

A Novel Technique for Preparation of Recipient Site and Autologous Bone Grafting in Autotransplantation of Single-Rooted Teeth: A Report of Two Cases

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Abstract

Low-speed drilling without irrigation has a long history of use in implant dentistry. It provides the advantage of avoiding the wash-out of proteins and biomolecules from the bone. In this case report, we describe the novel use of this drilling protocol in the preparation of bone alveolus during the procedure of tooth autotransplantation. Two cases with early tooth loss in the upper maxillary arch were treated by the autotransplantation of permanent teeth with immature root development and the use of plasma rich in growth factors. Autologous bone fragments (from drilling) were harvested and used for alveolar bone augmentation. The follow-up time was three and seven years since tooth autotransplantation. All the autotransplanted teeth achieved a closed apex with no signs of loss of vitality. Low-speed drilling without irrigation did not jeopardize the outcomes of tooth autotransplantation and warrants further investigation in the context of periodontal ligament healing.

Categories: Dentistry

Keywords: prgf, tooth vitality, periodontal healing, root development, low-speed drilling, tooth autotransplantation

Introduction

Dental implants as a prosthetic replacement of the dental root have demonstrated high success rates. Several longitudinal studies have reported survival rates of 90-95% over follow-up periods of 5-10 years [1]. In young patients, however, the ankylotic healing of dental implants may lead to infraocclusion. The risk of infraosition of dental implants (ankylosed) can be related to the growth of the alveolar bone height in an individual with ongoing vertical growth [2]. This results in the infraosition of the dental implant relative to the surrounding teeth. In the 1960s, Slagvold and Bjercke described a protocol for the autotransplantation of teeth at the University of Oslo [3]. This article reported for the first time the procedure for performing tooth autotransplantation and the steps to be followed to perform the technique [3]. Since then, the technique has been widely accepted as an alternative to dental implants or other restorative treatments, especially in young patients. Tooth autotransplantation is especially indicated to replace missing teeth in children and adolescents but also is being applied in adults [4]. Tooth autotransplantation allows the formation of the periodontal ligament, the normal development of the alveolar bone, and the capacity for functional adaptation [3]. The success of tooth autotransplantation can be affected by different factors such as tooth type, root development, extraoral time, mechanical stress, and tooth stabilization, among others [5].

Since the technique has been described, it has undergone several modifications, mainly to achieve the best fit between the recipient bed and the morphology of the root of the autotransplanted tooth [6]. The tooth must be inserted in a new alveolus that adapts well to the root morphology, generating support for the tooth while revascularization and bone neof ormation occur. The use of 3D-printed root replicas has been introduced to guide clinicians during the preparation of the bone alveolus [4]. Care should be paid not to excessively compress the developing apex. Therefore, the protocol for preparing the receptor bed when preparing the alveolus for the insertion of the transplanted tooth is crucial [6].

In implant dentistry, the dental implant success at the early stages of healing can be deteriorated by bone exposure to overheating and excessive trauma during the drilling of the alveolar bone [7]. Low-speed bone drilling without irrigation has been suggested to avoid the lavage of growth factors and biomolecules from the bone [8]. The isolation of human alveolar bone cells from the bone tissue harvested by this drilling protocol is indicative of its thermal safety that has not affected cellular viability [8]. These cells have shown characteristics of mesenchymal stem cells with osteogenic properties and a high proliferation rate [8].

The objective of this case series is to describe the implementation of low-speed drilling without irrigation in the procedure of tooth autotransplantation and the clinical outcomes.

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Case Presentation

The first patient was a 12-year-old female who, after a trauma caused by a bicycle accident, lost several teeth in the anterior-superior sector. The upper central incisors (#11 and #21), the upper left lateral incisor (#22), and the upper left canine (#23) were missing (Figure 1).

