

Autotransplantation of Teeth and the Reconstruction of Alveolar Bone Defects Using Artificial Bone: A Case Series

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Abstract

The aim of this study was to evaluate the outcome of autotransplantation or replantation of extracted teeth combining with reconstruction of alveolar bone defects in use of artificial bone grafting clinically and radiographically. This article presents a more useful and convenient method for repairing tooth and reconstruction of bone defecting with some interesting cases. Eleven patients (seven men and four women) in whom teeth with complete root formation were extracted and autotransplanted, the bone of receiving area was insufficient. All transplanted teeth were stabilized with orthodontic wire and resin or 4-0 silk sutures; at the same time, artificial bone powder was filled. In 11 cases, the missing teeth were restored by autogenous teeth and the alveolar bone defect was restored by artificial bone, the improvement in the radiographic and clinical parameters strongly suggest that it may be a useful therapy to solve the problem of the missing teeth and alveolar bone insufficiency simultaneously. However, the risk of replacement root resorption remains.

Keywords

Autotransplantation of Tooth, Artificial Bone, Bone Defect

1. Introduction

Autotransplantation of teeth (ATT) and reconstruction of alveolar bone involve transplanting autogenous teeth and placing artificial bone to repair missing teeth and defecting bone.

As we know, trauma, tumor, dentomaxillofacial deformities and so on often

lead to the loss of teeth and alveolar bone. Usually, we can recover teeth missed by removable partial denture (RPD), fixed partial denture (FPD), implantation, ATT and so on. Gradually, we prefer implantation and ATT to RPD and FPD. On the one hand RPD and FPD would damage our healthy teeth or not very comfortable, on the other hand, ATT or implantation can make alveolar bone lengthened which is not only beneficial to the normal physiological function of teeth, but also beneficial to the beauty. Implants have changed the traditional restoration methods to a certain extent, but the bonding relationship between metal implants and bone tissue, namely “integration”, cannot form physiological periodontal ligament. So, the bonding relationship between implants and alveolar bone is not the same as that between normal teeth and alveolar bone. Furthermore, The low cost of ATT and the development of technology in periodontal tissue regeneration lead it to become a potential treatment option to restore the occlusal function of lost tooth, meanwhile the transplanted tooth can function normally if it success [1] [2] [3]. However, in most reports about ATT, there are strict indications for the selection of cases, in which adequate alveolar bone is essential [4]. Some scholars tried to operate ATT when alveolar bone defect and got good results, but patients in these studies are adolescents whose teeth root are not formed completely and the maxillofacial developing will promote the alveolar bone and the teeth healing. Study on ATT on adult with bone defect is hardly seen.

In our study, 11 teeth, roots were formed completely, were transplanted to area where tooth missed and alveolar bone defect severely and implanted with Bio-Oss artificial bone powder, the outcome of these teeth promising clinically and radiographically. The purpose of this article is to share a kind of treatment for tooth missing and bone defecting with two typical cases of eleven.

2. Materials and Methods

2.1. Patients

The protocol of this study was approved by the Institutional Review Board of Anhui Medical University Dental School in compliance with the Helsinki Declaration. All patients provided informed consent before undergoing treatment.

This study included 11 patients (7 men and 4 women) in whom teeth were extracted with complete root formation were autotransplanted at Hefei Stomatological Hospital. The age of patients at the time of tooth extraction ranged from 15 to 29 years with a mean age 20.72 years. The donor teeth consisted of 1 central incisor, 7 canines, 1 premolar and 2 molars (Table 1).

2.2. The Inclusion and Exclusion Criteria

The inclusion criteria: 1) patients in need of dental extraction and dentition defect reparation; 2) autogenous teeth with or less than three roots and the roots are not excessive bending; 3) sufficient recipient area to transplant the donor teeth; 4) patients who are healthy or have well-controlled systemic disease(s); 5) patients who agree to our treatment plan.

Table 1. Tooth autotransplantation in 11 patients with dentition defect.

TIME (year)	Gender	Age	Diagnosis	Donor sites	Recipient sites	Retention styles				Postoperation root canals treatment (month)				
						Segmental arch	Arch splint	Bondin g	Suture fixation	no	≤1	1 - 3	3 - 6	≥6
1) 2007	man	25	trauma	13	13		√			√				
2) 2007	woman	20	operation	33	33	√				√				
3) 2014	man	15	deciduous teeth	25	25	√				√				
4) 2016	woman	25	deciduous teeth	23	23	√						√		
5) 2016	man	16	deciduous teeth	13	13	√							√	
6) 2016	man	20	deficiency	23	23	√				√				
7) 2017	man	29	root absorption	48	47			√		√				
8) 2017	man	21	operation	21	21	√				√				
9) 2018	woman	20	deficiency	23	23	√						√		
10) 2018	woman	22	residual root	18	36	√		√			√			
11) 2018	man	15	deficiency	13	13	√				√				

The exclusion criteria: 1) patients with significant comorbidities such as recent heart attack or coagulation disorder; 2) patients with poor plaque control and untreated chronic periodontitis; 3) patients with acute infection, periapical lesion, root fracture, root caries of teeth and so on.

