Immediate Implant Placement Simultaneously with Ridge Augmentation in the Maxillary Esthetic Region Using Allograft versus Autogenous Bone Rings

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Abstract:

Objective: To evaluate allogeneic versus autogenous bone rings (harvested from the chin) for ridge augmentation the of maxillary esthetic zone simultaneously with implant placement. **Materials and Methods:** This randomized clinical trial included 14 patients who were seeking implant rehabilitation of partially edentulous atrophic ridge the in the esthetic zone. The patients were randomly and equally divided into two groups; immediate implants were placed simultaneously with each autogenous bone ring from chin group I (control group) and, with allogenic bone ring group II (study group). The evaluation was done immediately (T0), postoperatively at 1 month (T1), at 3 months (T3), and after 6 months (T6) to assess implant stability, soft tissue healing, relative buccal bone volume, and bone gain and bone loss around the dental implant. **Results:** The fourteen patients were randomly divided into two groups; 3 females and 4 males in group I and 2 females and 5 males in group II. Their ages ranged between18 to 45 years old with the mean age of both groups 31 years, standard deviation was 31.0+- 10.65 for group I and 31.0+-11.69 for group II. No statistically significant differences were found between both groups in implant stability, soft tissue healing, bone density, relative buccal bone volume, and buccal bone gain but the bone loss was higher in group I than group II with a statistically significant difference between them (1.61mm^2 versus 1.21 mm^2). **Conclusions**: The bone ring approach either allogenic or autogenous reduces treatment time for restoring function and aesthetics even in the severely atrophied alveolar bone.

Introduction:

Tooth loss caused by trauma, periodontal disease, or pathological deformity is followed by a bone resorption process, resulting in diminished alveolar crest height and width. Nonetheless, the quantities of hard and soft tissues become insufficient due to the long-term absence of a tooth.[1]

Many procedures have been documented for ridge augmentation, including the use of particulate bone substitutes and guided bone regeneration (GBR); autogenous, allogenic, and xenogeneic block or ring gr afts; and distraction osteogenesis.[2]

Two-stage surgery is frequently recommended when there is the inadequate bone volume in the alveolar ridge and dental implant therapy is planned.[3] Reconstructing local alveolar deficiencies in the aesthetic area necessitate horizontal and/or vertical augmentation of autogenous bone grafts (the gold standard of bone grafting methods).[3,4] Autogenous bone block grafting is appropriate for three-dimensionally repairing alveolar lesions due to its osteoinductive, osteoconductive, and osteogenic qualities. The donor sites are chosen based on the volume of bone replacement necessary, which can be done extraorally or intraorally.[5] The quantity of autogenous grafts available is limited. As a result, allogenic block grafts have been developed to avoid these disadvantages. According to the data presented, it was of interest to compare autogenous bone rings and allogenous bone rings in the aesthetic zone for ride augmentation.[6]

In the aesthetic area, doing bone augmentation before dental implant insertion to obtain acceptable bone volume has become standard, with predictable cosmetic results..[7,8] Horizontal abnormalities may be repaired with predictable clinical outcomes; however, vertical defects might be difficult to restore. [8]Immediate implant placement has several advantages such as prevention of bone resorption, reduced number of surgical visits, better esthetics, and higher patient satisfaction compared with delayed placement of implants.[9]

The bone ring technique was found to be a reliable alternative to reconstruct severe defects of the alveolar crest and to insert a dental implant in a one-stage surgery. The bone ring technique shortens the treatment time and enables implantation with primary stability, including atrophied local bone.[10]

Material and Methods:

Material: A randomized clinical trial was conducted on 14 patients who seeking implant rehabilitation of partially edentulous atrophic maxillary ridge in the esthetic zone; the patients were selected from the Out

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The patients in this study were chosen according to the following criteria: inclusion criteria; Freshly extracted socket in maxillary esthetic zone with the severely compromised alveolar ridge, co-operative patients willing to complete the follow-up periods, patients age from 18-45 years, adequate inter-arch relation and inter-occlusal space that could accommodate the implant abutment and the future restoration, while exclusion criteria; Any pathological condition at the site of surgery that contraindicated immediate implant insertion, patients with systemic diseases that contra-indicate the surgical procedure such as uncontrolled diabetes mellitus, bleeding disorders, serious osseous disorders, mental disorders, smoking, alcoholism and parafunctional habits such as bruxism and clenching. Written informed consent was taken from all patients and all of them were informed about the benefits, risks, complications, and follow-up periods. This study was approved by the Ethical Committee of the Faculty of Dentistry, Mansoura University with No. (A02040521).

Methods:

The patients were randomly and equally divided into two groups:

Group I: (control group): involved 7 patients where autogenous bone rings were used for ridge augmentation with simultaneous implant placement.