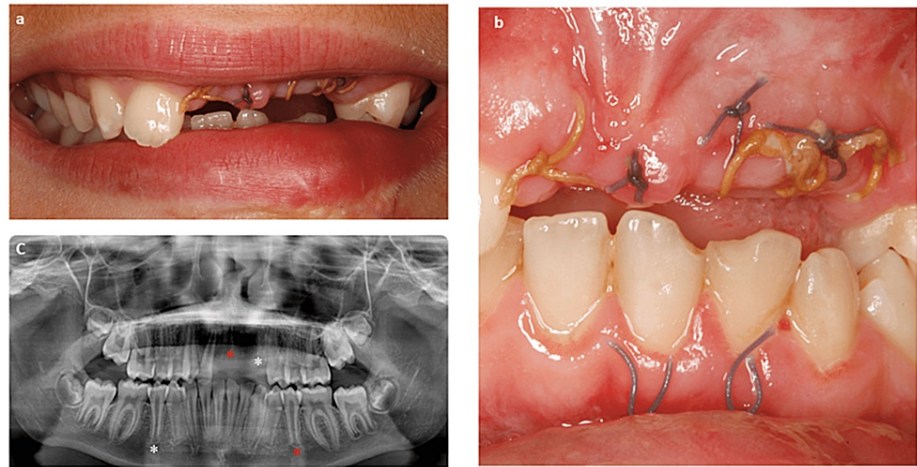


FIGURE 1: The clinical case at the patient's first visit to the dental office.

The patient had missing upper central incisors (#11 and #21), upper left lateral incisor (#22), and upper left canine (#23) (a-c). The lower second premolars (#35 and #45) had an open apex with incomplete root formation (c).

*: Labeling the teeth to be autotransplanted and their future position.

The lower second premolars (#35 and #45) had an open apex with incomplete root formation. The treatment plan was designed to restore the upper anterior sector by the autotransplantation of the lower second premolars at the position of the upper left central incisor (#21) and upper left lateral incisor (#22).

The second patient was an 11-year-old male who reported a history of trauma in the anterior sector. The clinical examination indicated the presence of root resorption in the upper right central incisor (#11). A supernumerary tooth was noted at the position of the upper left lateral incisor (#22) (Figure 2).

