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Assessment Of Anterior Alveolar Bone Graft healing With And Without Coverage, With Collagen Membrane

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Cover Page Footnote

First and foremost, I would like to thank God for giving me the strength, knowledge, ability and opportunity to undertake this research study and to persevere and complete it satisfactorily. Without his blessings, this achievement would not have been possible. First , my heartiest gratitude to my supervisor, Dr. Ragia Mounir Professor of Oral & Maxillofacial Surgery, Faculty of oral and dental medicine / Cairo University, it was a real privilege and honor for me to be under your supervision, I would like to thank you for giving wonderful suggestions and constructive criticism which gave this study a life. In my journey towards this degree, I have found a professor, an inspiration, a role model and a pillar of support in my Guide, Dr. Ahmed Barakat Professor of Oral & Maxillofacial Surgery, Faculty of oral and dental medicine / Cairo University, Head of Oral & Maxillofacial Surgery Department, Faculty of oral and dental medicine / Future University in Egypt, Manager of Future university dental hospital He has been there providing his heartfelt support and guidance at all times and has given me invaluable guidance, inspiration and suggestions in my quest for knowledge. Without his valuable guidance, this thesis would not have been possible and I shall eternally be grateful to him for his assistance. I extend my gratitude to Dr. Mohamed Farid Associate Professor of Oral & Maxillofacial Surgery Department Faculty of oral and dental medicine / Cairo University For his valuable help, motivation, advice, and support in completing this thesis. I express my humble gratitude to my supervisors for their willingness to spare me their time and guide me to complete my study. This work would not have been possible without the generous support offered to me by Future University in Egypt. Also I am thankful to all my Professors & colleagues from the Department of Oral & Maxillofacial Surgery Department, Faculty of oral and dental medicine / Future University in Egypt for their support and motivation. My acknowledgement would be incomplete without thanking the biggest source of my strength, my family. I thank all who in one way or another contributed in the completion of this thesis. I would like to dedicate my thesis to my beloved son Andrew Hany Abd ElMessih

Anterior alveolar bone graft healing with and without collagen membrane coverage

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Abstract

Objective: This study was designed to evaluate the retromolar as a new donor site and its ability to augment the alveolar ridge horizontal and/or vertical defects prior to implant placement.

Method: Twelve patients were selected for future implant placement after anterior maxillary ridge augmentation.

CBCTs were performed preoperative, immediate postoperative and 6 months postoperative. After induction of general anesthesia, an envelope full mucoperiosteal flap was raised to expose the maxillary alveolar ridge defect. A donor site full thickness flap was elevated to expose the lateral body of the ramus, the graft was fixed in all the twelve patients but in six of them a collagen membranehas been used to cover the graft area.

Statistical analysis: which showed no statistically significant difference regarding the bone width gain between the two groups in all the intervals till the end of the study.

Conclusion: The cortico-cancellous blocks obtained from the retromolar region represented successfully a new donor site for bone harvesting, offering quantity of bone that could be adequate to reconstruct localized alveolar defects ranging from one to four teeth in both horizontal and/or vertical manner., with possibility for bilateral bone harvesting sites.

Clinical Relevance: This study highlights how this technique is easy to perform, provide low donor site morbidity as the donor and host sites are in a single surgical field as well as the effectiveness of retromolar region in providing adequate bone quality bone showing active signs of remodeling and viability on the histological level.

Keywords: Alveolar ridge, Bone grafting, Collagen membrane, Maxilla

1. Introduction

Achieving optimal aesthetics, function and phonetics with implant-supported restorations depends largely on the amount of bone present at the site where the implant has to be placed. Sometimes, patient reports with compromised conditions which makes the implant placement difficult [(1)]. The placement of dental implantsin anterior maxilla is a challenge for clinicians because of patients' exacting esthetic demandsand difficult pre-existing anatomy [(2)] as maxillary anterior sites have potential issues related to the "triangle of bone" that are not encountered in molar sites and demand different approaches to ensure treatment success [(3)].

Experienced clinicians were able to recognize the implant restoration in the majority of patients and were most critical of the soft tissue form rather than the crown, the compromised site can be deficient in soft tissue and bone in horizontal or horizontal with labial undercut[(4)] so different bone grafting procedures to maxilla have been introduced [(5)], due to its osteoinductive, osteoconductive and osteogenic properties autogenous bone is still considered the golden standard as graft material [(6)],

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while the use of bone substitution is increasingly utilized combined in many cases with the application of barrier membrane, a process that proved to guide bone tissue formation and maturation. These techniques utilize the principle of using a barrier membrane to maintain the space under- neath and to prevent soft tissue in-growth that inhibits bone regeneration [7].

