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THE EFFICACY OF RIDGE PRESERVATION ON MAXILLARY SINUS PNEOMATIZATION AND ALVEOLAR BONE RESOORPTION AFTER EXTRACTION OF POSTERIOR MAXILLARY TEETH

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ABSTRACT

Purpose: To evaluate maxillary sinus and alveolar crest dimensional changes after posterior maxillary tooth extraction, using bovine bone graft (Bio-Oss®) and platelet-rich fibrin membrane for ridge preservation.

Patients and methods: Twenty-four patients were selected from those attending outpatient clinics of the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry for boys Al-Azhar University, presented with maxillary posterior molar indicated for extraction. All selected patients randomly allocated into two equal groups. Group one is a Study group, extraction one of maxillary posterior teeth with application of Bio-Oss® and platelet-rich fibrin membrane for ridge preservation. Group two is a Control group, extraction one of maxillary posterior teeth without any grafting material. The measurements were performed includes: distance from the bone crest (BC) to the sinus floor (SF), distance from SF to the sinus roof (SR) to evaluate maxillary sinus and alveolar crest dimensional changes after posterior maxillary tooth extraction in both groups.

Results: There was statistically significant decrease in alveolar ridge height (BC to SF) and significant increase is sinus vertical dimension (SF to SR) for both groups. While there is a significant increase of bone quantity in the study group than the control group.

Conclusion: It can be concluded that tooth extraction in the posterior maxilla may lead to sinus pneumatization and crestal bone loss, using Bio-Oss® and platelet-rich fibrin seemed to reduce sinus pneumatization along with minimizing crestal bone resorption.

KEY WORDS: ridge preservation, sinus pneumatization, bone grafts.

INTRODUCTION

The task of restoring the edentulous posterior maxilla with an implant-supported prosthesis may represent a challenge for the clinician. A major reason for this may be the lack of sufficient vertical bone height for stable implant placement after tooth loss.

The problem of lack of bone at the posterior maxillary area is thought to be the result of two simultaneous processes: resorption of the maxillary

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alveolus and pneumatization of the maxillary sinus. Alveolar resorption has been shown by many to occur after the extraction of a tooth. This resorption results in both vertical and horizontal alveolar dimension loss intraorally. Beyond intraoral resorption, teeth extracted in the posterior maxilla may also result in intra-antral resorption via inferior expansion of the maxillary sinus [1,2].

Pneumatization of the maxillary sinus is a normal physiologic process that results in an increased volume of the sinuses during development [3]. Reasons why sinus pneumatization takes place after growth cessation and following extraction of posterior maxillary teeth are poorly understood. However, several factors including heredity, bone density, previous sinus surgery, and extraction of posterior maxillary teeth have been postulated as factors that influence the amount of sinus pneumatization [4].

It has been reported that ridge preservation after tooth extraction minimizes the bone resorption of the socket walls therefore maintaining the anatomic shape of the alveolar ridge [5,6]. Ridge preservation becomes common practice with different grafting materials and techniques in different locations within both maxillary and mandibular arches [7]. Many recent studies supported using of bovine bone and platelet rich fibrin (PRF) in socket and ridge preservation. [8,9]. Recent researches also have been hypotheses that, if ridge preservation acts by limiting the loss in hard tissue volume of the alveolus intraorally, it may also inhibit post-extraction sinus pneumatization. [10,11]. The purpose of this study was to evaluate maxillary sinus and alveolar crest dimensional changes after posterior maxillary tooth extraction, using Bio-Oss® bone graft and platelet-rich fibrin membrane for alveolar ridge preservation.

MATERIALS AND METHODS

Study Design and Population was selected to address the purpose of this research. A prospective randomized control study was designed and performed. The study population included twenty-four patients were selected randomly from those attending outpatient clinics of the Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University. The inclusion criteria included: Patients who underwent extraction of either of the posterior maxillary teeth related to maxillary sinus, free of any sinus problems and medically free. The exclusion criteria included**:** Cases of immediate implant placement, intra-operative sinus perforation, patients with Osseo-metabolic disorder. e.g. rheumatoid arthritis and patients with systemically compromised situations like uncontrolled diabetes, liver and renal disorders, taking steroids or anti-cancer drugs. The included patients were randomly divided equally and allocated into two groups. Group 1: was the study group (12 patients 8 males and 4 females ranged in age between 41.0–46.0 years with a mean age of 43.83 ± 1.83 years) in which Bio-Oss® bone graft and platelet-rich fibrin membrane used for ridge preservation after posterior maxillary molar extraction. Group 2: was the control group (5 males and 7 females ranged in age between 33.0 - 36.0 years with a mean age 34.50 ± 1.05 years) so, there was no any graft used after extraction.

