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EFFECT OF XENOGRAFT ALONE VERSUS XENOGRAFT MIXED WITH VITAMIN-D ON PRESERVATION OF ALVEOLAR SOCKETS OF CHRONICALLY INFECTED TEETH

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ABSTRACT

Objective: The present study was performed to evaluate clinically and radiographically the effect of xenograft alone versus xenograft mixed with vitamin D3 in alveolar socket preservation after tooth extraction. **Subjects and method**: Thirty patients with teeth indicated for extraction were assigned randomly in three groups: Group I: the patients received xenograft as a grafting material for the extraction socket. Group II: the patients received xenograft with vitamin D3 gel and in Group III: the socket left without any a grafting material. All patients were evaluated clinically and radiographically for dimensional changes of extraction sockets at; base line and after 6 months. Results of the present study were recorded, tabulated and statistically analyzed. **Results:** Group II showed least dimensional changes followed by Group I without statistical significance, while Group III exhibited significant reduction in sockets' dimensions. **Conclusions:** Vitamin D3 gel mixed with xenograft may have a positive effect, comparable clinically and radiographically to xenograft alone, in minimizing bone loss and socket preservation after tooth extraction.

KEYWORDS: Socket preservation, xenograft, vitamin D3

INTRODUCTION

Alveolar socket preservation therapies aim to maintaining the hard and soft tissue dimensions of the alveolar ridge that are partially lost after tooth extraction as part of the natural physiological healing process. The reduction of alveolar bone volume following tooth extraction may interfere with placement of implants and affect the treatment and success of fixed or removable prosthesis with regard to function and esthetics. Alveolar socket preservation via socket filling with a bone graft can be an effective therapy to prevent physiologic bone loss after extraction of teeth in both the horizontal and the vertical dimension[1-3].

The different alveolar ridge preservation techniques do not totally eliminate post extraction resorption. However the reduction in ridge width and height following alveolar ridge preservation may be less than that which occurs following natural socket healing [4,5]. Several method have already been used for alveolar ridge preservation in preclinical and clinical studies, such as socket grafting with

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autogenous bone, demineralized freeze-dried bone allograft (DFDBA)[6,7]. Xenografts, growth factor, alloplast with bone morphogenic proteins (BMP) [8], and also with barrier membrane alone or with bone graft [9].

Xenografts are the most commonly used in regenerative therapy for alveolar ridge preservation as they contain similar hydroxyapatite content to that of natural bone which allows the graft to revascularize and be replaced by new bone [10,11]. Using barrier membrane to cover the graft has been demonstrated to prevent invagination of the aggressive oral epithelium into the healing socket. This enhances the repopulation of bone cells and concentrate growth factorsleading to more bone fill[12,13].

The application of biological mediators embedded in the biomaterial can induce specific cell and tissue response, which can improve bone quality and quantity. Dental research has focused on improving bone substitutes by morphologic or biochemical modification [14, 15].

One of the biological mediators used around implants to improve osseintegration is vitamin D3[16,17]. The major physiological role of vitamin D3is to facilitate the intestinal absorption of calcium, by stimulating the expression of proteins involved in calcium transport. Vitamin D3 also plays a crucial role in providing the proper balance of minerals necessary for bone growth and function. It acts on mineral regulating target tissues such as intestine, Kidney, parathyroid glands and bone to participate in maintaining calcium and mineral homeostasis [18, 19].

Various studies confirmed the positive effect of systemic administration of vitamin D3 on total bone mineral density[16,20], moreover, vitamin D3 acts directly on the osteoblast to alter the transcription of osteoblast-associated genes including osteocalcin[21,22] osteopontin and alkaline phosphatase[23]. In addition, vitamin D3act on reducing osteoclastic function by suppressing the expressing of receptor activator of nuclear factor kappa B ligand(RANKL) in osteoblast-lineage cells[24].It was shown that locally applied vitamin D3 in combination with bovine bone mineral matrix improved the bone formation and strengthened the site of the fracture in ovariectomized rats[25].Local application of vitamin D3also proved to be promising in promoting osteogenesis and mineralization for restoration of mandibular bone defects[26]. Grounding on this incites, it has been suggested that vitamin D3 might exert a positive local effect on alveolar bone regeneration. This study was out to explore effect of locally delivered vitamin D3 in alveolar ridge preservation after extraction of chronically infected teeth.