Group II: (study group): involved 7 patients where allogeneic bone rings were used for ridge augmentation with simultaneous implant placement.

A. Preoperative phase: Personal data was taken and recorded in full detail, including the patient's name, age, gender, occupation, residence, and phone number. Medical history and dental history were taken from each patient. Inspection and palpation of both intraoral and extraoral tissues were done carefully. A clinical evaluation of the surgical site was done to rule out any infections or abnormalities. CBCT radiographic examination of the recipient and harvested sites for evaluation of the quantity and quality of bone, evaluation of any bone anomalies, measurement of crystal bone width and height, and study casts were made for each patient to evaluate occlusion and interarch space.

B. Operative phase: Surgical procedure: The prophylactic antibiotic was administered one hour before surgery[11] Amoxicillin 875 mg+ clavulanic acid 125mg tablet (Augmentin, GSk, Hungry) and Chlorhexidine HCL 0.12 % mouth wash

(Hexitol the Arab Drug Company, Cairo, A.R.E.) was done for 1 minute immediately before surgery.

For the control group : Harvesting of symphyseal bone ring: The position of the augmented chin bone ring was based on the preoperative CBCT planning, after induction of local anesthesia, a vestibular flap was elevated. The bone ring was completed monocratically prepared from 5 to 7 mm in length using the trephine bur No.8 (Trephine bur kit, Bosco, Pakistan.) with copious irrigation. Before removal of the ring from chin implant drills (Dental implant NucleoSS, Turkey) were sequentially inserted through the center of each ring to prepare osteotomy for a 3.5mm implant. Figure 1.

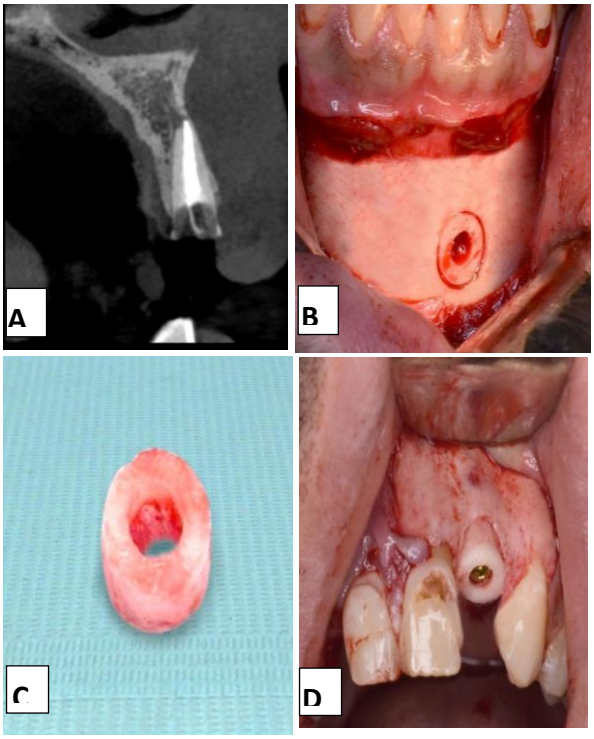

Figure1:CBCT Preoperative Cross-sectional view (A). Osteotomy site preparation through bone ring (B).
Fresh autogenous bone ring from chin area. (C). Implant with autogenous bone ring placement (D)

For study group :The 8mm pre-prepared allogenic bone ring (Maxxeus. USA) with an osteotomy in its center to accommodate a 3.5 mm implant was used in each patient in this group. Figure 2 .

For both groups: Preparation of the recipient site under local anesthesia, a rectangular flap was performed. After elevation of the full-thickness mucoperiosteal flap, the unrestorable teeth were extracted, followed by preparation of the recipient site using a 7mm trephine bur, under saline copious irrigation.

Finally of both groups the bone ring (8mm in diameter) was inserted and immobilized by friction into the prepared recipient site and positioned 1–2 mm above the adjacent socket walls to compensate for the anticipated bone resorption, then the implant drills were sequentially inserted through the central osteotomy of the bone ring to prepare at least 3mm of the apical bone for implant initial stability, the implant was placed 1 mm below the surface of the bone ring to compensate for any crystal bone resorption, any sharp edge of the rings were smoothed using round surgical bur, primary implant stability was determined using

Resonance Frequency Analysis Device, Osstell (Osstell, Gothenburg, Sweden.) and the flaps were primary closed used 3/0 vicryl suture.

