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Case Report

Ridge Rehabilitation in the Esthetic Zone Using Alloplastic Bone Graft and Albumin-Coated Allograft: A Case Report with 5 Year Follow Up

Ahmed Halim Ayoub[1]* and Soulafa Mohamed Belal[2]

[1]President of the Egyptian Society of Oral Implantology, Alexandria, Egypt, Faculty of Dentistry- BPP University, London, UK
[2]Oral Medicine, Oral Diagnosis and Oral radiology, Faculty of Dentistry, Tanta University, Egypt

***Corresponding Author:** Ahmed Halim Ayoub, President of the Egyptian Society of Oral Implantology, Alexandria, Egypt, Faculty of Dentistry- BPP University, London, UK.

Received: August 16, 2017; **Published:** September 26, 2017

Abstract

Aim: In this case report a male teenager patient is presented with a congenitally missing right upper central incisor. Different treatment methods have been combined, including socket preservation technique with different types of bone graft.

Methods: Extraction of the retained deciduous tooth and socket preservation using alloplastic bone graft was done. After five years, a ridge augmentation using sticky bone was carried out to add to the ridge thickness with implant placement at the same time.

Results: The high esthetic outcome, achieved with the augmented ridge contours using sticky bone and proper type of bone graft (Albumin coated bone allograft).

Conclusion: The albumin coated bone allograft used in the present case allowed for successful horizontal ridge augmentation of a partially atrophic ridge. Both its effectiveness and its remodeling properties should be subjected to further investigations.

Keywords: *Alloplastic Bone Graft; Albumin-Coated Allograft; Implants*

Introduction

Dental patients with congenitally missing anterior teeth may present with undeveloped alveolar bone, causing challenges in implant placement [1,2]. While missing teeth have been successfully replaced by implants in the last decade, dental restoration and surgery still struggles with cases of restoring missing teeth in esthetic zone where the use of implant supported restorations is still a technically sensitive subject [3].

The congenitally missing of central incisors is occurring much infrequently, and the presence of agenesis of central incisor without any combined developmental lesion is real rarity. Therefore it is hard to find any documentation and literature description. Some cases have been described about prosthetic restoration of missing central incisors with implant supported dental bridgework. Abbo and Razoog [4] reported cases of the placement of narrow platform, internal tri-lobed implants, with the restorative solution of 4-unit zirconium fixed partial denture in order to restore the missing mandibular central incisors.

Description of the prosthetic replacement of a missing central incisor has also been published, where transformation of the anterior teeth were achieved, with laminate veneers, to simulate a complete dentition. The first premolar was transformed to mimic the esthetics of a canine, the canine to a lateral incisor and the lateral incisor to a central incisor [5].

Implant replacement of a single missing central incisor is rarely documented in the literature, and guidelines, so treatment protocols may vary and depend on the clinicians and the team performing the orthodontic and prosthetic restoration of the patient. In cases of missing central incisors with insufficient space for the tooth, only sophisticated treatment options can achieve the required results. Moreover, in a growing child or adolescent multi-disciplinary cooperation between different specialties such as the prosthodontist, the oral surgeon and the orthodontist can lead to optimal outcomes [6].

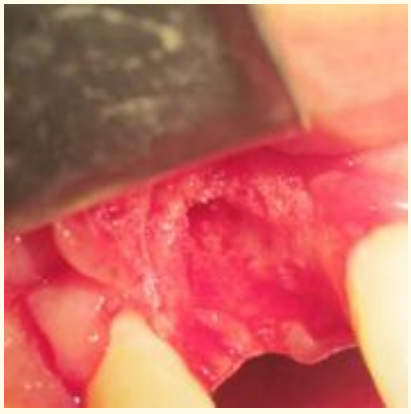
The success of implantation is mainly determined by osseointegration, achieving a stable anchorage between the dental implant and the bone structure [7]. However, positive esthetic outcome is not always in correlation with osseointegration. Patients' rising esthetic demand, together with inadequate pre-surgical anatomy will challenge clinicians [8]. Furthermore, a unique challenge is presented to the dental implant surgeons at sites with atrophic bone [9]. As the current concept of the treatment has moved from "bone driven implantology" to "restoration driven implantology", and the demand for aesthetic restorations and healthy soft tissues around the implant has increased [10], the esthetic success of the implant needs to be planned and evaluated carefully.

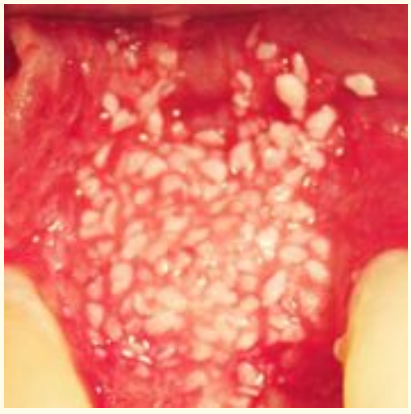
For the ideal position of the implant the recipient site often needs modification of, where previously onlay grafts harvested from the hip, maxilla or chin have all been used with success. However, as onlay grafts require secondary surgical site, the harvesting of bone with burs and chisels can cause postoperative morbidity [9]. Among alveolar ridge augmentation techniques, allogeneic bone substitutes are extensively used in bone replacement interventions, such as, fresh-frozen, freeze dried or demineralized bone. Although, allografts are generally safe, every step of the preparation process was shown to compromise bone-forming capacity [11]. For example, the harsh physico-chemical methods needed to remove antigens and reduce contamination, which also results in the reduction in osteogenic response of demineralized bone matrix (DBM). One way of tackling this issue is to replace the missing ossification factors in the bone grafts before implantation.