SUBJECTS AND METHOD

This randomized, controlled clinical trial was carried out on 30 patients of both sexes (11 males and 19 females), (ranged in age from 18-40 years) with un-restorable maxillary anterior teeth or premolars. All patients were selected from outpatient clinic of Oral Medicine and Periodontology Department clinic, Faculty of Dentistry, Al-Azhar University. This study was approved by the ethical committee, Faculty of Dentistry, Al-Azhar University, Cairoboys (Code: 741/4000). All patients participating in this study were fully informed of the study protocol and the associated risks of the work procedures; they signed a written consent form.

Inclusion criteria: Adult, systemically healthy patients with hopeless infected teeth and non-restorable remaining structure or root.

Exclusion criteria: Systemic or local disease/ condition that would compromise post-operative healing (e.g. Diabetics, patients who in need for systemic corticosteroids).

Patients grouping: Patients were randomly assigned in three equal groups by choosing numbers concealed in closed envelops.

Group I: Contained 10 patients received xenograft and covered with collagen membrane as a grafting material for the extraction socket.

Group II: Contained 10 patients received xenograft mixed with vitamin D3 gel(mixing ratio3:1 by volume) and covered with collagen membrane as a grafting material for the extraction socket.

Group III: Contained 10 patients without any grafting materials for the extraction sockets.

Patient preparation: All patients were submitted to full mouth supragingival and subgingival scaling and root planning (SRP) procedures prior to extraction.

Vitamin D3 gel preparation:

Accurately weighted carboxy methyl cellulose (3g) ($C_8H_{15}NaO_8$) (Alamia company for chemicals 10th Of Ramadan, El Sharkeya, Egypt) was added to required amount of biocompatible solvent (water 10g), to prepare carboxy cellulose in situ gel. The mix was heated at 50-60 C and shaken well with a mechanical shake to obtain a clear solution. Weighted amount of aqueous solution of vitamin D3 (Vidrop (cholecalciferol 2800I.U/ml) "MUP"(80 IU) was added to the previous solution and dissolved completely to obtain a homogenous gel of vitamin D (25ml). This gel was loaded in sterile plastic syringes and store in dry cool environment until the time use [26].

Surgical procedures & application of graft materials: After local anesthesia, intra-sulcular incisions were performed to the adjacent interdental papillae and marginal gingiva of the tooth to be extracted. Reflection of the flap was done to expose the crestal bone for direct visualization and measurement of the crestal bone level. A forceps of anatomic design and periotome was used to retrieve the tooth from the alveolus. Curettage of the socket was followed by irrigation with 0.9 saline concentration. Then the socket was filled with graft materials according to group types. Only xenograft in group I, xenograft mixed with Vitamin D gel in group II, and group III the socket was closed without any materials. Interrupted sutures were done to achieve primary closure of the surgical wound. All the patients were instructed to refrain from interfering with the wound or sutures, or using tooth brushing in the operated area.Medications(Augmentin1gm tablet (875mg Amoxicillin and potassium clavulanate equivalent to 125mg of clavulanic acid) was prescribed twice daily for 5days(GlaxoSmithKline, Fifth distract, New Cairo, Cairo Egypt).Cataflam 50mg tablet was prescribed twice daily for 5 days to minimize the postoperative pain(Novartis Pharma, Heliopolis, Cairo, Egypt).A 0.2% chlorhexidine digluconate Hexitol mouthwash (The Arabic Drug Company ADCO, Cairo, Egypt) twice daily for the first two postoperative weeks was also recommended.

