process and further deposition of mineralized tissue due to the high pH level and antimicrobial properties [94, 103-106]. Endodontic treatment after transplantation

supports higher survival of teeth in comparison with effects obtained after extraoral or preoperative endodontic treatment, because it helps to decreases the time interval between extraction and transplantation phases. There is also a risk of periodontal ligament fibers and cells damage during extraoral endodontic treatment [18, 19, 21].

Take-home protocol of surgical and treatment measures during tooth autotransplantation

- Anesthesia.
- Providing an access to the area of surgical intervention.
- Atraumatic extraction of the tooth and its preservation within the Hanks' balanced salt solution.
- Preparation of the recipient site and its irrigation with sterile saline solution.
- Placement of the donor tooth below the occlusal plane and its stabilization with a flexible splint.
- Flap suturing.
- Prescription for patients: antibacterial therapy, liquid diet and soft food, rinses with 0.12% chlorhexidine for 1 week.
- Removal of sutures after 1 week and splinting after 2-4 weeks.
- Endodontic treatment of donor tooth in cases of complete root development after 2-3 weeks.

Clinical case

Patient G., 40 years old, with an unfavorable restorative, periodontal and endodontic prognosis of tooth 4.7 was referred to the dental clinic (Fig. 1-2). After the examination and in-detail consultation extraction of tooth 4.7 was recommended as a treatment option. Autotransplantation of retained and impacted tooth 4.8 on the site of tooth 4.7 was proposed as alternative method of treatment.

The surgical phase of treatment was performed by Dr. Oleg Strashko (Kharkiv). After the extraction of the failed tooth 4.7 (Fig. 3-4), the recipient site was properly prepared. At the next stage atraumatic extraction of tooth 4.8 was performed, and it was placed at the previously prepared socket of tooth 4.7 (Fig. 5-6). The tooth was positioned in infraocclusion and secured with the cross sutures.

The sutures were removed 4 days after the surgery during second visit of patient (Fig. 7). Endodontic treatment of tooth 4.8 was performed 4 weeks after the initial intervention (Fig. 8-15). Tooth was restored with permanent composite filling (Fig. 16). After 5 months of monitoring tooth 4.8 was covered with a ceramic overlay (Fig. 17).

The final assessment of the transplanted tooth was provided at the period of 6 months after primary intervention. No pathological periodontal changes were observed, tooth demonstrated normal occlusal interactions, and X-ray periapical images shown complete integration of transplanted tooth with surrounding bone tissue (Fig. 18).

Figure 1. Patient G., 40 years old, was referred to the dental clinic with problematic tooth 4.7. Tooth demonstrated unfavorable restorative, periodontal and endodontic prognosis. Tooth extraction was recommended as a primary treatment option (May 2021).

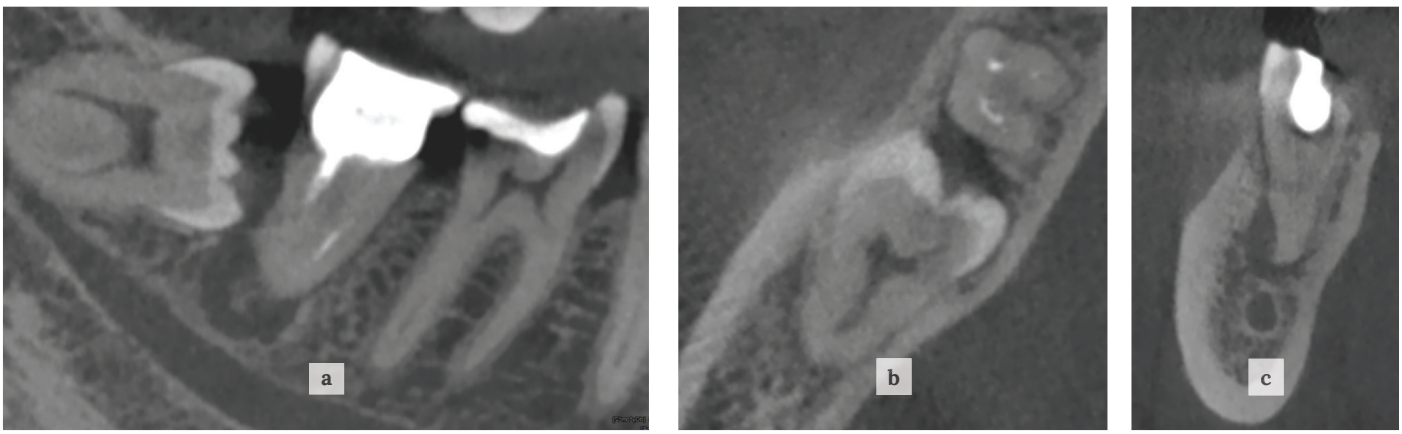


Figure 2 a, b, c. CBCT slices at the projection of teeth 4.6-4.8.

