Cancer cell research 11 (2016) 257-261

www.cancercellresearch.org Article

Evaluation of bone remodeling ability in transalveolar elevation osteomes with two different methods—without or with coral bone substitute

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Abstract: **To evaluate the degree of osteogenesis achieved by using a coral bone substitute and a space holding device in transalveolar maxillary sinus floor elevation procedures. 33 patients were received treatment with a maxillary posterior implant in the Dental Medical Center of the First Affiliated Hospital of Jinan University between January 2013 and June 2014. The vertical bone defect in the implant region was 3.8 mm on average in all patients. The 33 patients were randomly classified into two groups: the simple closed maxillary sinus augmentation group (n=17) and the closed maxillary sinus augmentation group with the coral bone substitute (n=16). A total of 40 dental implants (Dentium, Korea) were implanted: 20 were used for the simple closed maxillary sinus augmentation and 20 were used with the coral bone substitute. Neoplastic bone formation was significantly less in patients that underwent simple closed maxillary augmentation compared with those that underwent the closed maxillary augmentation with the coral-based bone scaffold (P<0.01). In closed maxillary sinus augmentation, a coral-based bone scaffold allows us to predict the bone volume and promotes osteogenesis compared to implants without a bone substitute.**

Keywords: Osteogenesis; Coral bone substitute; Transalveolar elevation

Received 25 April 2015, Revised 2 June 2016, Accepted 6 June 2016

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1. Introduction

Excessive gasification of the maxillary sinus is one of the main reasons with maxillary posterior tooth segment bone defects. Due to the existence of the maxillary sinus, the planting of this area becomes very complicated. In order to avoid the influence on maxillary sinus, Venturelli [1] implants into the upper jaw with the implant, while the short implants and bone implants seem to have become a better choice {Nocini, 2000 #33}. But since 1980, the Bonyes and James found maxillary sinus mucosa augmentation operation method, and then the maxillary posterior segment can be planted. The mucosa of maxillary sinus elevation mainly refers to the classic side wall fenestration of maxillary sinus mucosal augmentation operation method. Due to its excellent visibility, it is widely used in the maxillary sinus augmentation operation method [2,3]. With maxillary sinus augmentation insertion of implants in body and autologous blood clot, Kim found in bone healing process that the blood clot volume reduce gradually, eventually only around the implant formed a small amount of bone [4]. Cricchio use space holding device in mucosa of maxillary sinus to keep submucosal space and obtain the good osteogenesis performance [5]. Ramirez [6] and Caubet [7] respectively use electron microscope and gene detection to substitute in the healing process. This process is gradually replaced by bone and is confirmed using a bone substitute material that has good osteogenic properties. Although Summers improved maxillary sinus mucosal elevation in 1994, which was proposed by alveolar ridge top mucosal augmentation operation method. Because it is not easy to judge the status of maxillary sinus mucosa perforation, therefore the technique of bone remodeling studies are seldom reported. However, with the application of CBCT and nasal endoscope in planting, the technology due to minor trauma, short surgery time, high satisfaction of patient, and be re-attentted [8]. Compared with the side wall opening, the mucosa augmentation operation method of the alveolar ridge can form a natural closed maxillary sinus mucosa space. In this prospective study, the use of the mucosa augmentation operation method of the alveolar ridge gain space of the sinus mucosa and simultaneous placement of implants, as the backbone of a tent will support mucosa. Basis on comparion, the amount of bone of relatively simple ascending mucosa, simultaneous implant and bone substitute materials, we studied scaffold materials and space maintainer osteogenic efficiency.

2. Methods

Time and place: cases from January 2013 to June 2014 Guangzhou Jinan University First Affiliated Hospital of oral medical center of maxillary posterior region planting patients.

Object: from January 2013 to June 2014 Guangzhou Jinan University First Affiliated Hospital of oral medical center, 33 patients with maxillary posterior implant treatment, age 25-67 years, average age of 46 years; 27 patients were male, 23 cases were female.

Table 1 General information of patients.

Group	Patient No.	Implant No.	Gender		Age (year)
			Man	Woman	
Closed augmentation	17	20	9	8	57.35
Closed augmentation +bone substitute implantation	16	20	8	8	58.25

P <0.01. There was no significant difference regarding to the gender and age distribution between two groups.

Inclusion criteria: quasi oral panoramic X-ray examination of the maxillary endossenous implants in the pre-operation patients, planting area is residual alveolar bone height (residual bone height, RBH), maxillary gingival distance >4mm, and maxillary sinus mucosa no thickening and no maxillary sinusitis. Signing informed consent for implant surgery patients are no the systemic disease.

Exclusion criteria: Severe bruxism, wine tastes, smoking, smoke more than 20 cigarettes a day, face and neck accept radiotherapy and chemotherapy, the abnormal liver and kidney function, the pregnant women, the autoimmune disease, the complexity of periodontal disease, local inflammation and severe patients with poor oral hygiene are excluded.