For the reconstruction of defects in the anterior maxilla, using autogenous bone grafts, intraoral donor sites offer several benefits; obvious advantage of local grafts is their convenient surgical access, the close proximity to recipient sites. In addition, patients report minimal discomfort and these areas may offer decreased morbidity from graft harvest, [8,9,10,11].

The ramus area has some advantages over mandibular symphysis as a donor site these include minimal patient concern for altered facial contour, lower incidence of incision dehiscence and has better outcomes related to neurosensory disturbance [12], however surgical access in some patients is more difficult, and there are limitations to the size and shape of the graft.

2. Aim of the Study

The aim of the current study was to evaluate autogenous alveolar bone grafts clinical healing, graft volume loss and regenerated bone quality when covered with collagen membrane.

Comparing those results to autogenous alveolar bone grafts without membrane coverage.

3. Patients and Methods

After taking approval of the ethical committee, twelve patients (6 females and 6 males) were selected randomly from the outpatient clinic at the Faculty of Oral and Dental Medicine /Cairo University and Faculty of Oral and Dental Medicine/Future University. Those patients were seeking at the first place to restore esthetics by usingdental implants and prosthetic rehabilitation of their partially edentulous maxillary anterior region where their maxillary anterior teeth were missing. All patients signed an informed consent describing the planned procedures after being described to them in details.

This study was designed to evaluate the suitability of the retromolar area as a donor site regarding the ability to augment the anterior maxillary ridge horizontally combined defect prior to implant placement.

For the twelve selected patients for this study; one or more implants will be placed replacing the missing anterior teeth. An initial evaluation was performed clinically using study models with wax up and radiographically on CBCT.

The surgical procedures were performed under general anesthesia with injection of local anesthesia with vasoconstrictor in the predetermined surgical incision sites. Pyramidal flap was raised in the anteriormaxillary deficient area (fig.1), then a donor site full thickness flap was elevated to expose the lateral body of the angle-ramus area. Two vertical cortical bone cuts were made and were connectedwith crestal bone cuts using reciprocating micro saw. Apical connecting cut was performed using surgical bone disk. The graft was then mobilized using spatula chisels(fig.2). The harvested cortical bone block was then sectioned into outer and inner cortices using the disk(fig.3). The graft wasthen adapted to the deficient site and was fixed using titanium microscrews (fig.4). The remaining pieces of the graft was particulates using bonemill and applied to bony grooves and pits to re- duce the risk of granulation tissue formation be- tween the recipient bed and the graft. The graft was fixed in all the twelve patients but in six of them a collagen membrane has been used to cover the graft area(fig.5,6).

Every patient was followed up clinically at 1- week postoperative, twice in the first month, and monthly in subsequent months before implant placement.

A subjective evaluation of neurosensory function was carried out at each clinical check-up by asking the patient if he /she detected any hypoesthesia, numbness or tingling in the lower lip or check region as well as checking anterior ridge area and surrounding soft tissue.

An immediate postoperative CBCT was performed to assess the dimensions of the new graft in place, and a follow-up CBCT was performed after 6 months, preoperative and postoperative CBCT were volumetrically analyzed to determine the volume of the graft immediately after grafting and after 6 months of healing.

After 6 months a re-entry surgery was done and fixation screws, were removed, a bone core biopsy was taken using a 2mm trephine drill, the bone core biopsy was then histologically evaluated. The sections were deparaffinized, hydrated, and stained with Hematoxylin and Eosin for descriptive histological evaluation, under a light microscope (fig.7). Implants (Zimmer Dental Screw–Vent Implant System) of proper diameter were placed as previously determined by the postoperative CBCT and inserted. After 6 months of implant insertion the covering screw was replacedby healing collar for 2 weeks then the final pros- thetic appliance was designed and delivered to thepatient (fig.8).