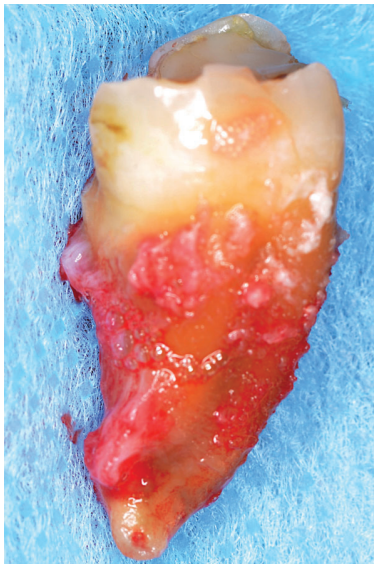


Figure 3. Tooth 4.7 after extraction

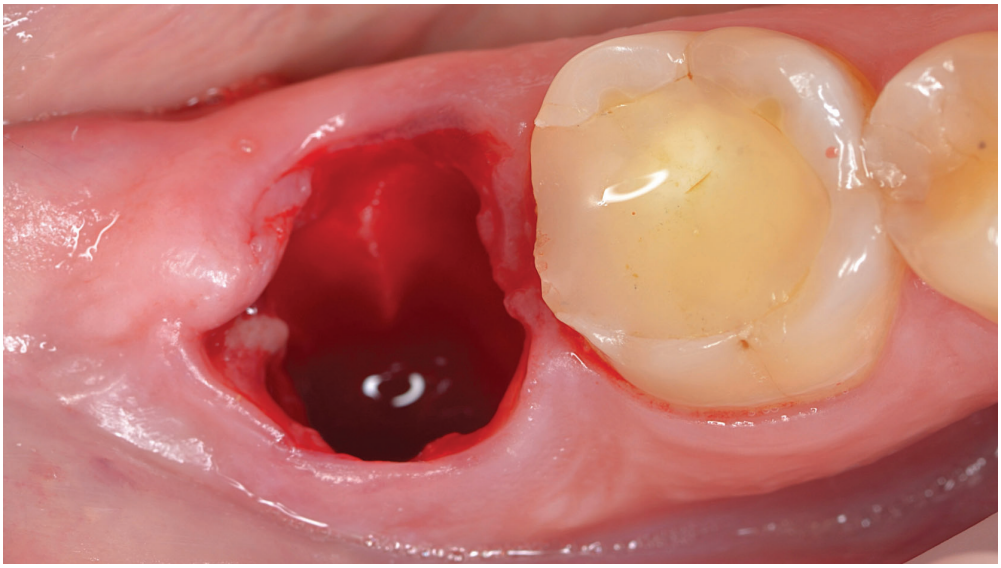
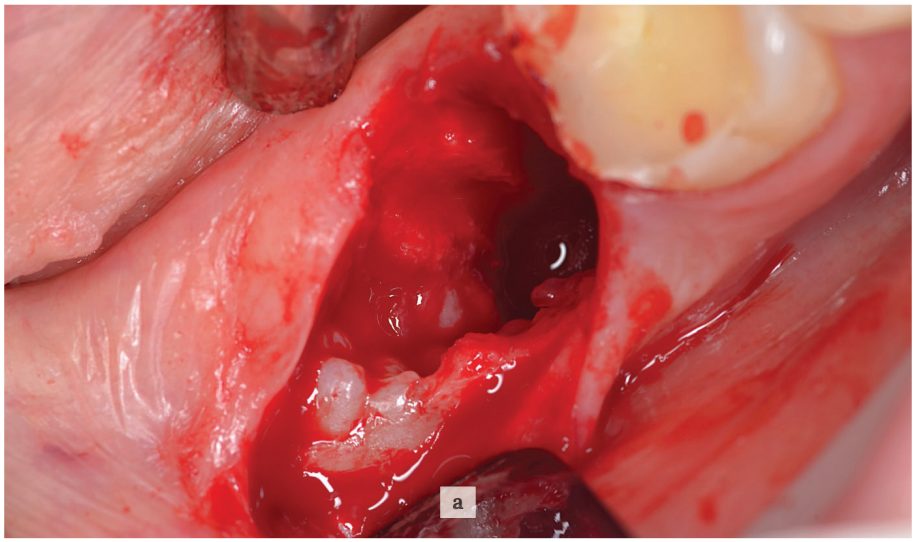


Figure 4. Post-extraction socket in the area of removed tooth 4.7.