33 cases were randomly divided into two groups according to the above standard. One group was 17 cases of outside maxillary sinus lifting group, the other group was 16 cases of inside maxillary sinus lifting group. In all cases, the average vertical bone defect was 3.8mm, and 40 implants were implanted with the south of Korea Dentium. 20 of them were inside group, and were implanted coral bone in the same period.

Planting system: Dentium column screw implants for the production of bone implants were from South Korea Dentium Company.

Table 2 Group Statistics.

	Group	N	Mean	Std. Deviation	Std. Error Mean
RBH	Closed augmentation	20	4.9450	1.41029	.31535
	Closed augmentation +bone substitute implantation	20	3.8350	1.29910	.29049
Closed augmentation height	Closed augmentation	20	5.0550	1.41029	.31535
	Closed augmentation +bone substitute implantation	20	6.4900	1.13272	.25328
Bone volume height	Closed augmentation	20	2.0150	.46597	.10419
	Closed augmentation +bone substitute implantation	20	6.1550	1.05305	.23547

Bone substitute materials: Tianbo teeth solid powder particles were from Beijing Kanghua Era Technology Co., Ltd., particles diameter were 0.25-0.5mm and weight are 0.25/0.5g.

In the inside maxillary sinus lifting group treatment method: before the operation, the surface layer of the film was taken to calculate the height of the implant. Planting system was Dentium column screw implant, implant device and maxillary sinus lifting tool. Preoperative prepared inside maxillary sinus lifting operation. After local anesthesia, incision and embedded parts of the mucosa, peeling, exposed bone surface and pioneers drill was used to prepare planting distance to nest of maxillary sinus floor about 1 to 2 mm. The cavity was expanded to quasi implant diameter and then with osteotomes as lifting equipment, from fine to coarse, gradual typing on maxillary sinus to the length of implant, the implant Dentium specifications for dental implant were 3.8 and 4.3 x 10 mm, then closed the wound.

Maxillary sinus lift + simultaneous bone replacement material treatment group: before the operation, the surface layer of the film was taken to calculate the height of the implant. Planting system was Dentium column screw implant, implant device and maxillary sinus lifting tool. Preoperative prepared inside maxillary sinus lifting operation. After local anesthesia, incision and embedded parts of the mucosa, peeling, exposed bone surface and pioneers drill was used to prepare planting distance to nest of maxillary sinus floor about 1 to 2 mm. The cavity was expanded to quasi implant diameter and then with osteotomes as lifting equipment, from fine to coarse, gradual typed in maxillary sinus to the length 1-2mm. This time we added Tianbo tooth solid powder particles to implant length. The implant Dentium specifications for dental implant were 3.8 and 4.3 x 10mm, then closed the wound.

Perioperative preparation: The patients before preoperative 30min were given clindamycin

(clindamysin) 300mg, oral. Postoperative cases were given clindamycin 300mg, 1/day/5 days. 0.01% furacilin ephedrine hydrochloride nasal solution 1ml drops nose, 2/day/5 days; 0.05% Fufang chlorine has been used for gargle, 3/day/5 days.

Imaging examination: Patients were accepted panoramic photography in preoperative, postoperative and postoperative for six months. The edentulous implant sites of residual bone height (RBH), enhance height and ultimately bone height were measured. All curved surfaces are obtained by a KODAK digital curve surface fault machine (USA).

Statistical analysis: The height of bone in each group was significant difference ($p<0.01$) using independent samples T test, all the statistical analysis using for Windows SPSS16.0.

Table 3 The measurement comparison between two groups by independent samples T-test.

	Levene's Test Equality of Variances		test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
RBH	.047	.830	2.589	38	.014
			2.589	37.747	.014
Closed augmentation height	.719	.402	-3.548	38	.001
			-3.548	36.310	.001
Bone volume height	13.909	.001	-16.078	38	.000
			-16.078	26.166	.000

P < 0.01. The bone volume around the implants was increased in all the patients by comparing panoramic films obtained before operation, immediately after operation, and six months after operation; and the average increase was around 4.09 mm in six months.

3. Results and Discussion

3.1. The number of participants analysis

33 patients were divided into two groups, treatment and followed up for 6 months, all cases were accepted timely referral, no shedding or other reasons. According to the analysis of the intention, all cases were entered the result analysis.

3.2. Two groups general data analysis

Two groups of patient's gender, age, have no significant difference.

The dental implant stability of 40 implants in maxillary sinus surgical procedure after maxillary sinus mucosa drum gas experiment was confirmed that there was no maxillary sinus mucosa perforation, while after the operation there were no inflammation of the surrounding tissues and maxillary sinusitis. In six months, the radiographic findings were observed different degree of new bone formation.