2.3. Transplantation Procedures

The transplantation procedure was based on immediate tooth transplantation. Clinical and radiographic observations of all donor teeth were obtained. The condition between the recipient socket and the donor tooth was checked according to the observations. Next, making mucoperio-steal flaps at the recipient site after local anesthesia. And then, the recipient socket was prepared with pilot drill, trephine bar, round bone chisel, piezosurgery and bone micro-power systems before extracting the donor tooth, based on the size and shape of the donor teeth with reference to CBCT imaging taken before operation. The donor teeth were extracted and stored in physiologic saline-soaked gauze less than 10 minutes to maintain the periodontal membrane and Hertwig's epithelial root sheath during the extra-oral procedure. All the granulation tissue in the extraction socket defect was thoroughly cleaned. Finally, the tooth was transplanted to the recipient socket, and the flaps were sutured with 4-0 silk. All transplanted teeth were stabilized with orthodontic wire, resin or 4-0 silk sutures. The sutures were removed after 7 days, and the wire splint was removed 3 - 9 weeks post-operatively.

2.4. Postoperative Examination and Evaluation of Prognosis

The patients were evaluated by clinical and radiographic examination after 1, 2, and 3 weeks and at 1, 3, 6 and 12 months. Thereafter, the patients were followed

up at intervals of 6 - 12 months. At each visit, all transplanted teeth were evaluated and recorded these in clinic and radiographic: 1) Mobility of tooth(using the Miller classification , 0 to 3); 2) Sensibility testing (using an electric pulp tester); 3) Root and alveolar bone condition from radiological image; 4) Periapical radiography; 5) Symptoms reported by the patient.

The following criteria were used to assess success after one year followed-up: 1) The tooth maintained normal function and without any discomfort; 2) Slight tooth mobility (horizontal displacement of <1 mm); 3) Radiologic examination revealed alveolar bone reconstruction in the transplant area; 4) No inflammatory root resorption (restricted root resorption and ankylosis are also considered successful); 5) No uncontrollable periapical lesion. If one of these criteria was not met, the case was recorded as a failure.

2.5. Result

The cumulative success rate of teeth was 100% at one year after transplanted and two of them were still asymptomatic from the clinical and radiological examination after ten years. According to the postoperative situation, 4 of the teeth had root canal therapy (RCT) at different times and 7 of these having no RCT so far. In 2 of 7 cases, which had no RCT at six months after ATT, sensibility testing showed inactivated. More importantly, we can find that the density and mass of alveolar bone increased and no infection was observed by clinical and radiographic examination. Although there was a little bone resorption in 3 of these cases, but the reconstruction is obvious compared to preoperative.

3. Case Reports

3.1. Case 1

A 29-year-old male was referred to Oral and Maxillofacial Department of Hefei Stomatological Hospital for complaining her right lower posterior tooth too loose to masticate for more than one year. At the recent, the mobility of the right lower posterior tooth had been more obvious, accompanied by swelling and pain. Patient was healthy and did not have systemic disease. He had non-pathologic gingivae surrounding the right lower first molar, and a small operculum was found at the site of the impacted third molar.

The tooth 46 was missing (**Figure 2(c)**) and the mobility of tooth 47 was II degree, the tooth 47 was incline to mesial, and the tooth 45 was incline to distal. So, the space between tooth 45 and tooth 47 is smaller than that in normal. The panoramic radiograph showed that the root of tooth 47 was partially absorbed (**Figure 1(b)**). The third molar (48) had not erupted and the crown inclined to mesial with odontogenic cyst (**Figure 1(a)**, **Figure 1(b)**).

Treatment process: 1) extract the tooth 47 and the tooth 48; 2) remove odontogenic cyst (**Figure 2(e)**); 3) autotransplant the tooth 48 to the site of the tooth 47 (**Figure 2(h)**); 4) alveolar bone defect filled with artificial bone powder (Bio-oss) (**Figure 2(g)**).