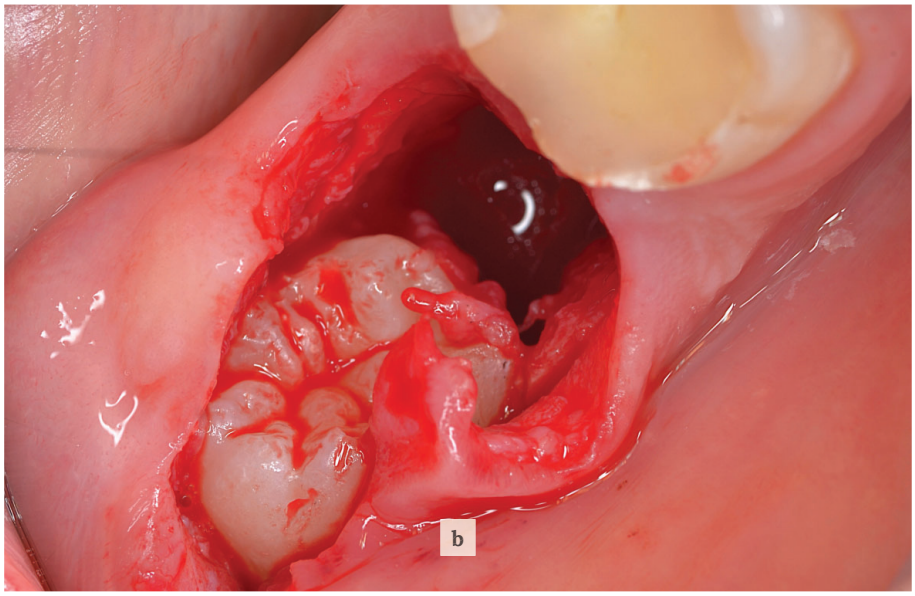


Figure 5 a, b. Atraumatic extraction of retained and impacted tooth 4.8.