Clinical and radiographic measurements:

Clinical measurements: were recorded at the baseline (after extraction and before placement of graft material) and after 6 months, (Fig 1).

Clinical measurements: Clear stent was used to standardize the measurement of clinical parameters. It was fabricated on the cast models of the dentition prepared during the treatment planning appointment using vacuum clear resin. It was prepared up to 1/2 of the crown covering the teeth adjacent to the surgical site. On the cast model, two perpendicular lines were drawn through the center of the alveoli, one in the mesiodistal direction and the other in the buccolingual direction. The point of intersection of buccolingual line on mesiodistal line was recorded for reproducibility. A corresponding hole to the central part of the alveoli and 2 grooves on the mid-buccal and mid-palatal were made in the prepared clear stent, corresponding to the respective cortical plates.

Mid-buccal crestal height was measured as the distance in millimeters from a fixed reference point (FRP) on the stent to the most coronal mid-buccal

crestal point on the buccal cortical plate using graduated periodontal probe. Relative socket depth was measured as the distance in millimeters from the central hole on the acrylic stent to the most apical end of the socket/ridge, using spreader (no.40) with a stopper. Bucco-palatal width was measured corresponding with the line 4 mm apical to the most coronal point on the socket/residual ridge using ridge mapping caliper.

Local infiltration anesthesia was used during recording the clinical measurements at 6 months follow-up.

Radiographic measurements: were recorded at the baseline (48 hours before extraction) and after 6 months (Fig 2)**:**

- **Ridge height evaluation:** Mesial bone peak height (MBPH) and Distal bone peak height (DBPH) which are involved essentially in evaluation of socket dimension changes were measured. Line drawn between apices of adjacent teeth as a reference line to achieve the anatomical registration, so it could be reproduced in all images another three line from the reference line to the following points; (a) Highest point mesially represents (MBPH).(b) Highest point distally represents (DBPH).(c) Mid-way point mesio-distally on buccal crest, which represents mid-facial height.
- **Ridge width evaluation:** It was measured by bucco-palatal distance 4 mm below the cemento-enamel junction of adjacent teeth.