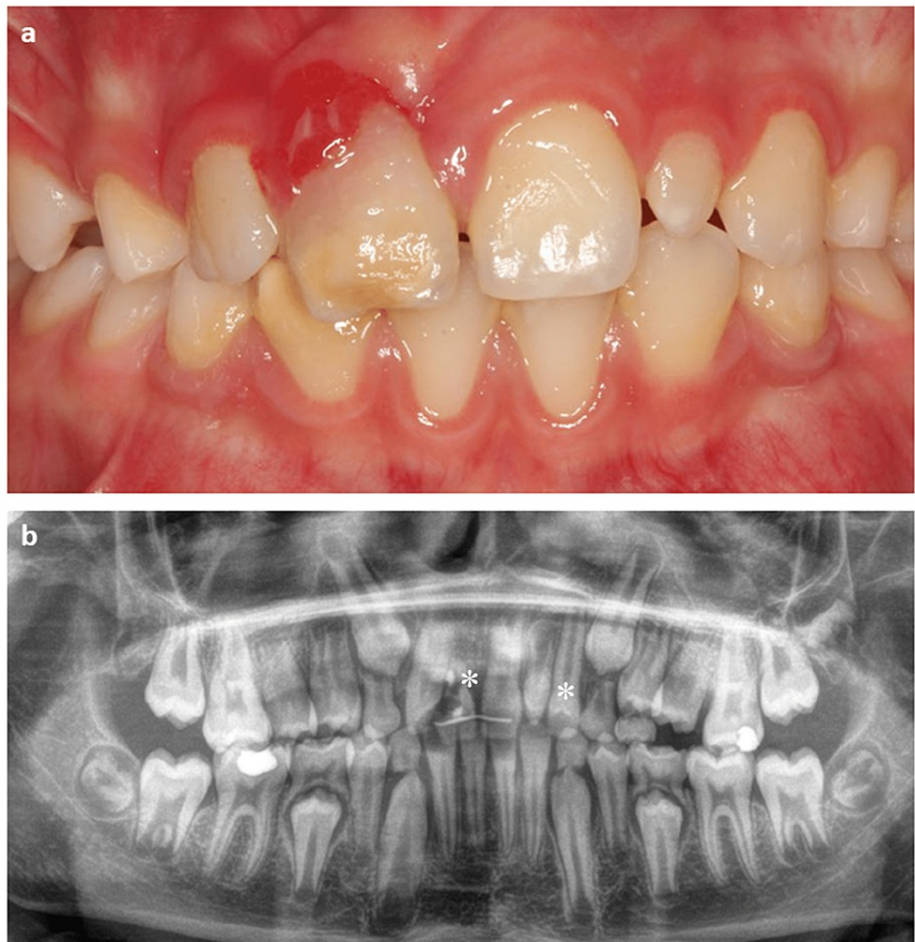


FIGURE 2: Internal resorption of the upper right central incisor (#11) (a and b).

*: Indicates the tooth to be autotransplanted and its future position.

The treatment plan was designed to extract the upper right central incisor (#11) and replace it with the autotransplantation of the upper left lateral incisor (#22). The conoide supernumerary was conserved to replace the upper left lateral incisor (#22). The surgical preparation of the recipient sites was planned using measurements on the cone-beam computed tomography (CBCT) scan (3D visualization of the teeth and alveolar bone) of the teeth to be transplanted (Figure 3).

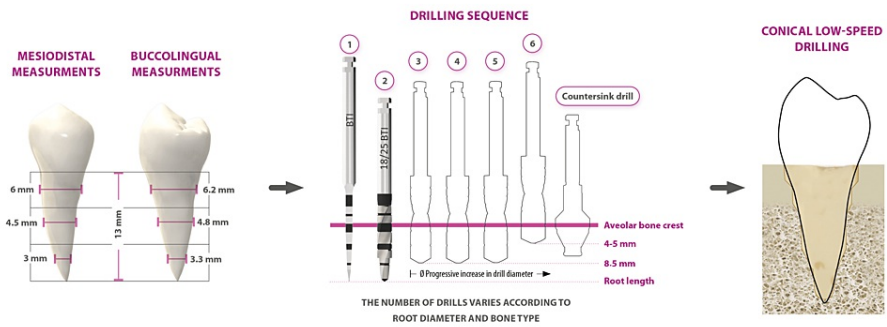


FIGURE 3: Scheme of the described technique for the preparation of an alveolus to receive the autotransplanted tooth.

The initial drill was used at high speed with irrigation. The diameter drills were used at low speed (150 rpm) without irrigation.

Image credits: Eduardo Anitua.

The diameter and length of each tooth were analyzed. The root was divided into coronal, medial, and apical thirds. The highest diameter of the root in each third was annotated and used to select the diameter of the drill for alveolus preparation. Under intravenous sedation, local anesthesia (4% articaine hydrochloride anhydrous with 1:200,000 adrenaline tartrate) was administered, and the alveolus was prepared following low-speed drilling without irrigation (150 rpm) except for the initial drill (850-1,000 rpm with copious irrigation) (Figure 3). Sharp new drills were used. Bone density at the recipient site was measured on the CBCT scan using software (BTI scan IV, BTI Biotechnology Institute, Vitoria, Spain). The length of the alveolus was divided into thirds and prepared using the drill with the same diameter as the root at each third (Figure 3).

Preoperatively, blood extraction into four anticoagulant-containing tubes (9 mL) (KMU 15; BTI Biotechnology Institute, Vitoria, Spain) was performed for the preparation of plasma rich in growth factors (PRGF). Briefly, after blood centrifugation (580 g for eight minutes) at room temperature, the plasma column was divided into fraction 1 (F1) and fraction 2 (F2) [9,10]. F2 was defined as 2 mL of plasma just above the buffy coat and F1 was the rest of the plasma column above the F2. For activation, 10% calcium chloride (PRGF activator) was used at a ratio of 20 μ L per 1 mL of PRGF. The activation PRGF was kept at 37°C for clotting (8-10 minutes).