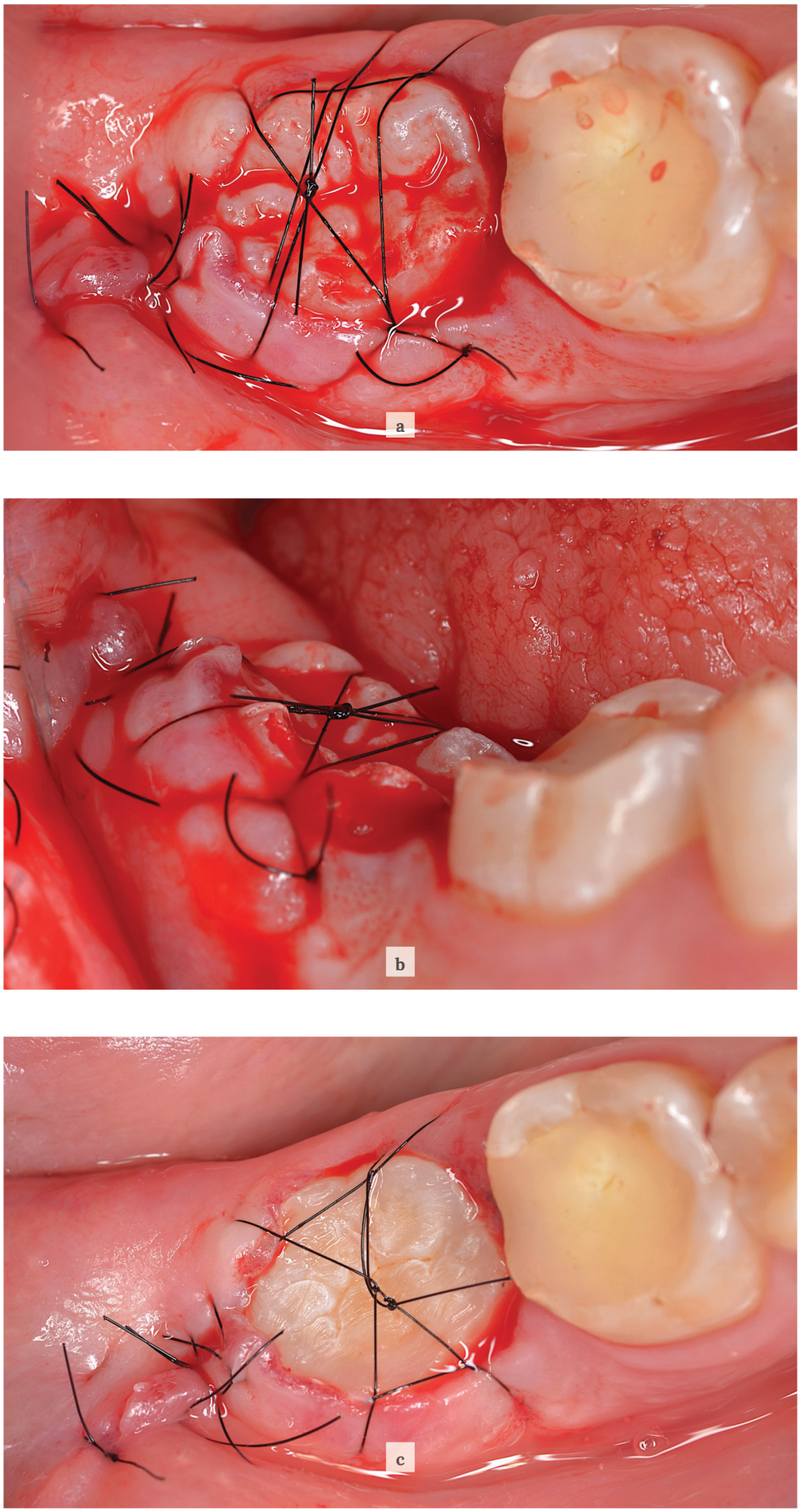


Figure 6 a, b, c. Placement of tooth 4.8 into the prepared socket of tooth 4.7. Tooth was positioned out of occlusion and stabilized with cross sutures.