In accordance with the Declaration of Helsinki, written informed consent was taken from all patients, and the local ethics review committee of the Faculty of Dental Medicine for Boys at Al-Azhar University approved the study.

Presurgical preparation:

Extra oral and intra oral examinations were carried out for all patients of both groups; hard and soft tissue structures were evaluated for detection any local signs of inflammation. Oral hygiene measures (scaling and root planning). Preoperative radiograph: CBCT was done preoperatively for each patient (Fig.1).

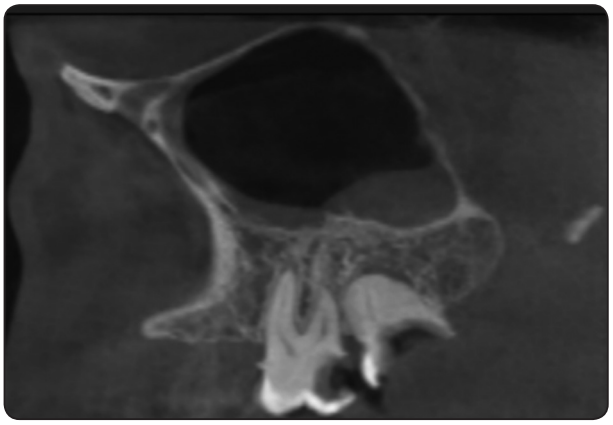

Fig. (1): Preoperative CBCT showing badly decayed maxillary second molar to be extracted and its relation to the sinus and adjacent structures.

PRF preparation:

The PRF was prepared as described by **Choukroun et al.**[12], 10 ml of the patient's venous blood was drawn and placed in vacuum tube without anticoagulant, and was immediately centrifuged at 3000 rpm for 10 minutes at room temperature (Fig.2). After centrifugation, the PRF clot was removed from the tube using sterile tweezer. Then the PRF clot was separated from the attached RBC base using scissors, then compressed to be used as a membrane.

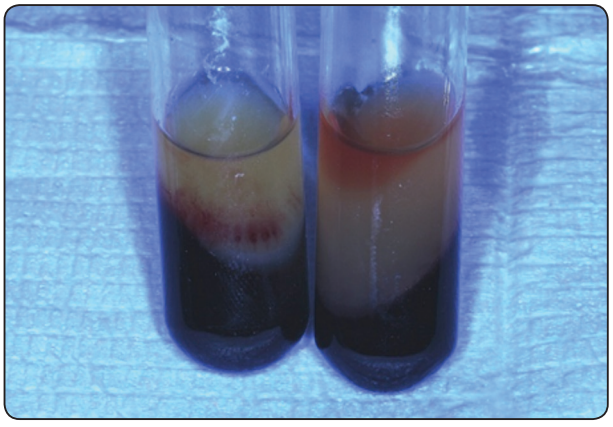

Fig. (2): prepared PRF ready to use.

All patients were asked to take a single dose of prophylactic antibiotic, one hour before surgery (Amoxicillin 875 mg + Clavulanic acid 125mg).

Surgical procedures:

All the patients were anesthetized locally with routine buccal and palatal infiltration local anesthesia. Atraumatic extraction of the targeted tooth was performed. A careful socket debridement was performed manually from the bottom of the socket up to the gingival margin. **In the study group:** Bio-Oss® bone graft was applied into the extraction socket and covered by platelet-rich fibrin for ridge preservation. The PRF membrane was seated over the graft material and sutured with soft tissue margins to act as a barrier membrane and assure proper healing (Fig.3&4). **In the control group:** The extraction sockets were left to heal spontaneously without any preservation procedure.

Fig. (3): Maxillary 1st molar indicated for extraction preoperative

Fig. (4) Graft and membrane postoperative

Patients were instructed to bite down gently but firmly on the gauze packs that have been placed over the extraction areas, making sure they remain in place and not to change them for the first hour unless the bleeding was not controlled, avoid rinsing vigorously and hot drinks and stick to soft diet.

Postoperative evaluation:

All patients received analgesics (nonsteroidal anti-inflammatory drugs for 3 days) and antibiotics for 1 week (amoxicillin plus clavulanic acid). Sutures were removed after 7 days and patients entered in a follow-up protocol:

Clinical evaluation: Assessment of extraction socket healing.

Radiographic evaluation: CBCT (Vatech, Korea, Scientific zone Egypt) radiograph was taken immediately after operation, and at interval three months and then six months after extraction for all patients of both groups. All the radiographic measurements were performed which included identification of landmarks, matching of radiographs and measurements as the following:

- Distance from BC to SF in the middle of the extraction site (fig. 5)
- Distance from SF to SR in the middle of the extraction site (fig. 6).