Before the surgery, postoperative and after six month, X-ray planting medical checking planted successfully 40 pieces had bone mass increasing. Postoperative cases in six months increased average of 4.09mm.

Two groups of patients with bone incremental data analysis

Within the group after 6 months of new bone formation were significantly less than that in the bone graft group ($P<0.01$).

Sinus floor bone reconstruction after maxillary can be considered as a part of the bone tissue engineering under the mucosa of the maxillary sinus floor. As one of the three elements of bone tissue engineering, bone support is the key point of this study. In the present study, the formation of new bone (Table1) was observed in the mucosa of the group alone. Currently on improving postoperative mucosal osteoblast specific mechanism is still controversial. Cricchio [9] is to enhance the maxillary sinus mucosa as a tent planted body protruding, plays the role of a tent pole, and the mucosa-planting body is like a tent in the branch of the maxillary sinus floor, and the device is similar to a void retainer, on basis the new bone formation.

According to the inferred Cricchio [10] made void retainer, and the formation of new bone can be observed. But in these works, only new bone formation and the success rate of planting were referred. The specific bone mass and bone substitute materials were not involved. Scala [11] observation of maxillary sinus found the early sinus mucosa into bone. Into bone source, the collagen condensation occurred in 30 days. As a result, and ultimately the formation of blood clots, and into the amount of bone is not obvious.

Scala confirmed maxillary sinus in promote traumatic hemorrhage. In the maxillary sinus mucosa blood clots to form on the basis of clot osteogenesis, so blood clot is considered to be the support. Kim [12] According to the theoretical basis, a large number of implants in the nest of coagulation clumps, and ultimately the formation of sinus floor in the process of collapse (collapse). A small amount around the implant has new bone. The volume of the bone and the research results are the same. Kim thought maxillary sinus pressure leads to within the maxillary sinus mucosa stick attached to the root end. They speculate that clot degradation rate is too fast, and ultimately the formation of bone mass is less.

In this study, to ensure maxillary sinus mucosa no perforation and to ensure the integrity of the maxillary

sinus mucosa, maxillary sinus mucosa of respiratory response was repeated. At this time, the integrity of the maxillary sinus mucosa has protective function. On the one hand, to control the operation of hemorrhage can only form a range of coagulation block. The blood clots become future bone remodeling of the bracket structure, while blood clot be rapidly degraded, which result in final bone significantly less than normal, and cannot predict the final bone [13,14].

In the present study, the bone substitute materials as a bone scaffold group, we obtained the satisfied imaging results. Through the analysis, the correlation between the bone mass and the height of the internal lifting is significant difference ($p<0.01$) (Table2 and 3). Coralline hydroxyapatite scaffolds be derived in deep-sea coral artificial synthetic materials [15,16], which can avoid organic bone scaffold materials to carry viruses and Chlamydiae risk. At the same time the slow degradation rate can maintain the shape of new bone that is a kind of ideal scaffold material. In this study, the promotion space can be well maintained, and in the healing process is degraded and autologous bone replacement.

In the study, Yuan also found that the fusion of coral bone scaffold and autologous bone appeared in 4-24 weeks, which was in accordance with [16] this study. The activation of $Ca2^{+}$channels in bone marrow stem cells is detected by Klar [17], which is the main signaling pathway that activates bone marrow stem cells to differentiate into osteoblasts and finally become into bone.

Research of animal model of Manassero [18] confirming coral scaffolds can induce stem cells and differentiation into bone cells, which is confirmed in vivo experiments. Coral scaffolds in six months are completely replaced with autogenous bone. The clinical and after maxillary sinus lift operation of planting the second stage operation time consistent, and the film like examination results are consistent.

In our study found that space was maintained the determinants of bone formation. Branch of the tent structure was formed by the implant and complete maxillary sinus mucosa, so in operation maintain of maxillary sinus mucosa integrity and simultaneous implantation body provides a space for the formation of autogenous bone. However, the maxillary sinus pressure and mucosa can be extended, the maxillary sinus mucosa in the healing process will be accompanied by scaffold degradation and collapse (collasp). The degradation rate of scaffolds and the influence of the submucosal space affect the final bone formation. In the simple mucosal enhance group, blood clot as the self support structure, is completely degraded about a month [19]. The raising the normal bone reconstruction time at least needs four months, so in a simple lifting operation to get bone level is unpredicted. With the coral bone scaffolds of enhance the group the bone rate is slightly faster than the degradation rate of the scaffold.

4. Conclusion

Till now, implant need much bone formation to meet the implant of the basic survival and long-term functional application is inconclusive. So we can not judge two operation qualities. Although two kinds of operation can obtain a certain degree of bone, the involvement of the coral scaffolds for bone enable predictors of bone mass becomes feasible. At the same time, using coral scaffolds of osteogenic effect is obviously better than that no accompanied by bone graft implant surgery.

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