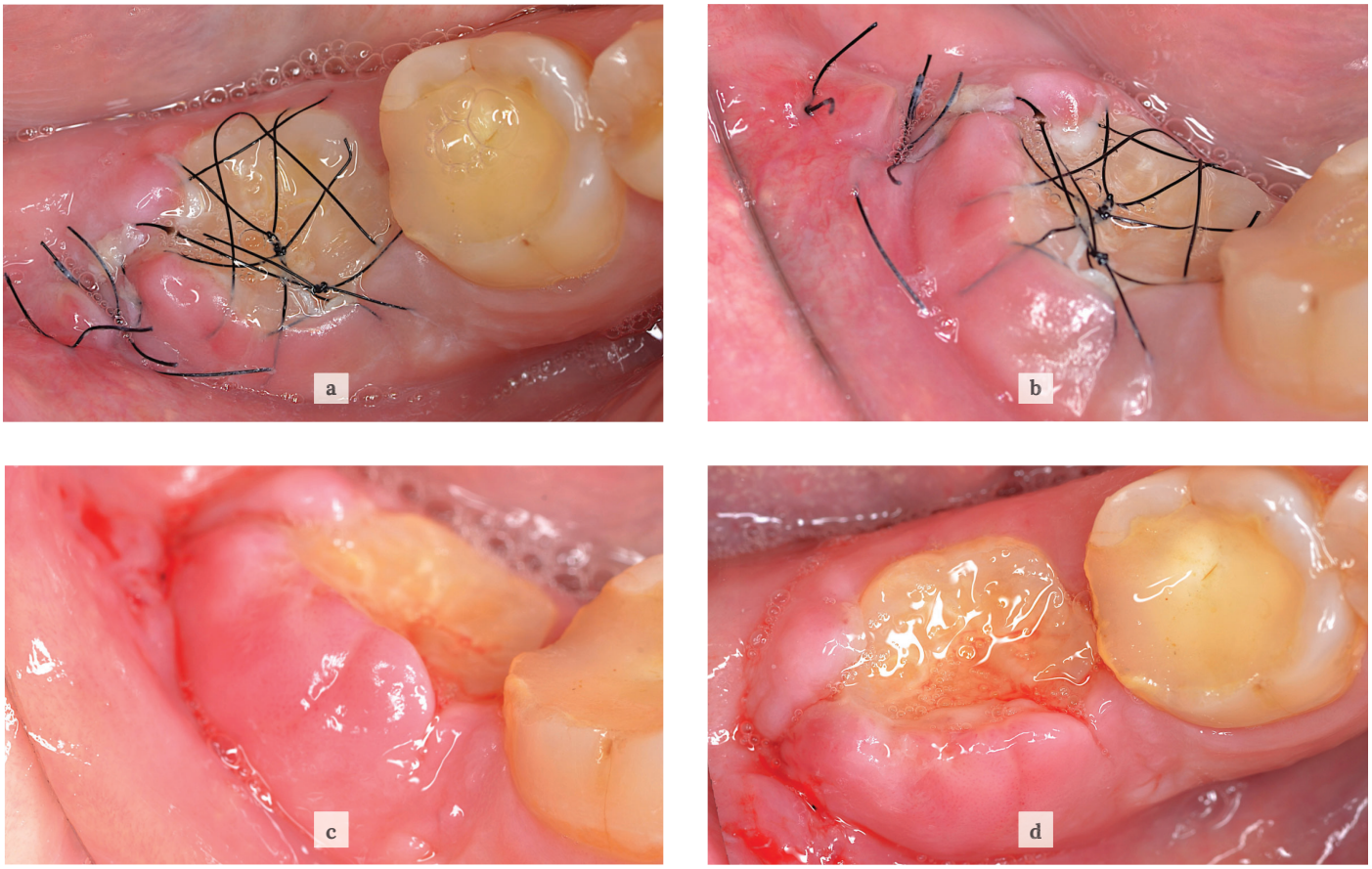


Figure 7 a, b, c, d. Evaluation of the transplanted tooth 4 days after surgery and removal of the sutures.

Figure 8 a, b, c. Evaluation of the transplanted tooth 4 weeks after surgery.

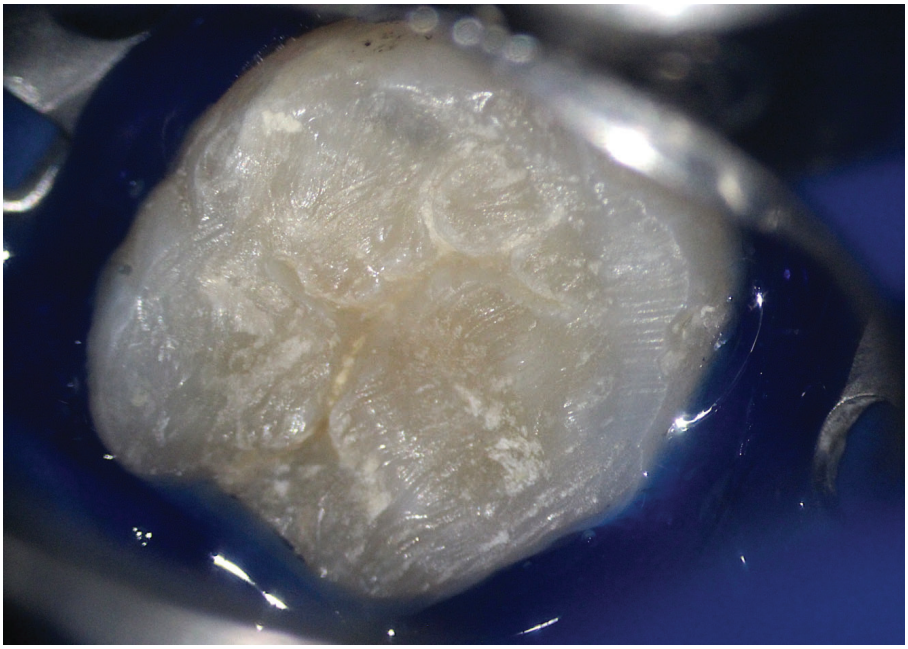


Figure 9. Preparation for the endodontic treatment.

Figure 10 a, b. Periapical X-ray of transplanted tooth 4.8 in parallel projection and with mesial angulation.