Statistical evaluation: F test (ANOVA) with repeated measures, Sig. bet. periods were done using Post Hoc Test (p: p value for comparing between the studied periods in each group, p_1: p value for comparing between Immediate and 3 months, p_2: p value for comparing between Immediate and 6 months, p_3: p value for comparing between 3 months and 6 months. *: Statistically significant at $p \leq 0.05$). U: Mann Whitney test also was applied for comparing between the studied groups (*: Statistically significant at $p \leq 0.0$)

RESULTS

When comparing the demographic data of both groups, there were statistically non-significant difference between the two groups regarding the mean of age and gender distributions. Alveolar bone resorption which represented by BC-SF (mm) was taken place in both groups and showed a significant decrease in mean BC- SF (mm) measurements from immediate post-operative to 3 and 6 months postoperative (9.36 ± 1.54, 8.62 ± 1.44, 8.42 ± 1.39) for group 1 and (8.95 ± 1.51, 7.60 ± 1.47, 7.16 ± 1.77 for group 2) respectively. When comparing the immediate, 3 months, and 6 months postextraction periods there was a statistically non-significant difference in mean BC- SF (mm) in both groups (tab.1&2).

Fig. (5): BC to SF distance measurement.

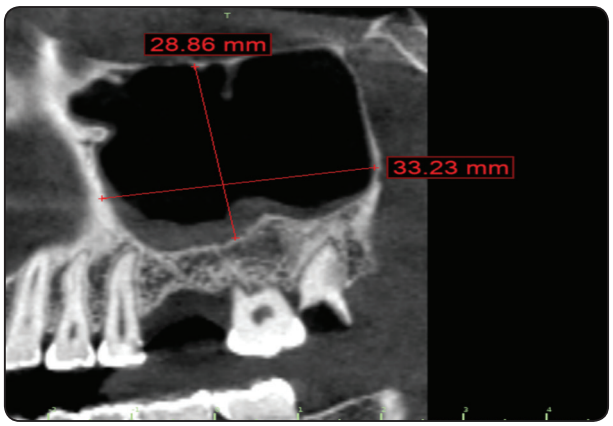

Fig. (6): SF to SR distance measurement.

Regarding the sinus pneumatization measurements which represented by SF-SR (mm): Both groups showed a statistically significant increase in mean SF-SR (mm) measurements from immediate post-operative to 3 and 6 months postoperative (28.10 ± 1.06, 28.83 ± 1.22, 28.98 ± 1.20) for group 1 and (27.90 ± 1.79, 29.41 ± 2.14, 29.92 ± 2.48) for group 2 respectively. In immediate, 3 months, and 6 months postextraction periods there was a statistically non-significant difference in mean SF-SR (mm) in the two groups. (tab.3&4).

When comparing the change of BC- SF (mm) at 3, and 6 months periods, there was a statistically significant difference in mean BC- SF (mm) in the two groups. Study group showed a less change of BC- SF (mm) than control group. Regarding change of SF-SR (mm) at 3 and 6 months: there was a statistically significant difference in mean SF-SR (mm) in the two groups. Study group showed a less change of SF-SR (mm) than control group. (tab.5).

TABLE (1): The Mean and SD of BC- SF (mm) in both groups through the study periods.

Groups	Time	BC- SF (mm)					
		Min.	Max.	Mean ± SD	Median	95% CI	
						LL	UL
Study (n = 12)	Immediate	8.0	11.30	9.36 ± 1.54	8.79	7.75	10.98
	3 months	7.10	10.30	8.62 ± 1.44	8.46	7.11	10.13
	6 months	6.90	10.0	8.42 ± 1.39	8.36	6.96	9.88
Control (n = 12)	Immediate	7.0	10.0	8.95 ± 1.51	9.86	7.36	10.54
	3 months	5.70	8.59	7.60 ± 1.47	8.50	6.05	9.14
	6 months	4.90	8.59	7.16 ± 1.77	8.0	5.30	9.02

TABLE (2): Comparison between BC- SF (mm) in both groups through the study periods.

	BC- SF (mm)			F	P
	Immediate	3 months	6 months		
Study	9.36 ± 1.54	8.62 ± 1.44	8.42 ± 1.39	31.924*	0.002*
Sig. bet. grps.	p_1=0.007*, p_2=0.007*, p_3=0.008*				
Control	8.95 ± 1.51	7.60 ± 1.47	7.16 ± 1.77	102.125*	<0.001*
Sig. bet. grps.	p_1<0.001*, p_2<0.001*, p_3=0.097				

TABLE (3): The Mean and SD of SF -SR (mm) in both groups through the study periods.