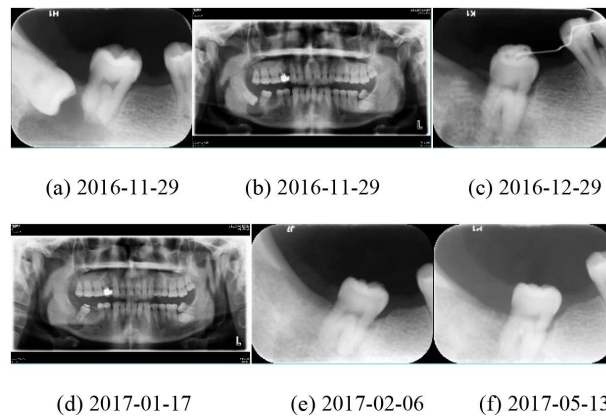


Figure 1. Dental film and panoramic views. Preoperative radiograph (a) and panoramic views (b); Postoperative radiograph timely (c); Panoramic views in 7 weeks postoperation (d); Radiograph in 9 weeks postoperation (e); Radiograph in 26 weeks postoperation (f).

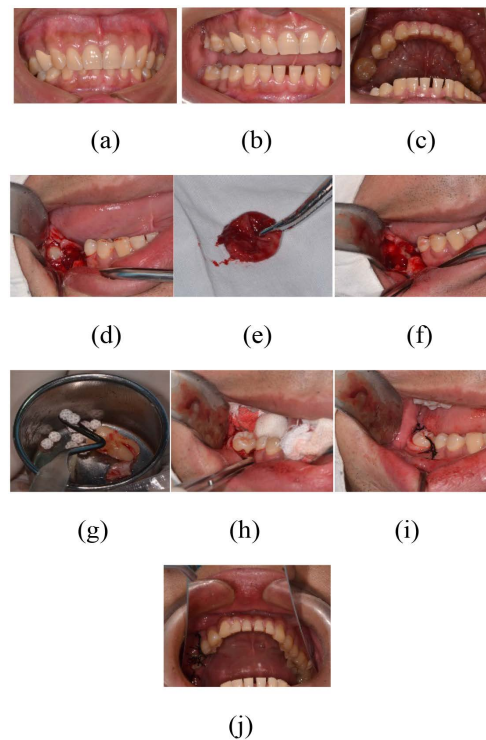


Figure 2. Impacted third molar transplantation procedures. Preoperative occlusal (a, b, c); Extract the second molar (d); Remove odontogenic cyst (e); extract the impacted third molar (f); impacted artificial bone (g); Transplant the third molar to the site of lower second molar (h); Suture the surrounding mucosa (i, j).

After the tooth 48 was transplanted to the site of the tooth 47, it was fixed on the tooth 45 with resin for about 9 weeks. Then, the fixture was removed. The

transplanted tooth was stable and the mobility was less than 1 mm.

Half a year after operation, the bone density was gradually increased and no infection was observed by clinical and radiographic examination. However there was a little horizontal bone resorption in the operative area (**Figure 1(e)**, **Figure 1(f)**).

3.2. Case 2

A 25-year-old female was referred to Oral and Maxillofacial Department of Hefei Stomatological Hospital for her missing tooth. Her left mandibular second premolar was extracted ten years ago, which led to the atrophy of the alveolar ridge. The medical history was no-contraindications.

Radiographic examination revealed impaction and malposition of the left mandibular canine and the height of alveolar ridge was less than 2/3 of the length of the adjacent root. These clinical, periodontal, and radiographic findings led us to diagnose the left mandibular canine as a impacted tooth. To resolve these problems, an interdisciplinary treatment plan was formulated; the patient was informed that the long-term prognosis of tooth 33 is poor and it is likely to hurt the alveolar bone due to it is too close to the root of the adjacent tooth. Under local anesthesia, the left mandibular canine was extracted and a mucoperiosteal flap was raised. And then the recipient socket was drilled by surgical burs with abundant saline irrigation in appropriate size and structure adjusted to fit the donor tooth extracted beforehand. Placing the donor tooth in the right position and filling the bone defect with artificial bone. The relationships between the adjacent and opposing teeth were also examined.

Orthodontic segment arch was placed for 8 weeks, and anti-inflammatory treatment routinely. After 1 month, the orthodontic segment arch was removed. The percussion test and electric pulp test of the left mandibular canine was with the chewing function without discomfort and the vitality of it was well maintained without any sign and symptom. The radiological examination results showed that the alveolar ridge graft bone healed, and the height of it increased about 7 mm. Furthermore, no radiologic evidence of a pathologic condition was apparent, and external root resorption of the left mandibular canine had not progressed as compared with initial radiographic film.