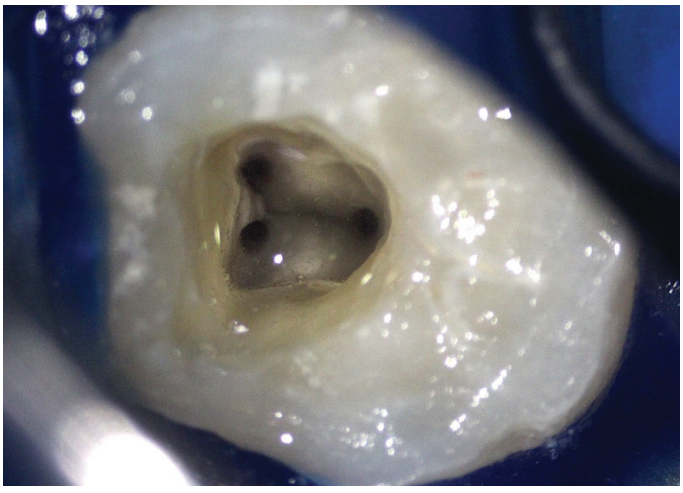


Figure 11. Access to the tooth cavity and root canals.

Figure 12. Endodontic treatment with WaveOne Gold reciprocal system.

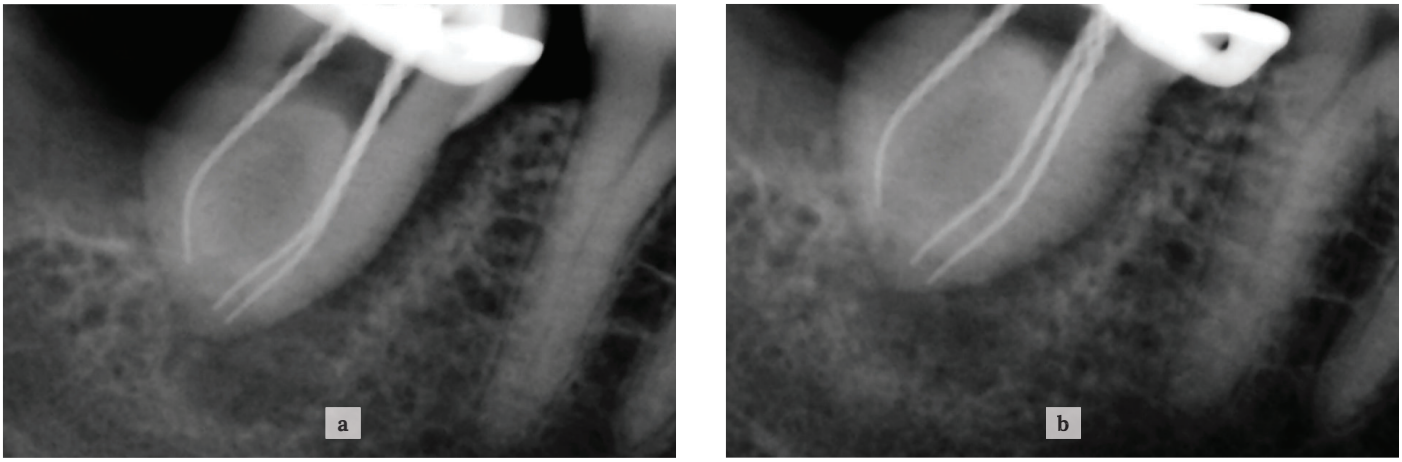


Figure 13 a, b. X-ray control of root canals instrumentation (in parallel and angulated projections).