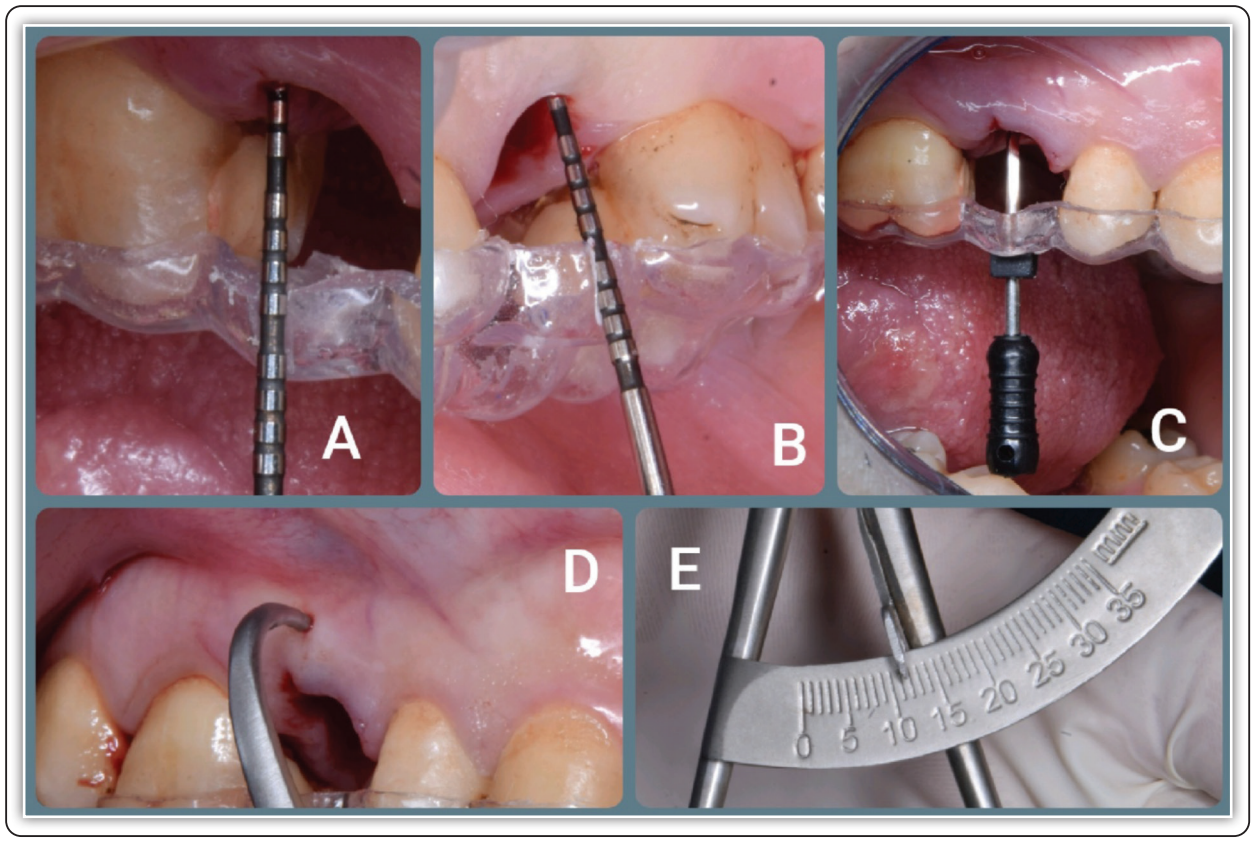

FIG (1) Clinical measurements of socket height and relative socket depth

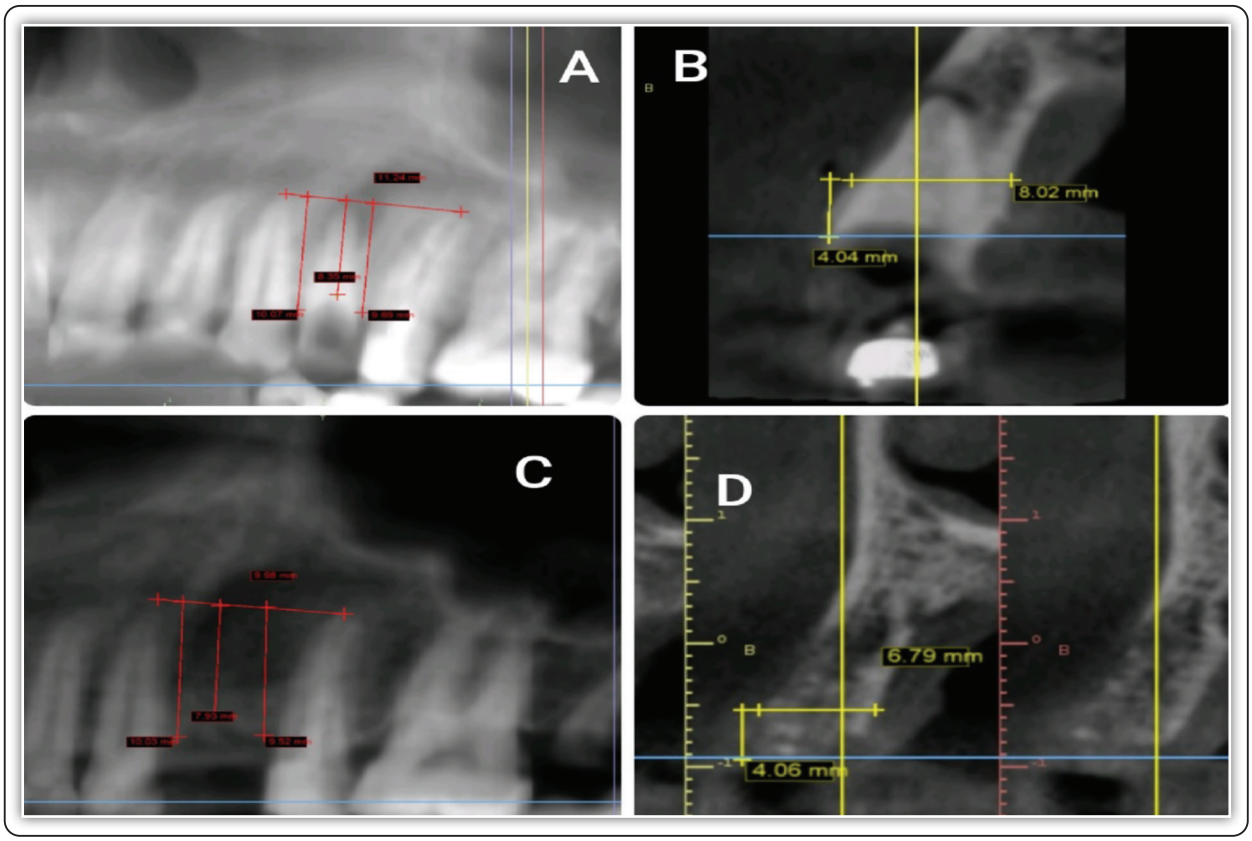

FIG (2) Radiographic measurements of height and width.

RESULTS

I. Clinical findings (Table 1):

Change in bone height in the three groups.

In mid-buccal height there was no statistically significant difference between groups I (1.45±0.42) and II (1.5±0.14); both showed statistically significantly lower mean decrease in bone height than group III (2.35±0.1).The decrease in mid-palatal height was generally less than decrease in mid-buccal crestal height in all groups (0.85±0.32), (0.7±0.2) and (1.85±0.13) for group I, II and III respectively).

Percentage decrease in bucco-palatal diameter in the three groups

There was no statistically significant difference between groups I (21.9±5.9) and II (20.8±7) while, both showed statistically significantly lower mean percentage decrease in bucco-palatal diameter than group III (30.9±4).

Percentage decrease in relative socket depth in the three groups

There was no statistically significant difference between groups I (45.6±7.9) and group II (46.6±9.1),but both showed statistically significantly higher mean percentage decrease in relative socket depth than group III (38±4.9).