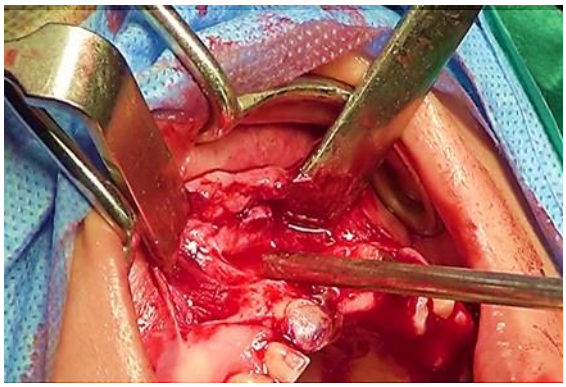


Figure 1: **Semi vertical releasing incisions& raising a full mucoperiosteal flap at recipient site**

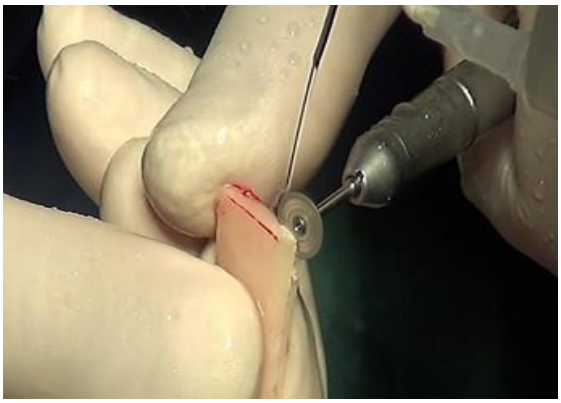
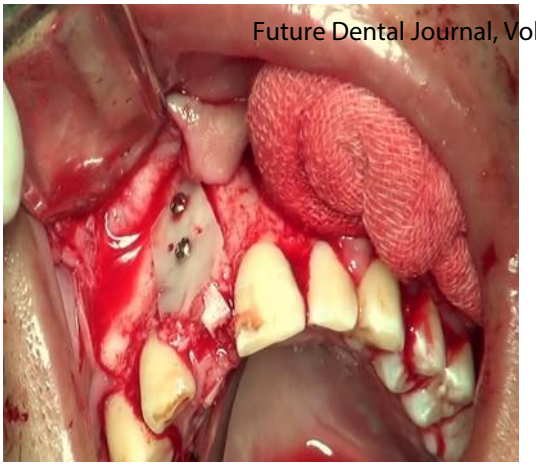


Figure 2: **The anterior cut is made in the mandibular body, inferiorly distally to first molar region, theposterior superior cut is made on lateral aspect of the ramus, perpendicular to the external oblique osteotomy, a four-armed window in bone cortex was created under copious irrigation.**

Figure 3: **Division of the graft using micro disc under copious irrigation was done to increase graftsurface area**



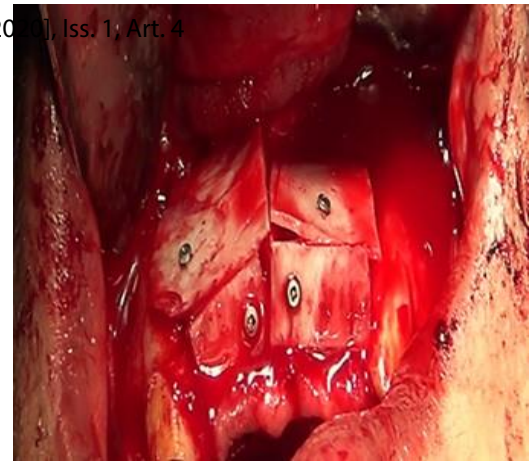


Figure 4 and Figure 5
Graft was adapted to the deficient site and fixed using Stryker titanium microscrews of diameter 1.2 mm

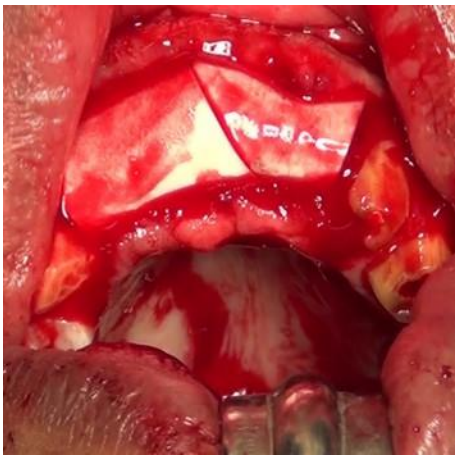


Figure 6: **Graft covered with collagen membrane**

Figure 7: **Showing healing collars used for 2 weeks**

Figure 8: **Final Restoration**

Points of radiographic measurements

A tangent was drawn on the palatal bone cortex from which a perpendicular line was drawn reaching the augmented buccal cortex, the length of the perpendicular line was taken cervically, middle and apically (fig.9,10).