4. Discussion

Alveolar bone is formed with the growth and eruption of teeth, and the height of alveolar bone reaches its peak at around 25 years old. Since then its height gradually decline because of periodontitis, trauma and pathological changes. The atrophy is most obvious after the loss of whole teeth [5]. Thus, teeth can be seen as alveolar bone scaffolds. Once lost, alveolar bone will collapse. The absence of teeth and alveolar bone will bring many troubles to patients, such as dysphonia, mastication difficulty and aesthetics problems. In addition, pulp and periodontal ligament are essential to a healthy tooth. Only when a tooth has healthy periodontal ligament, pulp and alveolar bone around it can have normal physiological function, at the same time, this is pursuing of ATT. In our study, absence of

teeth and alveolar bone in these cases, we have four problems that cannot be ignored after ATT: maintain stability of teeth, pulp revascularization or RCT, reconstruction of alveolar bone and the combination of teeth and artificial bone.

In the early stage of transplantation, all of our cases were fixed firmly, arch splints or bonded directly to the adjacent teeth to ensure that the transplanted teeth will be stable. Simple suture fixation was not advocated in our cases. We believe that it is necessary to retain the transplanted teeth firmly in the initial stage, which is more conducive to the combination of the teeth and the surrounding artificial bone. It is hard to believe that transplanted teeth can have a good heal if it is not fixed firmly, just like the vacillating seedlings. Even if there is no mobility during the implantation operation, the periodontal bone may atrophy in the future gradually with the remodeling of the periodontal bone or there is not enough alveolar bone in the recipient area. Besides, it is unavoidable that the patient will hit it in the chewing or speaking. In combination with our two cases, it is not difficult to find that artificial bone (Bio-oss) may be a good choice to improve the success rate when performing ATT in the area of alveolar bone defect.

Although dental autotransplantation is affected by many uncertainties as well as donor sources, which results to its low popularity in clinical practice, many scholars have achieved remarkable results in this field, which deserves the attention of clinical experts [6]. But, the occurrence of pulp necrosis and root resorption after dental transplantation is still an unpredictable clinical problem [7]. At present, more and more scholars believe that it is difficult for the pulp to “connect” with the capillaries of the recipient area through the fine apical foramen after the permanent teeth transplantation [8]. RCT should be performed to reduce the incidence of root resorption. Some scholars advocate that RCT should be completed before the transplantation; otherwise it may reduce the possibility of periodontal healing of the transplanted teeth. However, Andreasen [9] and some other scholars [10] believe that the pulp can maintain the living condition by forming vascular connections through many small pores in the apex. So they do not advocate “pre-root canal therapy”. In addition, they believe that the residual periodontal ligament cells on the surface of the root have the possibility of stimulating or inducing alveolar bone regeneration, and they emphasize avoiding mechanical damage during the operation. Although these views are not acceptable to all, they do confirm the blood flow in the pulp cavity after dental transplantation by pulp staining [11] and have observed the new alveolar bone on the root surface in animal studies [12]. In our cases, RCT was not performed immediately, with our follow-up, we perform RCT for 5 of 11 teeth due to the pulp condition is not ideal. Although RCT has not been done on other teeth so far, these teeth show no pulp problems from radiology and clinical examination. However, our electric pulp test is still inactivated after 6 months in 2 cases, we speculate that although the pulp establishes blood supply, the nerve has not been repaired, or has been delayed significantly, which is consistent with other literature [13].

Meanwhile, the reconstruction of alveolar bone defects is very important in periodontal tissue regeneration, artificial bone powder (Bio-oss) is an ideal choice to achieve this goal [14]. It promotes the formation of new bone, repair bone defects, restore the anatomy of alveolar bone, so as to achieve ideal bone regeneration and periodontal healing. In our 11 cases, we use artificial bone to repair bone defect and get obvious benefit. However, from the radiology image, this kind of interface clarity is different from the normal periodontal ligament image, which could result by reattachment or new attachment [15], of course, it is also different from the integration of implant and bone. In the study of replanted teeth, this phenomenon is called “bone adhesion”. After teeth replanted, the way of periodontal healing is “adhesion” growth, which is easy to cause root resorption [16]. Whether the degradation of bone graft materials, regeneration of new bone and the formation of new dental bone bonding on the root surface or not need to be confirmed by experiments. In our other study, we applied the orthodontic surgery technique [17], to cut off the root with the surrounding alveolar bone together. This “whole” transplantation method, changed the traditional root and alveolar bone graft healing mode, made it become a more favorable healing mode between bone and bone. In addition, it reduced the complications of tooth transplantation [18] [19].

5. Conclusion

ATT is considered to be an ideal treatment for patients with suitable donor teeth [20]. In most cases, receipt area had sufficient alveolar bone. This paper reports the ATT of cases with severe alveolar defect and donor were permanent teeth. Although the prognoses of our 11 cases are good, it is still necessary to continue to carry out study of larger samples and longer follow-up, so as to further to improve the success rate and predictability of ATT and the reconstruction of alveolar bone defects using artificial bone.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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