TABLE 1: The percentage decrease in relative socket depth, mid-buccal height and mid-palatal height

	Group I		Group II		Group III		*P*-value	*Effect size (Eta Squared)*
	Mean	SD	Mean	SD	Mean	SD		
Mid-Buccal height	1.45	0.42	1.5	0.14	2.35	0.1	0.014*	0.242
Mid-palatal height	0.85	0.32	0.7	0.2	1.85	0.13	0.003*	0.368
Relative socket depth	45.6 ^{A}	7.9	46.6 ^{A}	9.1	38 ^{B}	4.9	0.033*	0.224
Diameter	21.9 ^{A}	5.9	20.8 ^{A}	7	30.9 ^{B}	4	0.001*	0.404

II. Radiographic findings (Table 2)

-Percentage decrease in (MBPH), (DBPH) and mid-facial height

There was no statistically significant difference between groups I (14.5±5) and II (12.9±6); both showed statistically significantly lower mean percentage decrease in bone height than group III (22.5±7.1).

-Percentage decrease in diameter

There was no statistically significant difference between groups I (20.9±12.1) and II (20.1±8.3); both showed statistically significantly lower mean percentage decrease in diameter than group III (29.6±5.7).

TABLE 2: The percentage decrease MBPH, DBPH, mid-facial height and diameter.