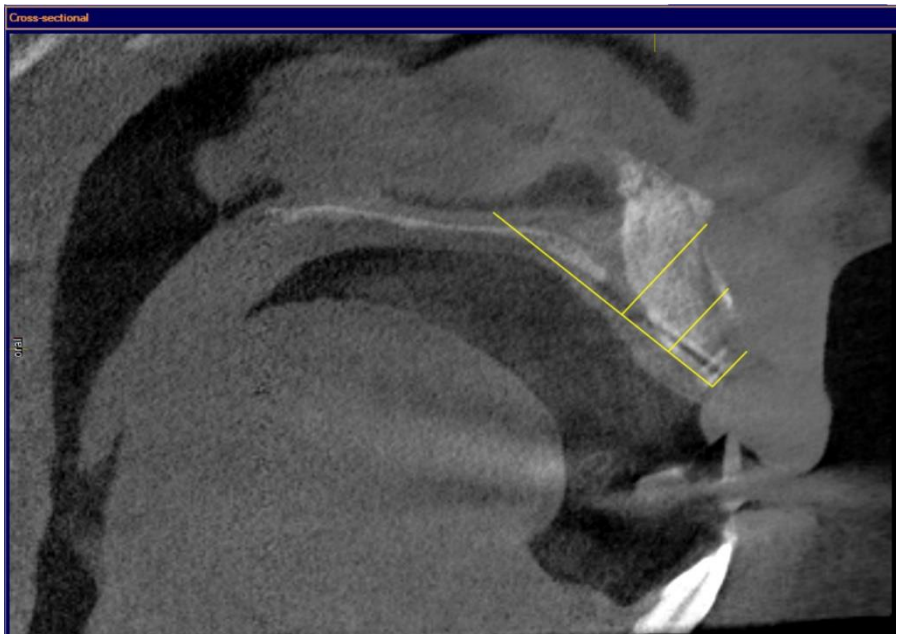


Figure 9 and Figure 10 showing measurements taken pre and postoperative

4. Results

The age of the studied candidates ranged from 22 years to 47 years with a mean of 30.75 years. The patient gender was 6 females and 6 males with equal sex distribution.

The defect ranged from horizontal bone width deficiency with or without labial bone undercuts, as shown in table (1)

Patient Number	Gender	Age	Type of Defect	No. of Missing Teeth	Donor Site Harvesting
1	F	26	- Horizontal - Labial Undercut	1	Unilateral
2	M	40	- Horizontal	2	Unilateral
3	F	29	- Horizontal - Labial Undercut	1	Unilateral
4	F	27	- Horizontal	1	Unilateral
5	M	22	- Horizontal - Labial Undercut	1	Unilateral
6	M	24	- Horizontal - Labial Undercut	2	Unilateral
7	M	34	- Horizontal - Labial Undercut	1	Unilateral
8	F	30	- Horizontal	1	Unilateral
9	F	47	- Horizontal	2	Unilateral
10	M	22	- Horizontal	1	Unilateral
11	F	37	- Horizontal - Labial Undercut	1	Unilateral
12	M	35	- Horizontal - Labial Undercut	2	Unilateral

Table 1: **Showing demographic characters of the studied candidates**

Case ID	Cervical 0	Middle 0	Apical 0	Cervical 1	Middle 1	Apical 1	Cervical 2	Middle 2	Apical 2	Gender	Age
1	3.9	4.6	4.4	6.2	8.6	9.08	5	7.2	8.3	Female	26
2	1.4	4	6.2	1.6	3.7	7.44	1.5	4.8	6.6	Male	40
3	1	2.2	2.7	5.6	5.4	7.85	3.1	6.8	8	Female	29
4	1.8	4	6	3.9	7	7.5	2.9	7	8.1	Female	27
5	3.6	3.5	4.9	6.3	7.7	9.7	4.5	7.2	9	Male	22
6	6.4	7	7.5	8.2	9.8	8.1	8.1	9.5	7.5	Male	24
7	2.7	4.9	7.6	9.6	11.9	13.4	8.4	11.4	13.5	Male	34
8	3.3	5.5	7.8	7.6	10.7	13.2	7.4	10.5	13.2	Female	30
9	2	4.5	6.3	7	8.3	9.5	0	5.3	9.1	Female	47
10	3.3	5.5	7.5	6.5	8.7	9	6.4	8.4	9.2	Male	22
11	3.4	5.4	7.4	5	9.4	10.74	6	8.5	10.5	Female	37
12	1.5	4.1	5.9	3.5	6.3	8.1	6.5	8.8	10.2	Male	35