After the elevation of the full-thickness flap, the initial and pilot drills were used to mark the site of the alveolus at the total length of the root of the tooth to be autotransplanted. Diameter drills were then used to shape the alveolus. All bone harvesting by low-speed drilling was preserved in F2 of the PRGF without being activated with calcium chloride. After finishing the preparation of the alveolus, surgical extraction of the tooth for autotransplantation was carefully performed. The tooth was extracted causing minimal surgical trauma possible, whereby careful rotational dislocation movements are performed. The recipient alveolus was irrigated with F2 of the PRGF without activation and the autotransplanted tooth was inserted. The extra-alveolar time was always less than 30 seconds and successful insertion was achieved on the first attempt. Activated PRGF was then applied around the autotransplanted tooth. The tooth was stabilized by figure-of-eight crossing sutures that anchored it to the alveolar ridge. For bone augmentation on the labial side of the alveolar bone, the PRGF with autogenous bone was activated by 10% calcium chloride to induce clot formation. The sticky bone graft was then placed on the alveolar bone. The entire surgical area was covered with autologous fibrin membranes prepared from F1 of the PRGF after being activated, retracted (50% of the original size), and compressed (Figure 4). The membranes were stabilized by replacing and suturing the flap.

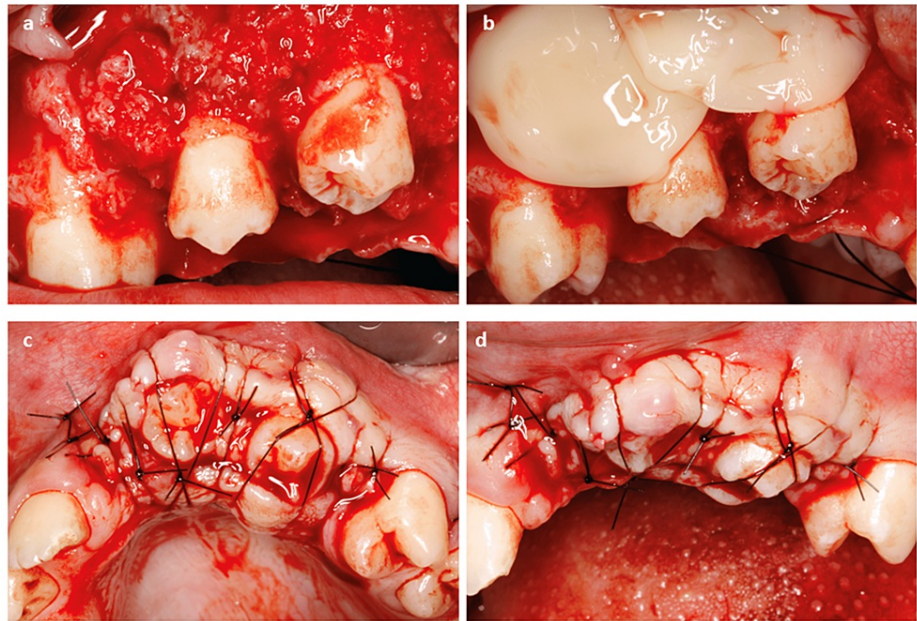


FIGURE 4: Clinical images of case one showing the placement of the autotransplanted teeth.

Placement of the two autotransplanted lower second premolars and the bone augmentation of the alveolar bone on the vestibular wall (a), plasma rich in growth factors fibrin membranes covering the surgical area (b), anchorage of the teeth with suspensory stitches (c), and closure of the full-thickness flap (d). This stabilized the autotransplanted teeth during the healing period.

Subsequently, the flap was sutured, and suspensory sutures were placed. The 5-0 polyamide monofilament suture was used. Amoxicillin 500 mg three times a day and ibuprofen 400 mg three times a day were prescribed for one week. A 0.1% chlorhexidine mouth rinse was also prescribed for seven days. A soft diet was instructed for 48 hours and chewing with the autotransplanted teeth was prohibited. The sutures were removed after two weeks.

