Coralline hydroxyapatite effects on socket site preservation after extracting maxillary incisor

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Abstract

BACKGROUND: The benefits of coralline hydroxyapatite as bone graft are predominantly its safety, biocompatibility and osteoconductivity. Therefore, it can be used as a substitution biomaterial for bone in many indications clinically.

OBJECTIVE: To observe coralline hydroxyapatite effects on maintaining alveolar ridge in the socket after extracting maxillary incisor.

METHODS: Seventeen un-savable maxillary incisors resulting from trauma in 11 patients were extracted and at the same time coralline hydroxyapatite was implanted in socket sites. The patients were subjected to clinical observation and oral panoramic radiographs detection at postoperative 3 months.

RESULTS AND CONCLUSION: All patients had no adverse symptoms and physical signs. X-ray findings suggested new bone formation in the implanted area with coralline hydroxyapatite at postoperative 3 and 6 months, the surrounding bone tissue had no obvious boundaries, and the height of alveolar bone was maintained. Socket preservation using coralline hydroxyapatite can effectively maintain ridge of alveolar bone following tooth extraction and can promote new bone formation.

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INTRODUCTION

Adequate alveolar ridge height and width are essential for the ideal placement of dental implants to attain proper stability, esthetics, and function. However, after tooth extraction, there can be significant physiologic and pathological absorption of alveolar ridge dimensions resulting from normal alveolar bone remodeling[1-3]. And the bone may loss occurs in both the horizontal and vertical aspects. There is more significant bone loss in the area of maxillary anterior teeth, which can bring a series of problems such as shortness of bone for teeth plant and lead to bad results to aesthetic repair of metal ceramic repair tooth.

In recent years, the bone preservation after extracting maxillary incisor has been becoming a hot spot of basic and clinical research[4-7]. Numerous grafting materials have been found to be effective in minimizing alveolar changes post extraction[8-11]. These materials, including allografts, xenografts, have a wide range of technique sensitivity. Coralline hydroxyapatite (CHA) is manufactured from marine coral, which has a natural trabecular structure similar to the bone, by the hydrothermal conversion of the calcium carbonate skeleton of coral to hydroxyapatite[12-13]. Whereas, can CHA be used safely and effectively in socket site preservation after extracting maxillary incisor? Now let's discuss in details as follows.

MATERIALS AND METHODS

Design

A controlled clinical trial.

Time and setting

All experiments were performed at Department of Stomatology, Second Affiliated Hospital, Xinjiang Medical University, China from July 2010 to December 2011.

Materials

CHA powder granular of Tianbo Chigu (Beijing Yihua Jianke Trade Limited Liability Company, Beijing, China), is composed of high quality marine corals, chemical formula is $[Ca_{10}(PO_4)_6(OH)_2]$, the character is the powder granular; Oral repair membrane of Haiao (Approval No. 080602-SS071201; Yantai Biological Technology Limited Company, China). Reso-Pac (Ackerstraβe 1. 47269; Duisburg Deutschland, Germany). CRANEX 3D oral digital panoramic X-ray

machine (Nahkelantie 160, Tuusula, Finland).

Subjects

The study group consisted of 11 patients with 17 un-savable maxillary incisors (aged 16 to 48 years, average of 37.5 years), and the people accepted tooth extraction because of the traumatism. Among them, 7 males with 11 potential extraction sites and 4 females with 6 potential extraction sites were recruited. Among the 17 potential extraction sites, there were 12 maxillary central incisors, and 5 maxillary lateral incisors. After hearing the comprehensive explanation of the study, the patients understood fully the treatment plan, and signed informed consent.

The subject tooth was limited to maxillary anterior teeth with normal occluding relation. Moreover, patients with uncontrolled systemic diseases, patients who received radiation therapy, patients with the history of the maxillary sinus diseases or symptoms, patients who were heavy smokers, patients with acute infection, and patients in whom bone destruction had progressed to the root apex were excluded from the study.

Methods

Hydroxyapatite filling

Atraumatic extraction (Micro-Motion Exodontia Technology) was adopted, which purpose was to present a method for atraumatic tooth extraction by using special instrument with specially designed inserts. This surgical technique provides the clinician with an efficient method for atraumatic tooth extraction and preservation of an intact labial plate[14]. Immediately after extraction, curettage was performed carefully and the socket was irrigated immediately. Next, the socket was filled with the CHA bone meal and it was condensed to the crestal level. The alveolar opening was sealed with a resorbable membrane cuted to size, which was sutured to the surrounding soft tissue to contain the graft within the socket. The barrier prevented the loss of graft and accelerated the crestal healing of the keratinized gingival. If the alveolar bone suffered from damage, the continuity of the alveolar bone was restored. After surgery, cephalosporin antibiotic and ibuprofen analgesic were intravenous administered for 3 days, gallnut gargle was used for 2 weeks, and after 7−10 days, the suture was removed. After 7−10 days, the situation of wound healing, whether substitute granular material of bone overflow and whether there was vulnus discharg pus, all needed to be checked.