Table 2: **the different bone width measurements were obtained and tabulated. Where "0" represents the preoperative, "1" represents the immediate postoperative and "2" represents the 6 months' postoperative intervals respectively.**
0 = Preoperative CBCT, 1 = 1-week Postoperative CBCT, 2 = 6 months Postoperative

Histological assessment:

After 6 months of postoperative healing, the histological examination of the bone specimen taken from the grafted anterior maxilla showed that the incorporation of the autogenous mandibular bone block into the receptor bed was well established through mature architecture of organized bone bridges showing well-organized lamellar bone structure with clearly identified Haversian systems consisting of Haversian canals surrounded with concentric lamellae, specimens showed characteristic features of highly remodeled bone showing multiple resting and reversal lines rich in concentric lamellae and osteons, resting lines demarcate bone deposition while the reversal lines indicate bone resorption by osteoclasts, it also showed wide thin walled capillaries indicating the ongoing of the bone regeneration process and the viability of the bone graft after its incorporation. There was no histological difference detected between both groups,

fig 11,12,13,14

Figure 11: Photomicrograph of non-membranous group showed lamellar bone **with acellular osteocyte lacuna. (H& E x400)**

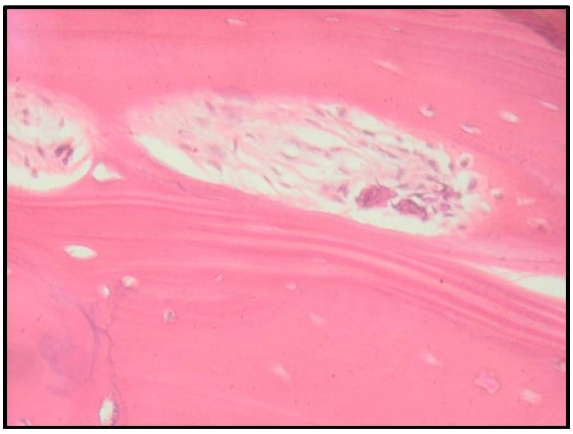


Figure 12: a photomicrograph of non-membranous group showed **highly vascularized bone marrow with numerous active osteoblasts. (H& E x400)**

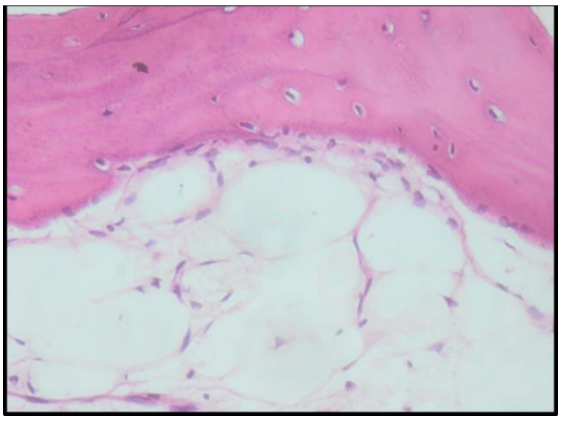


Figure 13: a photomicrograph of membrane group showed **bone marrow rich in osteoblasts on bone trabecular (H& E x400)**

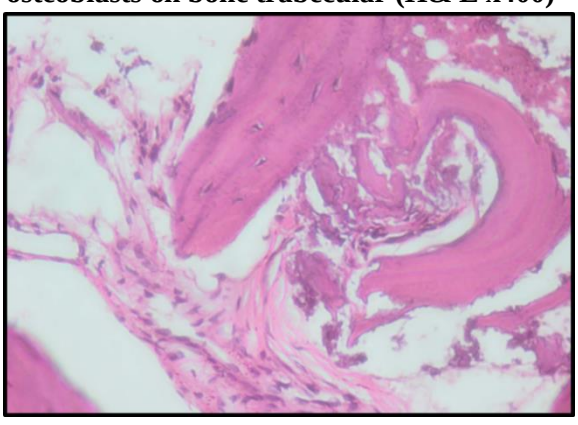


Figure 14: a photomicrograph of membrane group showed **lamellar bone with cellular osteocyte lacuna and fibrovascular connective tissue. (H&E x400).**

5. Statistical analysis

All Data were collected, tabulated and subjected to statistical analysis. Statistical analysis is performed by SPSS in general (version 17), also Microsoft office Excel is used for data handling and graphical presentation.

