Coralline Hydroxyapatite Bone Graft in Non-Contained Defects: Case Report

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Abstract

Substitute bone grafts are gaining popularity in orthopaedics and faciomaxillary surgery. There are numerous products that are available to clinicians currently on the market. Here, we present a case report of a large non-contained mandibular defect that was successfully treated with a Coralline Hydroxyapatite (CHA). This paper will discuss the need for CHA in dental bone defect repair, and its effectiveness in the specific case study.

Keywords

Bone Grafting; Mandibular Defects; Regenerative Medicine; Orthobiologics

Introduction

Bone grafts primarily act as a scaffold, whereby new bone formation and wound healing can occur. The need for this stems from the need to fill defect sites that may have arisen due to surgery, trauma, infection, or congenital factors [1]. Failure to fill defect sites and tooth loss causes rapid resorption of alveolar bone from a lack of intraosseous stimulation, harming the functionality and form of facial structure [1]. Hydroxyapatite is commonly used as a graft

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material due to it being a constituent of inorganic bone tissue. It facilitates bone regeneration and stem cell proliferation, and becomes almost indistinguishable from bone after implantation [2]. Loss of skeletal mass in the face contributes to the appearance of aging in the face, and is also associated with various functional challenges [3].

Case Report

The following case outlines successful integration of coralline hydroxyapatite graft into the bone. These two images demonstrate respectively a large mandibular defect, before and after treatment with coralline hydroxyapatite. The patient was a 66-year-old woman, with an odontogenic cyst causing the mandibular defect (Fig. 1).

The defect healed well post-operatively without any complications. The latter image clearly shows a well-integrated graft, and a filled mandibular defect.

Figure 1: (A): Pre-operative image of mandibular defect; (B): 8-month post-operative image of Integrant GraftIT treated mandibular defect.

Discussion

The need for bone grafting is increasing in society. Approximately 5-10% of all bone defects have poor healing results, and as of 2016, over 2.2 million bone grafts were being performed each year [4]. Pneumatization (bone air spaces) results in a lack of mass in cancellous and cortical bone, resulting in instability, and a heightened likelihood of implant failure [5]. Non-autograft products are gaining in popularity as the issues of limited supply and donor site morbidity become increasingly problematic with increasing demand. Coralline hydroxyapatite (CHA) is manufactured from marine coral, a biomimetic approach given the trabecular structure of coral, resembling that of bone.

The mandibular defect presented in the above case is large, and could pose a significant functional and cosmetic challenge. Issues related to malocclusion and even proprioception can be the result of such defects. In the above case, the surgeon considers a whole variety of functionality, including chewing, swallowing and speech [3]. The CHA graft clearly restores bony contour. Long-term follow-up is necessary to assess the patient on cosmetic and functional factors.

It is also important to consider alternate graft treatment options for such a patient. Autologous materials represent a gold standard in the industry. Whilst they avoid donor wait lists and encourage bone ingrowth, they require two surgeries, and the resultant increased costs, inflammation, infection and scarring [6-8]. The size of the defect also makes donor site morbidity a key concern. The complications of donor site morbidity can often be more severe than the presenting pathology [9]. The difficulties of pathogen transmission with allografts and xenografts make natural coralline hydroxyapatite grafts a suitable solution [10].

As previously mentioned, a supportive structure such as a collagen membrane might provide utility for facilitating stability during bone graft ingrowth [11]. In this case, no membrane was used and optimal results were still observed. A membrane would have posed no additional benefit in the presented mandibular defect. However, there is still clinical benefits of membranes to prevent soft tissue in growth from interrupting osteogenesis by creating a protected tissue environment [12].

Integran GraftIT allows population of osteoblasts within three months that will convert to woven bone over two years. Resorption of bone present in soft tissue will occur. Studies have demonstrated limited to no inflammatory reaction, superior cell adhesion, and osteoconductivity [13]. GraftIT's osteoconduction indicates that the graft acts as a scaffold for bone ingrowth and cell infiltration [1]. It is likely that better results would be seen if the graft were osteoinductive, meaning osteoprogenitor cells differentiate into osteoblasts and form new

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bone [9]. Despite this, good results in terms of vascularisation and cell penetration have been demonstrated, which is essential for osteogenesis [5]. Because of an inherent mechanical weakness, CHA is suited for low load maxillofacial applications [14].

The acquisition of coral is important to consider, and is subject to ethical and regulatory concerns. Coral from the Porite and Goniopora species are used given their anatomical similarities to human bone. After toxin screening and shaping, the calcium carbonate skeleton is converted to hydroxyapatite granules, where carbonate phases are decomposed, and organic materials removed [15]. A pure coralline HA powder is formed by reaction with ammonium phosphate which is used in the production of GraftIT [14]. Exploitation of marine ecosystems is an important consideration, given that corals contribute greatly to marine biodiversity. Harvesting must be done in moderation to preserve ecosystems and prevent extinction (Fig. 2-4) [16].

Figure 2: The trabecular structure of natural coral [6].

Figure 3: Microstructure of coralline hydroxyapatite bone scaffolds of c. 200 µm pore size and d. 500µm pore size [7].

Figure 4: GraftIT bone graft substitute.

Conclusion

Coralline hydroxyapatite provided a successful solution for the grating of a large non-contained defect of the mandible. Grafting will increase in frequency with the aging population and the co-existing desire to maintain the function and cosmesis associated with having teeth. The use of synthetic and natural bone grafts will expand into the future due to inherent issues associated with autografts and allografts. Further research into the field is necessary to improve the mechanical loading capabilities of grafts, as well as osteoinductivity.

Conflict of Interest

Dr. Gordon Slater is medical Director of Integrant a medical Device Company.

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