Oral panoramic radiographs detection

Patients were given CRANEX 3D oral digital panoramic radiographs by a tationary technician who did not know the patient's information before and 3 and 6 months after surgery to evaluate the fullness of the gums and the original bone healing after teeth extraction socket. Filming requirements: Frankfort line was parallel to the ground, and head of sagittal plane was vertical to the ground. Fixing the head with forehead and head clamp, going on the same exposure conditions were 60 kV, 6 mA, exposure time was 13.3 seconds. A fixed technician evaluated the amount of new bone formation and residual graft material remaining through naked eye analysis, including the bone texture number, thickness, and density of bone[2]. And then the distance between alveolar crest and incisal edge of adjacent teeth was measured, and the measurement results were evaluated by SPSS 17.0. By analysis of variance, $P < 0.05$ was considered statistical significance.

RESULTS

The effect of CHA on extraction alveolar

Macroscopic observation: Three months postoperation, inspection report showed that the shape of the alveolar was enough. And there was no obvious height decrease of alveolar compared with adjacent socket ridge.

X-ray observation: 11 patients with 17 sockets were all valid. The sclerotin at graft area increased obviously, and the image of sclerotin density evenly distributed. Uniform structure of bone trabecula could be seen from the image, which integrated the bone tissue with bone graft material, and the boundaries almost disappeared. All socket sites had enough new bone and did not require bone graft again. Before teeth extraction, the distance between alveolar crest and incisal edge of adjacent teeth was (8.17±0.18) mm, and after bone graft, the distance was (8.23±0.19) mm, showing no statistically significant difference ($P > 0.05$). The results showed that there was no obvious absorption of alveolar bone before and 3 months after the experiment (**Table 1**).

Typical cases

For a male patient, 24 years old, maxillary central incisor was injured because of traumatism. Residual roots were extracted immediately with mini-invasive surgery under local anaesthesia. After cleaning out the operation area we transplanted hydroxyapatite bioceramics bone in extraction socket, and overlapped tooth extraction wound with a full thickness free mucosal flap, sutured without tension. The examinations were done at periodic intervals at 3 and 6 months after the surgical procedure (**Figure 1**).

Before the tooth extraction, the alveolar bone height of

Table 1 The distance between alveolar crest and incisal end of adjacent teeth measured by X-ray before and 3 months after implantation of coralline hydroxyapatite (CHA) ($\bar{x}$±s)

Time	*n*	Distance (mm)
Before implantation of CHA	17	8.17±0.18
Three month after implantation of CHA	17	8.23±0.19
F		0.81
P		> 0.05

Figure 1 The effect of coralline hydroxyapatite on alveolar bone of a male patient (X-ray examinations)

maxillary central incisors was cow. At the same time, CHA was placed in socket site. Three months after extraction, wound healing was good, similar structure of bone trabecula that integrated the bone tissue with bone graft material could be seen, and the boundaries almost disappeared. The bone invagination in the alveolar ridge was significantly reduced, approximate to the height of alveolar bone crest adjacent. Then, dental implant was transplanted. Three months after implantation, the implant was fused well with surrounding bone tissue, and there was no significant absorption of alveolar bone that healed well.

Adverse effects

The 17 sockets in 11 patients were all clinically healed. In addition to the local mild swelling, no bone debris or purulent materials appeared. The patients felt fine during recovery periods.

DISCUSSION

Implant denture can significantly improve masticatory function, similar to the real teeth, especially to solve some complicated cases that normal denture is difficult to solve[15, 16]. Usually, delayed implant restoration method is to extract teeth that cannot be kept firstly: after its natural healing 3–6 months, dental implantation will be done. However, in the process of self healing of extraction sockets, the alveolar ridge and the surrounding bone have varying degrees of physiologic or pathologic absorption, leading to narrowed alveolar bone thickness and decreased height. Studies have suggested that most loss of alveolar height in anterior tooth area occurs in the first 3 months, and 3–4 mm of the ridge width and height is lost after 6 months[17]. Adequate alveolar ridge height and width will influence the ideal placement of dental implants and tissue esthetics[18].

Socket preservation means to maintain hard and soft tissue after tooth extraction, especially the gingival papilla in the esthetically relevant anterior maxillary area, and a substantial tissue volume is highly critical for the success of implant-retained restorations[19].

Recent research has indicated that after tooth extractions there will be physiologic and pathological absorption of alveolar ridge dimensions as a result of normal alveolar bone remodeling. Physical absorption is the oppression of alveolar bone from lip on the organization; pathological absorption is caused by peripheral soft tissue injury in extraction socket and the microenvironment in the progress of natural healing. The contraction of blood clot and accumulation of debris in the tooth socket may limit the potent of alveolar bone regeneration[20].

Barrier membrane covering the tooth socket that can reach into the bone maintains a stable environment, in order to reduce the loss of alveolar bone height and width. Animal experiments and clinical studies have shown that filling bone graft materials into the tooth socket can form a bracket, to induce bone formation and reduce the absorption of alveolar bone[21-23], which is named membrane guided bone regeneration technology[24-26]. The membrane prevents the gingival connective tissue and epithelial tissue migrating into the defect and its contained osseous graft, while protecting the blood clots, reduce tissue stress and achieve bone regeneration. The wound stabilization is very important in periodontal repair and may also be of importance for the healing extraction sites.