Quantitative variables are described by the Mean, Standard Deviation (SD), Standard Error (SE), the Range (Maximum – Minimum) and 95% confidence interval of the mean.

Qualitative categorical variables are described by proportions and percentages.

Shapiro-Wilk test of normalityis used to test normality hypothesis of all quantitative variables for further choice of appropriate parametric and non-parametric tests. For all the variables the assumption of normal distribution cannot be rejected. Hence, parametric tests are used throughout the analysis. Log linear Model (LGM) one-way repeated measure ANOVA is used for analyzing the changes withineach group. Multiple comparisons are applied using Bonferroni method. Comparison of themeans of two groups is carried out by independent sample t test. Significance level is consideredat $P < 0.05$ (S); while for $P < 0.01$ is considered highly significant (HS). Two Tailed tests are assumed throughout the analysis for all statistical tests. The patient sample was divided randomly in to two groups, one with using collagen mem- brane (study group) and one without using collagen membrane (control group). Studying the ridgewidth in the control group showed average bone width 3.02 mm cervical and 5.2 mm apical and 4.22 mm in the middle area between cervical & apical. IN the study group the ridge width showed average bone width 2.70 mm cervical and 7.08 mm apical and 4.98 mm in the middle area between cervical & apical.

There was no statistically significant difference regarding the bone width gain between the two groups in all the intervals till theend of the study.

Figures:15,16,17

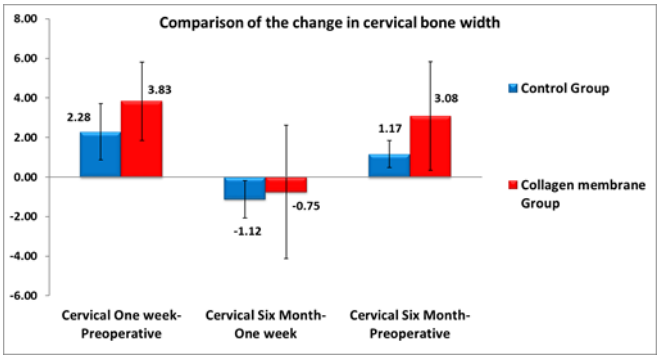


Figure 15: **Comparison of cervical bone width change within both groups at different phases of treatment**

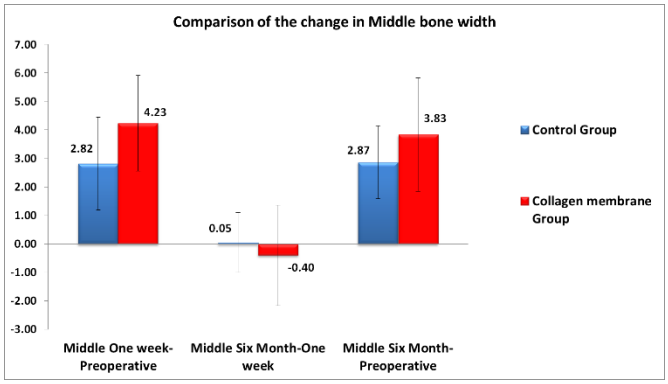


Figure 16: **Comparison of middle bone width changewithin both groups at different phases of treatment**