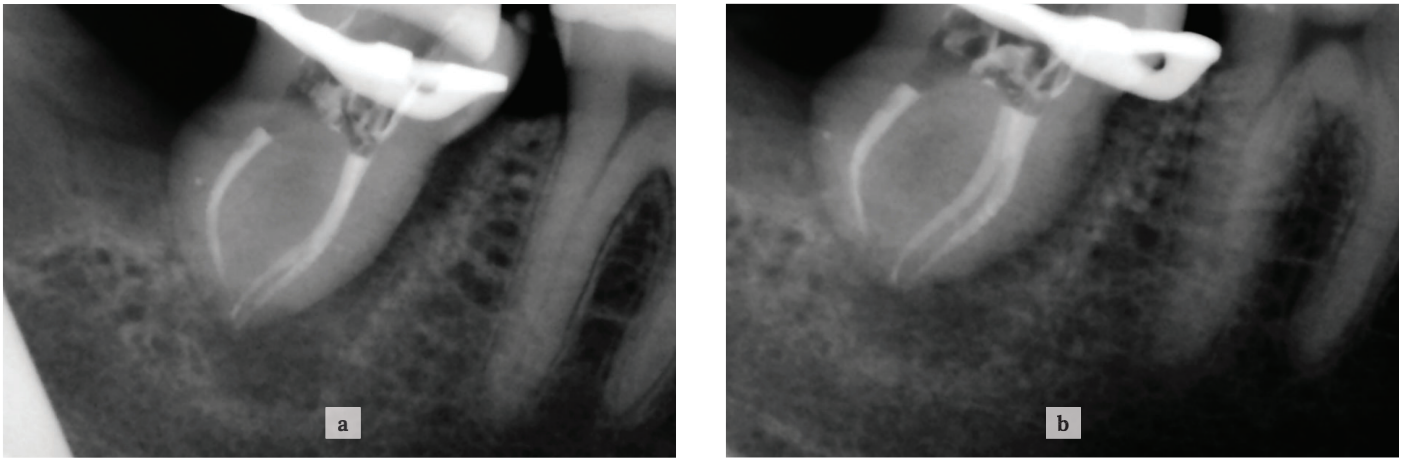


Figure 14 a, b. X-ray control of root canals obturation by the continuous wave method (in parallel and angulated projections).

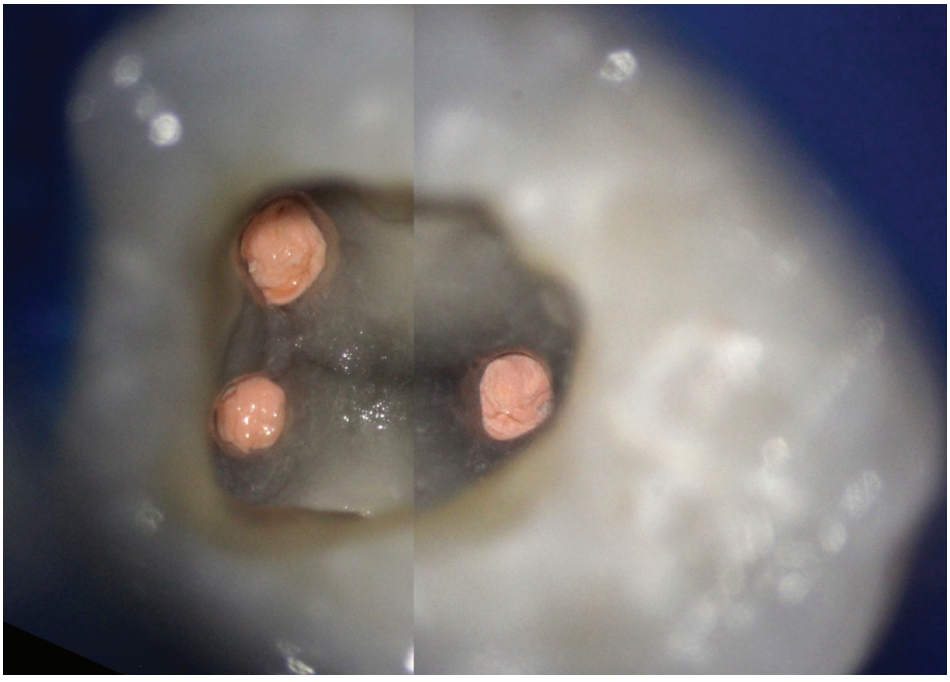


Figure 15. Tooth cavity after filling the root canals and cleaning the access area.

Figure 16. Permanent composite filling after endodontic treatment.

Figure 17. Clinical situation after 6 months. Tooth 4.8 was restored with ceramic overlay.

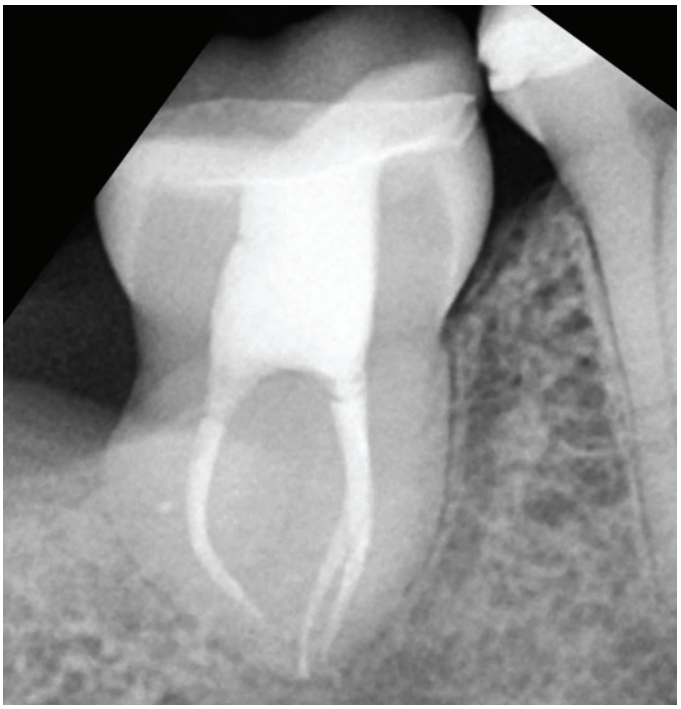


Figure 18. X-ray at the control period of 6 months demonstrated full integration of the transplanted tooth.