Serum albumin is a well-known proliferation factor for stem cells in culture and we hypothesized that this feature may also be beneficial as a bone graft additive [12]. In previous in vitro experiments we showed that freeze-dried serum albumin coating on human allografts provides a convenient milieu for mesenchymal stem cell (MSC) proliferation [13]. Albumin coated human allografts were also implanted in a rat nonunion femur model in vivo, where we found significant defect consolidation at four weeks after implantation [14]. At this time point, albumin coated allografts successfully bridged nonunion bone defects, while uncoated grafts failed. Later, we investigated the safety and surgical applicability of albumin-coated allografts in a human experiment, during which albumin coated allografts were implanted in 10 cases of aseptic revision arthroplasty as a support for the metal prosthesis [15]. These experiments successfully showed the applicability of albumin coating and raised hope for better clinical outcome.

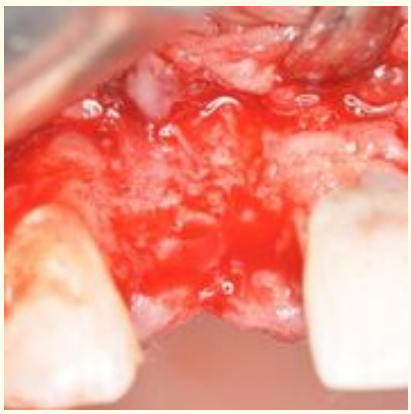
Case Description

A 13 years old male patient presented with retained deciduous maxillary central incisor (right central). He required an implant supported fixed restoration. Upon clinical and radiological examination, we found that there was a congenitally missing permanent maxillary central incisor. A decision was taken to extract the retained deciduous tooth and preserve the extraction socket using alloplastic bone graft. Conventional pedicle flap was elevated and the socket was filled with the bone substitute and then suturing (Figure 1,2). Sutures were removed after one week and the patient was informed that he will be able to place implant when he reaches 18 years (Figure 3).



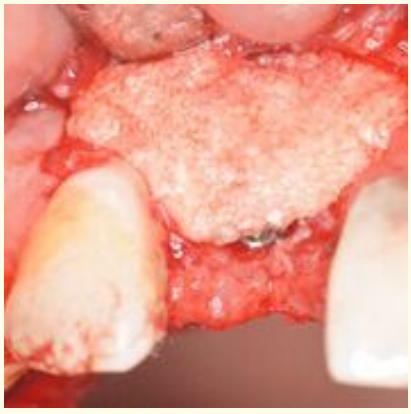


After five years post-surgical, the patient came seeking for implant placement. Upon clinical and radiographic examination, there was enough bone height and thickness for the implant placement (Figure 4,5). During osteotomy drilling, the bone was fragile and after implant placement there was labial bone thinning, which will resorb as expected during period of osteointegration (Figure 6). So, a decision was taken to augment the defected labial bone using sticky bone.



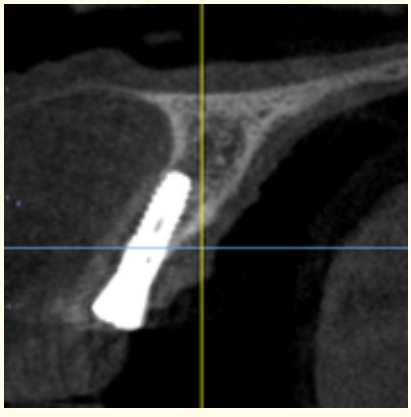
Preparation of the sticky bone started, 2 tubes of 10 ml of venous blood were taken from the patient and placed in a centrifuge at 2500 rpm/min for 15 min. At the end of the centrifugation, the blood in the tube was separated into two compartments; one yellow and one red. The yellow part is withdrawn with a syringe to be mixed with (Albumin coated bone allograft manufactured by OrthoSera@). They was mixed using a probe, until the formation of a single homogenous mixture of fibrin network with integrated bone graft particles inside was obtained which was rich in platelets, leukocytes and mesenchymal cells (Figure 7).

The sticky bone, which has been obtained, was placed in the defected anterior maxillary ridge; the edges of the mucosal flaps were approximated to each other and sutured using 3-0 Monoacryl sutures. Working time was approximately 30 minutes (Figure 8).



A prophylactic oral antibiotic, Augmentin@ 625 mg t.i.d. was used routinely, beginning one day prior to the procedure and continuing for five days postoperatively.