Autogenous tissue flap and oral biofilm[27-28] are commonly used as membrane to guide bone regeneration. The use of oral biofilm can always bring about exposure of membrane. However, autogenous free full thickness mucosal flap has been found to be conducive to soft tissue healing and has been reported to serve as a barrier membrane.

The space under membrane determines the size and the morphology of bone regeneration, but only the barrier film itself is unable to sustain the increase of space alveolar bone, and the bone graft material must be depended on[29]. At present, various bone graft materials existing are widely used in the repair of bone defects. Natural and synthetic graft materials that have been studied in vitro and in vivo and used in different medical procedures in osseous tissue have focused mainly on freeze-dried bone, hydroxyapatite, tricalcium phosphate and coral[30]. CHA (Tianbo Chigu) is a newly developed artificial bone graft polymer material, which is composed of high quality marine corals, chemical formula is $[Ca_{10}(PO_4)_6(OH)_2]$, the character is the powder granular. The ostiole on skeleton ($CaCO_3$) of coral hydroxyapatite thin layer provides a good space for the tissue growth. Additionally, CHA contains two hydroxyl groups, which can bond water molecules by hydrogen, so to have a good hydrophilicity. The benefits of CHA as bone graft are predominantly its safety, biocompatibility and osteoconductivity so that it can be used as a substitution biomaterial for bone in many indications clinically.

This study used autogenous free full thickness mucosal flap and CHA (Tianbo Chigu) to restore the shape of alveolar bone[31-32]. After operation, macroscopic observation and X-ray showed that the loss of height and width of alveolar bone was reduced. In this research, porous maxillary anterior bone was chosen, because the bone has rich blood circulation, sensitive marrow stromal cells and good ability of anti-infection. A good bone graft bed filled with substitute materials after tooth extraction will provide good support conditions for planting denture.

These cases indicated that there were several methods to reduce or avoid bone absorption after teeth extraction: (1) For reducing cicatrix of soft tissue, operator trys to avoid doing any incision on gum; (2) atraumatic extraction can help preserve the residual supporting bone; (3) bone graft materials, such as CHA, are grafted into the socket, and replaced by new bone slowly; (4) mucoperiosteal flap at palatal side covering graft area after tooth extraction cannot only prevent gingival recession because of tissue pulling, but also form good sealing to isolate the accumulation of debris in the tooth socket, and to promote bone regeneration.

Given the vast scientific evidence and documentation of the above information, the benefits of conducting CHA in socket after tooth extraction and covering the wound with mucosa flap is emphasized. It is recommended to use CHA as graft material. CHA improves the prognosis by maintaining the residual bone and realizes the purpose of sockets preservation. Thus, hydroxyapatite as a bone graft material has good bone compatibility and security, which is worthy of development.

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珊瑚羟基磷灰石保护拔牙位点的效应

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文章亮点：

1 缺牙后，上颌前牙区相比其他区域更容易产生牙槽骨萎缩，如何种便捷、安全、有效的保护拔牙区牙槽骨还有待研究。

2 在此研究中，创新性地将珊瑚羟基磷灰石填充入上颌前牙拔牙后的牙槽窝，牙槽骨未见明显吸收，种植体植入后与周围骨组织结合良好，可见珊瑚羟基磷灰石可以作为一个有效的生长因子促进骨整合。

关键词：
生物材料；口腔生物材料；珊瑚羟基磷灰石；拔牙位点；保存；拔除上颌切牙；骨移植物；牙槽骨；种植牙；微创拔牙
主题词：
牙槽窝；牙槽骨质丢失；磷灰石；牙种植体；组织工程

摘要

背景：珊瑚羟基磷灰石作为骨移植物的优点主要有安全性、生物相容性和骨传导性，所以对于许多临床适应证它可以作为一个替代骨的生物材料。

目的：观察应用珊瑚羟基磷灰石于上颌切牙拔出后的牙槽窝后，对牙槽嵴的保持结果。

方法：将 11 例患者的 17 个因创伤不可保存的上颌切牙拔除，拔除后即刻将珊瑚羟基磷灰石植入拔牙窝。植入后 3 个月对患者进行临床观察和口腔全景 X 射线片检测。

结果与结论：所有患者均无不良反应和体征。X 射线研究发现珊瑚羟基磷灰石植入后 3，6 个月后在植入区有新骨形成，与周围的骨组织无明显界限，且保持了牙槽骨的高度。说明珊瑚羟基磷灰石可以有效保持脊拔牙后牙槽骨的高度，并能促进新骨形成。

***作者贡献*:** 第一作者和第二作者构思并设计本研究，第三，四作者共同实施实验并分析实验结果。

***利益冲突*:** 文章及内容不涉及相关利益冲突。

***伦理要求*:** 实验获得新疆医科大学第二附属医院伦理委员会批准。

***学术术语*:** 微创拔牙采用专门气动高速机头及微创手术器械，通过精细的手术操作，不损伤牙槽骨，轻柔的拔除牙齿，很好的保护了周围组织和骨组织，牙周组织受到的损伤降至最低，愈合更快。

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