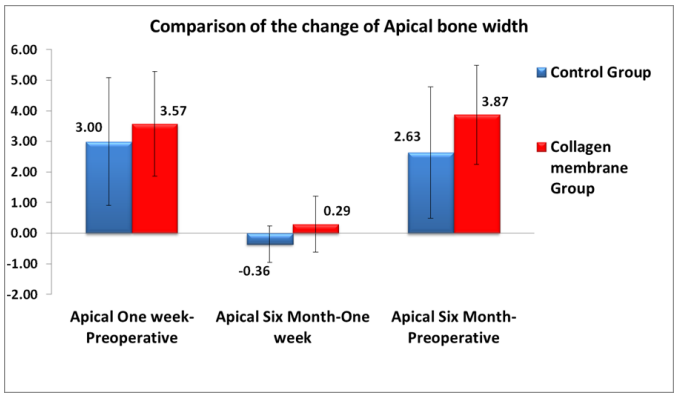


Figure 17: **Comparison of Apical bone width changewithin both groups at different phases of treatment**

6. Discussion

Restoring the alveolar ridge height and width was addressed by many grafting techniques and materials, horizontal and /or combined three dimensional (3D) alveolar ridge augmentations are challenging procedures in dental implantology. The approach should provide an adequate site forthe osseointegration of titanium implants with an intense revascularization and revitalization of the reconstructed area for long-term tissue stability [13].

The use of bone substitutes can result in excellent bone regeneration in intrabony defects,

these bone grafts or bone void fillers are usually based on porous calcium phosphate grains which, once disposed into the bone defect, act as scaffolds by incorporating, to their own porosity, the intergranular one [14].

Building bone height and width outside the boundaries of the native bone are best achieved by autogenous cortical bone grafts. With the use of an appliance to hold graft particles like titanium mesh for example proved to be a good technique but the graft material is best to be autogenous particulate form or a mixture of autogenous and xenogenic particles.

Many intra and extra oral donor sites for autogenous bone harvesting were reported, one of them is the retromolar region. Cordaro et al. and Raghoebar et al. found that the retromolar area provide good volume for grafting and many grafting modifications techniques. Against the com- mon belief, the incidence of inferior alveolar nerveinjury is less than those found with chin bone graft harvesting. [15,16]

Retromolar bone grafts were utilized after splitting longitudinally into two shelves allowing the cortical part of the graft to be thinner and more customizable. The bone shells were stabilized by micro screws in direct contact or at a distance from the native bone to restore the alveolar ridge to a normal volume and anatomy, the gap in be- tween the cortical shell and the alveolar bone is filled with milled pieces of harvested bone from the same donor site.

In this study the patient sample was divided into two groups one of them after graft adjustment and fixation were covered by collagen membrane where GBR procedures act as biological and mechanical barriers, preventing the invasion of non-bone-forming cells (e.g., connective tissue/epithelial cells) [17] while in the other group no membrane was used.

Comparing the results of the two groups in our study did not show any advantage for the membrane coverage, an observation that can be explained by the presence of cortical bone as an outer layer that could prevent the ingress of fibroblasts to the grafted area.

The sectioning of the bone graft also made the cortex thin for the ingress of blood vessels into the graft tissue from the mucosal side as well as from fenestrated alveolar bone from inside and led to a considerably good healing and close to normal bone quality.

During implant placement the preliminary osteotomy was done using a trephine drill which allowed the harvesting of bone from the grafted area.

The histopathological evaluation of the bone graft showed lamellar bone tissue with acellular osteocyte lacunae and an intensely eosinophilic bone matrix. Highly vascularized bone marrow and haversian canals with numerous active osteoblasts showed in both groups.

The retromolar graft region represented a successful donor site for bone harvesting, providing a possibility for bilateral bone graft harvesting. The quantity of bone obtained could be adequate to reconstruct localized alveolar defects ranging from one to four teeth. This technique is easyto perform and provides low donor site morbidity. It also obviates the need for additional surgical procedures in distant areas such as the calvarial, tibial or iliac crest for graft harvesting. Using cortical bone shells helps in new bone formation as a result of an osteoinductive and osteogenic action since the cortical bone presents the greatest amount of BMP (bone morphogenic protein). (18,19,20)

7. Conclusion

1-The retromolar graft region represented successfully a new donor site for bone harvesting, providing a possibility for bilateral bone harvesting, sites.

2-The quantity of bone obtained from the retromolar region could be adequate to reconstruct localized alveolar defects ranging from oneto four teeth.

3-The cortico-cancellous blocks obtained from the retromolar region can be used in augmenting the alveolar ridge in a horizontal and/or combinedmanner.

4- The retromolar region provided an adequate bone quality bone showing active signs of remodeling and viability on the histological level.

5-This technique is easy to perform, provide low donor site morbidity as the donor and host sites are in a single surgical field

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