Clinical and radiographic examination was performed to assure that the tooth was asymptomatic and periodontally healthy. After six months of autotransplantation, orthodontic treatment was initiated to correct the occlusion and position the autotransplanted tooth in the dental arch (Figure 5). Fixed orthodontics with metallic braces were applied to correct the tooth position. The orthodontic treatment was finished in both cases in less than two years. Once they were moved to the corresponding area of the arch, aesthetic and functional rehabilitation of the autotransplanted tooth, wherever considered necessary, was performed (Figure 6). In both cases, porcelain veneers were used.

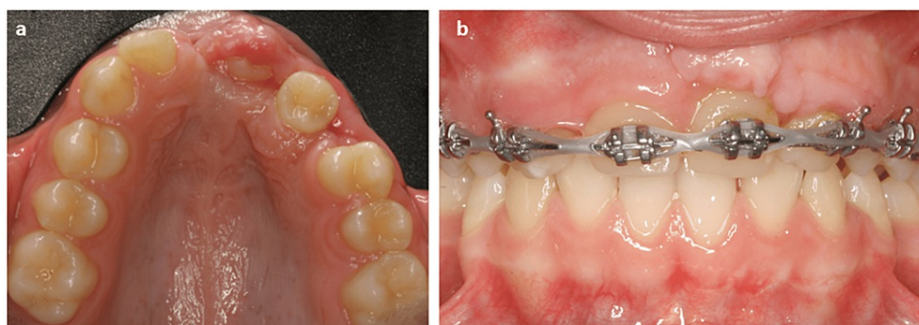


FIGURE 5: Case one follow-up.

The clinical situation of case one at the end of the healing period (a) and at the orthodontic treatment (b). During the process, aesthetic contouring of the teeth was performed to achieve correct occlusion and aesthetics, transforming premolars into lateral and central incisors.



FIGURE 6: Long-term follow-up of case one.

Clinical images of case one showing temporary aesthetic reconstructions after finishing the patient's orthodontic treatment (a and b) and case evolution after seven years of follow-up, with aesthetic reconstructions carried out after the patient reached adulthood (c and d).

Furthermore, root development was monitored to detect any signs of problems. Successful autotransplantation was indicated by the absence of inflammatory root resorption or apical periodontitis, and the roots of the autotransplanted tooth were completely formed (Figure 7).



FIGURE 7: Clinical follow-up of case two.

Clinical and radiographic images of case 2 showing the stabilization of the autotransplanted upper lateral incisor at the position of the upper right central incisor by splinting to the upper left central incisor (a), postoperative periapical radiograph at four days after tooth autotransplantation (b), the teeth position at the end of orthodontic treatment (c) and root formation with the closure of the apex of the autotransplanted tooth after one year (d), and the aesthetic reconstruction of the autotransplanted tooth (e).

Discussion

Tooth autotransplantation is a versatile technique with a long history in dental practice for the rehabilitation of missing teeth in young patients where the insertion of implants cannot be carried out [3,5]. Other indications include the management of impacted or ectopic teeth [4]. In comparison to osseointegration, successfully autotransplanted teeth allow the growth and development of the alveolar bone, the eruption of the adjacent teeth, and the formation of new and vital periodontium [4,11]. The success of autotransplantation is sensitive to favorable healing of the periodontal ligament [11]. Care should be paid to avoid mechanical and/or biochemical damage to the periodontal ligament tissue [4]. For example, inadequate tooth extraction or alveolus preparation would place the periodontal ligament tissue under mechanical stress that may jeopardize healing and the success of tooth autotransplantation. Indeed, successful tooth autotransplantation is an outcome of adequate mechanical and biomechanical manipulation (extraoral environment) of the autotransplanted tooth. For that, it is plausible that the planification of the drilling protocol and the implementation of low-speed drilling without irrigation have generated adequate stimuli for successful outcomes. In implant dentistry, low-speed bone drilling without irrigation does not cause overheating of the bone [8]. The good quality of bone particles has confirmed the absence of bone damage [8]. Furthermore, periodontal ligaments have a major role in the healing of periodontal wounds. The periodontal ligaments have a high capacity for remodeling and renewal. The periodontal ligament fibroblasts are the predominant cell type and have osteoblast-like and fibroblast-like properties. This is important for periodontal regeneration which requires a coordinated formation of new