Conclusions

Autotransplantation is an excellent solution for replacing missing teeth. Correct surgical manipulations, which should be as atraumatic as possible to preserve the periodontal ligament of the transplanted tooth, is a key of autotransplantation successful outcome. The success of the treatment is also related with the stage of root development. Autotransplanted teeth with incomplete root development characterized with 96% probability of clinically successful pulp healing. In cases of transplanting the teeth with complete root development endodontic treatment should be performed approximately in 2 weeks after primary intervention. Long-term successful result of tooth autotransplantation could be achieved if all aspects of corresponding clinical protocol is followed in correct manner.

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Declaration of competing interest

There are no conflicts of interest in the materials or subject matter dealt with in the manuscript.

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Аутотрансплантація зубів: огляд актуальних лікувальних аспектів для клінічного успіху

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A – розробка концепції та дизайну дослідження, B – збір та або систематизація даних дослідження, C – аналіз та тлумачення даних дослідження, D – написання публікації, E – критичне доопрацювання тексту публікації, F- остаточне затвердження.

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зуб, трансплантація, аутотрансплантація, видалення зуба, стоматологічне лікування, огляд літератури

Анотація

Введення. Аутотрансплантація зуба може розглядатися як цінний варіант лікування для подолання несприятливих наслідків втрати зуба та запобігання ускладнень, пов'язаних із імплантацією. Суть такої маніпуляції полягає в видаленні донорського зуба з його місця локалізації з подальшим розміщенням його в іншому місці ротової порожнини того ж пацієнта найменш травматичним способом.

Мета. Систематизувати та проаналізувати актуальні лікувільні аспекти аутотрансплантації зубів, які максимально пов'язані з її клінічним успіхом.

Матеріали та методи. Комплексну стратегію пошуку було реалізовано за допомогою баз даних PubMed (https://pubmed.ncbi.nlm.nih.gov/) і Кокранівської бібліотеки (https://www.cochranelibrary.com/), а також через Google Scholar (https:/ /scholar.google.com/) пошукова система для розширення можливостей ідентифікації цільових публікацій. Первинне виділення цільових досліджень забезпечувалося їх назвою та анотацією. Критерії прийнятності включали публікації з описом оригінальних практичних і теоретичних аспектів процедури аутотрансплантації зубів, тоді як публікації з повторюваною інформацією або недостатньо аргументованими/недоказовими твердженнями були виключені з подальшого аналізу.

Результати. Остаточна кількість придатних для аналізу досліджень становила 82 публікації з відповідним звітом про результати, пов'язані з поточною метою дослідження. З цього числа 8 було представлено у формі систематичних оглядів, 3 у формі огляду літератури, а всі інші були представлені у формі звітів про випадки, серії випадків, протоколів, рекомендацій, подальших заходів, експериментальних і клінічних досліджень.

Висновок. Запорукою успішного результату аутотрансплантації є правильне проведення хірургічних маніпуляцій, які мають бути максимально атравматичними для збереження періодонтальної зв'язки трансплантованого зуба. Успіх лікування також пов'язаний зі стадією розвитку коренів. У випадках трансплантації зубів із повним розвитком кореня ендодонтичне лікування необхідно проводити приблизно через 2 тижні після первинного втручання.

Заява про фінансування.
Це дослідження не отримало жодного спеціального гранту від фінансових установ у державному, комерційному чи неприбутковому секторах.

Декларація про конфлікт інтересів.
Автор не має будь-яких фінансових чи майнових інтересів щодо матеріалів, представлених у цій статті.

Подяка
Автор висловлює щиру подяку доктору Олегу Страшку (Стоматологічна клініка «Ваш Стоматолог»), яка надала клінічні фотографії та рентгенівські зображення для ілюстрації практичних аспектів процедури аутотрансплантації зубів у цьому огляді літератури.

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