Groups	Time	SF-SR (mm)					
		Min.	Max.	Mean ± SD	Median	95% CI	
						LL	UL
Study (n = 12)	Immediate	27.90	30.20	28.10 ± 1.06	28.59	27.79	30.00
	3 months	28.89	31.40	28.83 ± 1.22	28.20	28.55	31.11
	6 months	28.94	31.50	28.98 ± 1.20	28.50	28.72	31.24
Control (n = 12)	Immediate	24.81	28.80	27.90 ± 1.79	27.10	25.02	28.78
	3 months	26.12	30.90	29.41 ± 2.14	29.20	26.16	30.66
	6 months	26.16	31.70	29.92 ± 2.48	29.90	26.32	31.52

TABLE (4): Comparison between SF- SR (mm) in both groups through the study periods.

	SF-SR (mm)			F	p
	Immediate	**3 months**	**6 months**		
Study	28.10 ± 1.06	28.83 ± 1.22	28.98 ± 1.20	20.765*	0.006*
Sig. bet. groups.	p_1=0.017*, p_2=0.018*, p_3=0.080				
Control	27.90 ± 1.79	29.41 ± 2.14	29.92 ± 2.48	45.581*	<0.001*
Sig. bet. groups.	p_1=0.002*, p_2=0.003*, p_3=0.057				

TABLE (5): Comparison between the two studied groups according to change of BC- SF and SF-SR.

Change from Immediate to	Study (n = 12)	Control (n = 12)	U	p
BC- SF (mm)				
3 months	0.74 ± 0.32	1.36 ± 0.11	0.000*	0.002*
6 months	0.94 ± 0.41	1.79 ± 0.41	4.000*	0.026*
SF- SR (mm)				
3 months	0.73 ± 0.49	1.50 ± 0.47	2.000*	0.009*
6 months	0.88 ± 0.58	2.02 ± 0.71	4.000*	0.026*

DISCUSSION

After dental extraction, the alveolar bone undergoes a remodeling process resulting in horizontal and vertical reduction of crestal dimensions [13]. Posterior maxillary ridge resorption and maxillary sinus pneumatization after molars extraction may lead to inadequate bone volume for dental implants insertion and create both functional and esthetic problems during prosthetic rehabilitation[1,14]. In this study alveolar bone resorption and maxillary sinus pneumatization has been recorded for both the study and control groups through 6 months study period.

Many surgical solutions are currently in use to regenerate an adequate amount of bone in the atrophied posterior maxilla, including lateral and trans-crestal sinus floor elevation, guided bone regeneration, and block grafting [15-17]. However, all of these options are associated with significant rate of complications, increased morbidity, high costs, and prolonged time of therapy [18]. In the attempt to reduce the need for advanced surgical procedures and to simplify the treatment plan, Alveolar ridge preservation were developed to reduce post extraction ridge resorption and decrees sinus pneumatization in posterior maxilla. with the application of different biomaterials, is the most common procedure aiming to control crestal bone resorption following dental extractions [5-10]. In this study the Bio-Oss® bovine bone graft was applied into the extraction socket and covered by platelet-rich fibrin for ridge preservation and it has been noticed that it is easy, economic technique without any major complications or morbidities.

The results of this study suggest that ridge preservation by using of Bio-Oss® bovine bone graft was applied into the extraction socket and covered by platelet-rich fibrin after extraction of maxillary posterior teeth may reduce the alveolar bone resorption and pneumatization normally seen in the maxillary sinuses after those teeth extraction. From the histologic point of view this due to new bone formation which was encouraged by distinct grafts as a result of osteoconduction at the apical and the middle part of the socket, while the coronal part and the central portion of the socket was discovered to be primarily occupied by particles of graft surrounded by dense connective tissue, also after many months after Surgery for alveolar ridge preservation. Finally, the larger percentage of the newly produced bone was discovered at the coronal region was of the woven-type, while lamellar-type bone has been found predominantly in apical and middle area.[19]. Regarding change of BC- SF (mm) at 3 and 6 months in this study: Sinuses associated with sockets that received graft material after extraction showed a less change of BC- SF (mm) than control group. Regarding change of SF-SR (mm) at 3 and 6 months: Sinuses associated with sockets that received graft material after extraction showed a less change of SF-SR (mm) than control group. This in agree with previous studies by Cha et al and Park et al [11,20]. Data presented in this study appear to support the notion that significant post extraction alveolar bone resorption and sinus pneumatization might be reduced via ridge preservation.

CONCLUSION

Based on the result of this study it was concluded that posterior maxillary teeth may lead to alveolar crestal bone loss and sinus pneumatization, using of bovine bone graft (Bio-Oss®) and platelet-rich fibrin membrane for ridge preservation after extraction of posterior maxillary teeth seemed to reduce the sequalae of sinus pneumatization along with minimizing alveolar crest bone resorption.

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