After ten days, sutures removal was carried out. After four month, clinical and radiographic evaluation was carried out, which revealed excellent soft tissue healing and fully keratinized and radiographic evidence of bone fill were recorded (Figure 9).



The cover screw then exposed under local anesthesia with a vertical mid crestal incision, placing healing cap for 3 weeks then fabrication of the final prosthesis was done (Figure 10,11).

Discussion

Implant-supported prosthetic rehabilitation in the esthetic zone presents one of the hardest challenges for oral surgeons, as several factors may compromise the final esthetic result. Among these, bone resorption caused by a previous tooth loss or extraction and the consequent lack of soft tissue support may lead to unsatisfying results. A second issue is how the choices undertaken at the moment of implant placement will condition the preservation of the esthetic result over time. For this purpose, the stability of both the hard and soft tissues is of paramount importance [16].

The two are interconnected, as only a bone volume, i.e., stable over time may guarantee adequate support to soft tissues and preservation of their long-term stability. Even when the dimensions of the alveolar bone are sufficient to allow for placement of osseointegrated fixtures, buccal bone augmentation is often advised to achieve a stable and satisfying esthetic restorative result [17].

Augmentation at the time of implant placement has thus become a common technique for enhancing implant survival and success or increasing soft tissue support in demanding esthetic cases [18,19]. When the available bone volume enables implant placement, buccal bone augmentation is usually performed following the principles of guided bone regeneration (GBR) [20,21].

Autogenous bone harvested from either extraoral or intraoral sites is regarded as the "gold standard", and it remains the material of choice for cortical-cancellous blocks. However, its use has many drawbacks as risks of donor site morbidity: infections, immediate postoperative pain and edema, neurosensory deficits, and hematomas. A variety of alternative allogeneic, alloplastic and xenogeneic bone grafting materials have been proposed in recent years, based on different biological mechanisms and bone regeneration principles, such as tissue engineering, and the osteoinductive and osteoconductive potential of different scaffolds [22].

Albumin coated bone allograft manufactured by OrthoSera@ was used in our study. Serum albumin is the most common protein in plasma, being responsible for numerous functions, like free radical scavenging, neutrophil adhesion and molecule transportation [23]. In addition, serum fractions like bovine serum albumin (BSA), or human serum albumin (HAS) are widely used additives in cell culture media, providing growth factors, carrying lipids, metals, and low molecular weight nutrients.8 Serum albumin was also shown to reduce the colonization of Staphylococcus aureus, Staphylococcus epidermidis, and Pseudomonas aeruginosa when applied as a coating on titanium surfaces [24,25]. Serum albumin coating also reduced infectious events in a rabbit model [26] therefore it could possibly function as a prophylactic agent against infectious complications in a variety of bone surgeries.

BSA was shown to improve adherence of osteoblast-like cells compared to adsorbed bone sialoprotein and osteopontin on hydroxyapatite surfaces [27]. The authors concluded that surface adsorbed albumin is changing the proliferation and attachment activity of the cells. Additionally, we found similar results on the surface of HSA treated surgical sutures [28].

In another experiment, the serum albumin coated sutures were able to attach significantly more MSCs after 48 h compared with classical attachment proteins like fibronectin and poly- L-lysine. More recently, data showed increased early adhesion and faster spreading of human gingival fibroblasts on BSA coated titanium surfaces [29].

Serum albumin could have other favorable properties besides the above mentioned functions, like molecule transportation. In fact, Liu concluded that adsorbed BSA increased surface energy, roughness and the hydrophilicity of the coated surface, which features promoted the adherence of biological macromolecules and therefore increased the possible connecting points between cells and the material [29].

Numerous scientific publications are available showing that the increased number of local stem cell or precursor concentration combined with different scaffolds are potent alternatives of autologous bone replacement therapies [30,31]. The beneficial effects of increased number of local precursors are twofold. First, various stem cells are capable to differentiate into osteoblast. Second, stem cells have beneficial immunomodulatory and paracrine effects after injury as well.

Sticky bone achieved both benefits of hard scaffold material, represented in bone graft material and the tissue engineering, represented in the PRF which is a source of fibrin network which is the extracellular matrix necessary for migration of specific cells in the tissue regeneration or repair. And it also contains growth factors necessary for the stimulation of differentiation or migration of cells [32,33].

Sticky bone is a cost-effective source of growth factors and is easy to prepare. It is used as alternative to titanium mesh or block bone procedure. Stability of grafted bone is granted against any motion, so the volume of augmentation is maintained during healing period, therefore the need of block bone and titanium mesh is minimized. Fibrin network entraps platelets and leukocytes to release growth factors, so bone regeneration and soft tissue healing are hurried [32,33].

Conclusion

Within the limitations of the case report, ridge preservation at the anterior maxillary zone becomes a mandatory by increasing the esthetic demands. Using suitable type for grafting, specially the one with uploaded growth factors such as serum albumin coated demineralized bone allograft can provide better results. Serum albumin increases the local number of precursor cells resulting in superior bone healing, which will aid in osteogenesis.

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Volume 14 Issue 5 September 2017