	Group I		**Group II**		**Group III**		**P-value**	**Effect size (Eta Squared)**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**		
Mesial bone peak	13.7 ^{B}	8.1	11.9 ^{B}	4.7	24.1 ^{A}	5.9	0.001*	0.460
Distal bone peak	13.8 ^{B}	7.6	12.6 ^{B}	5.2	23.5 ^{A}	5.9	0.003*	0.357
Mid-facial height	14.5 ^{B}	5	12.9 ^{B}	6	22.5 ^{A}	7.1	0.024*	0.201
Diameter	20.9 ^{B}	12.1	20.1 ^{B}	8.3	29.6 ^{A}	5.7	0.029*	0.187

DISCUSSION

The alveolar ridge bone resorption and soft tissue shrinkage always occur after tooth extraction, which compromise the alveolar ridge esthetics and function. It has been reported that, 6 months after tooth extraction, the loss of alveolar bone is approximately 29% to 63% of width loss and 11% to 22% of height loss. In addition, the bone resorption rate is rapid in the first 3 months, and in the subsequent days, it slows down [27].

In the present study, the clinical measurements of ridge width and height were also accompanied with radiographic evaluation by cone beam computed tomography, as it is considered a reliable tool for providing three-dimensional information about bone volume at an acceptable radiation dose risk [28].

Generally, in the current study, group I and II showed statistical significant difference in all evaluated parameters compared to group III without striking or significant differences between them. The horizontal measurements (width) for alveolar ridge by bone caliper in the three groups in the present study revealed reduction from base line. By comparing the percent change in ridge width between three groups. These changes may be limited but not avoided when grafting the socket is used. However, group III showed a higher and statistically significant mean value of percentage reduction compared the other two groups of socket preservation. The greater mean percent decrease was noted in group I (21.9%) more than group II (20.8%), and the least in group III (30.9%). These results were the highest in the study compared to reduction percentage of the other evaluated parameters. This is in agreement with the other studies that reported post extraction healing is always characterized by osseous reabsorption especially in the horizontal plane of residual alveolar ridge [10,16,29].

Slightly better and statistically insignificant values for most of the evaluated parameters in the present study were in favor of group II. This may be attributed to the local effect of vitamin D3, which is in accordance with some previous studies in this regard, Liu et al [26] showed that local application of vitamin D3 with bone graft caused increase in new bone formation and promoted bone maturation for restoration of mandibular bone defects. Also**,** Satué et al [30] showed that topical application of vitamin D3improved bone formation around implant immediately after extraction. In addition Rajkovie et al [31] showed that locally applied vitamin D3 in combination with bovine bone mineral matrix promoted the formation of normal bone tissue and generation of higher amount of better calcified new bone.

Regarding vertical measures (height) for alveolar ridge by customized vacuum stent. In group II; a higher mean value was recorded at 6 months. The value of difference between baseline and 6 months was (1.45mm). In group I a higher mean value was recorded at 6 months. The value of difference between baseline and 6 months was (1.5mm). In control group, a higher mean value was recorded at 6 months. The value of difference between baseline and 6 months was (2.35mm). And thus in agreement with other reviews that showed that a certain degree of ridge height loss should be expected even if alveolar ridge preservation is applied the mean difference in control group was (2.26) and in experimental group was (0.73mm). So alveolar ridge preservation may significantly prevent post extraction alveolar bone remodeling, but this effect is variable, likely due to the influence if local and systemic factors [2].

It was apparently noted that vitamin D3 added to xenograft did not lead to a significant clinical or radiographic benefits in socket preservation compared to xenograft alone. However, it should be taken into consideration that group II consumed less xenograft volume compared to group I. The graft in group II was a homogenous mix of xenograft and vitamin D3, which might reduce the volume of used graft by a ratio of almost one third, occupied

by the gel. This might suggest a positive effect of vitamin D3 in socket preservation. Another issue is the bone quality that needs further accurate assessment using CT Hounsfield units to reveal the difference in mineral bone density. However, the absence of statistical significance between group I and group II might also be accounted for an inadequately effective concentration of vitamin D3 in different sockets. Moreover, age, body weight, sex, environmental factors, or genetic variations of vitamin D3 receptors also could influence the effect of vitamin D3[16].

CONCLUSION

Within limits of our study, vitamin D3 gel mixed with xenograft may have positive effect, comparable clinically and radiographically to xenograft alone, in minimizing bone loss and socket preservation after extraction.

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