cementum, new alveolar bone, and new periodontal ligament [12]. PRGF has significantly enhanced the proliferation, migration, and adhesion to collagen type I matrix of the periodontal ligament fibroblasts. It has also stimulated the synthesis of hepatocyte growth factor (anti-inflammatory and anti-fibrotic growth factor) and the connective tissue growth factor [13]. This factor is involved in several functions that include angiogenesis, cell proliferation, cell migration, cell adhesion, and extracellular matrix production.

Furthermore, the autotransplanted immature teeth in this study achieved root development and the formation of the closed apex. This is indicative of the presence of adequate blood supply and reservoir of stem cells that have resulted in the presence of vascularized connective tissue in the pulp that would induce root development and maintenance of tooth vitality [4]. Positive response to electric stimulus and the closure of root apex are expected outcomes for autotransplanted teeth with incomplete root development [4]. Furthermore, the use of PRGF has been effective in inducing the human dental pulp stem cell homing of root canal through a chemoattractant effect on the neighboring cells, as well as the stimulation of cell migration and proliferation [14]. The potential of PRGF to stimulate human dental pulp stem cell differentiation has been reported [15]. Furthermore, it provides a scaffold that supports cell homing of the root canal. It stimulates neoangiogenesis and the vascularization of the connective tissue [16]. In an inflammatory model using lipopolysaccharide, the use of platelet-rich plasma augmented the genetic expression of pro-angiogenic genes and adhesion molecule-related genes [17]. Moreover, it stimulated the expression of the cytokine CXCL1 (induces the migration of microvascular endothelial cells and tube formation) and suppressed the expression of IFNA1 (inhibits angiogenesis). PRGF is a pure platelet-rich plasma that contains no leukocytes that would induce inflammation and decreases the stability of the fibrin scaffold [14,16]. PRGF has anti-inflammatory properties that would enhance the balance toward tissue reconstruction and improve the quality of life of the patient [18]. PRGF has also shown antibacterial properties upon its activation to start clotting and is better resistant to bacteria-induced fibrinolysis [19]. Additionally, the filling of the socket with PRGF can (after clotting) help stabilize the tooth and impede the bacterial colonization of the gap (non-critical bone defect) between the socket walls and the autotransplanted tooth [18,20].

PRGF has been used with successful long-term outcomes in the autotransplantation of mature teeth [18]. It has been used as a scaffold for the revascularization of an autotransplanted mature tooth after the application of the fragile fracture technique.

The study has several limitations. The study describes cases where the autotransplanted tooth has an open apex and no information is yet available on its use when the tooth is mature with a closed apex. Providing an equilibrium between the primary stability and the compression of the periodontal ligament is needed. The lack of a control group regarding the drilling speed and the use of PRGF is another limitation of this study. More studies with larger sample sizes are needed.

Conclusions

Within the limitation of this case report, the use of low-speed drilling without irrigation to prepare the alveolus for tooth autotransplantation has resulted in successful outcomes. The bone fragments can be collected and used as graft material for the overcorrection of the alveolar ridge. The contribution of autologous PRGF in the enhancement of the probability of successful autotransplantation needs further investigation.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** EA is the Scientific Director of BTI Biotechnology Institute and MHA is a researcher at BTI Biotechnology Institute, a company that produces, distributes, and commercializes a dental implant system and Endoret (PRGF) technology. LP has no conflicts of interest. **Financial relationships:** Eduardo Anitua declare(s) employment, a patent and stock/stock options from BTI Biotechnology Institute. United States Patent US6569204B1. Mohammad H. Alkhraisat declare(s) employment from BTI Biotechnology Institute. **Intellectual property info:** United States Patent US6569204B1. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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