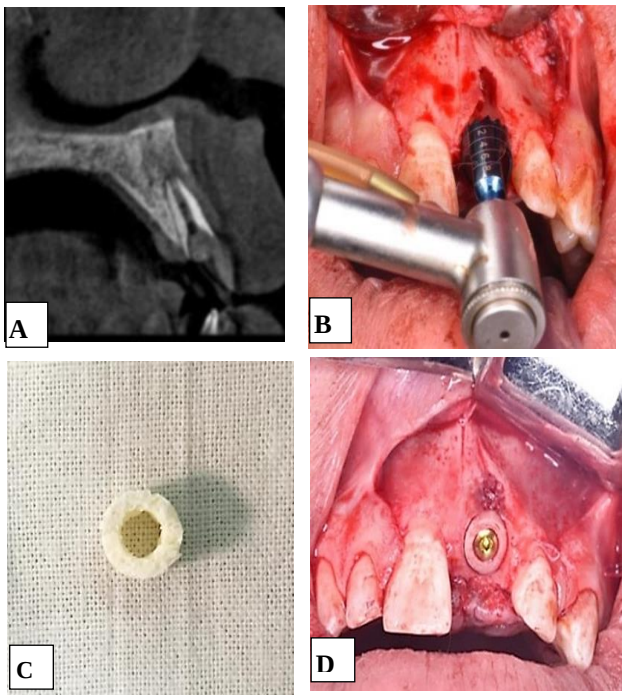

Figure2: CBCT Preoperative Cross-sectional view (A). Preparation of recipient site by trephine bur 7mm(B). Allogeneic bone ring. (C). Implant with allogenic bone ring placement (D)

C. Postsurgical phase: Patients were instructed to apply cold fomentation for 20min/ 1hour on the first day after surgery and avoid any trauma to the grafted site and maintain good oral hygiene during the healing period. Antibiotic (Amoxicillin 875 mg+ clavulanic acid 125mg), tablets, twice daily for 7 days. Non-Steroidal anti-inflammatory analgesic drug (Cataflam (50 mg): Novartis, Egypt.) 2 times daily for 5 days, mouth wash 3time /day.

D. Follow-up phase : Patients were scheduled immediate post-surgery (T0), at 1 month (T1), at 3 months (T3), and 6 months (T6) postsurgical for:

II. Clinical Evaluation:

1-Implant stability: The implant stability was measured at T0 and T6 using the Osstell device. The ISQ is a scale from 1 to 100 that measures an implant's stability, scales greater than 70 ISQ indicate strong stability, ISQ scales ranging from 60 to 69 indicate medium stability, and scales lower than 60 ISQ indicate low stability.
2- Soft tissue healing: was assisted using the soft tissue healing index by Landry et.al.[12] At T1, T3, and T6 in Table 1 as follows:
II. Radiographic Evaluation: CBCT was taken for each patient at (T0) and (T6) to assess:
1-Relative buccal bone volume (RBBV) at T0 and T6;
-Area button was pressed to select the area to be measured. Figure 3A.

-The measurements included:

Table 1

Score	Clinical finding
1=Dehiscence	-Exposure to bone graft
2=Very poor	-Tissue color: ≥50% of gingiva red -Response to palpation: Bleeding -Granulation tissue: Present -Incision margin: Not epithelialized, with loss of epithelium beyond the incision margin -Suppuration: Present.
3=poor	-Tissue color: ≥50% of gingiva red -Response to palpation: Bleeding -Granulation tissue: Present -Incision margin: not epithelialized, with connective tissue exposed
4=Good	-Tissue color: less than 50% of gingivae red -Response to palpation: no bleeding -Granulation tissue: none -Incision margin: no connective tissue.
5=Very good	-Tissue color: less than 25% of gingivae red -Response to palpation: no bleeding -Granulation tissue: none -Incision margin: no connective tissue exposed.
6=Excellent	-Tissue color: All tissues pink -Response to palpation: No bleeding -Granulation tissue: None -Incision margin: No connective tissue exposed.

1- Residual buccal bone at T0. Figure 3B.
2- Buccal bone at T0. Figure 3C.
3- Bone gain at T0 = Buccal bone at T0 (2) - Residual buccal bone (1).
4- Buccal bone at T6. Figuer 3D
5- Bone gain at T6 = Buccal bone at T6 (4)- Residual buccal bone (1).
6- Bone loss at T6 = Buccal bone at T0 (2)- Buccal bone at T6 (4).

2-Relative bone density (RBD) at T6: RBD was measured after six months at the graft–implant interface' a straight line was drawn just parallel to the long axis of the implant from the crest of the bone graft buccally to the apical end of the implant at the same level of 1-mm, 3-mm, and 5-mm from the implant platform in cross-section, the mean bone density was obtained from CBCT (OnDemand3D™ App, Yuseong-gu, Daejeon, South Korea) (using the ROI tool present in the software). Figure 4A and B .

E. Prosthetic Phase : Six months later, a crestal incision was performed under local anesthesia, and a small flap was performed to remove the cover screw. The healing abutment was then secured, and the flap was closed around it to restore the gingival natural contour after healing. After 15 days, the healin

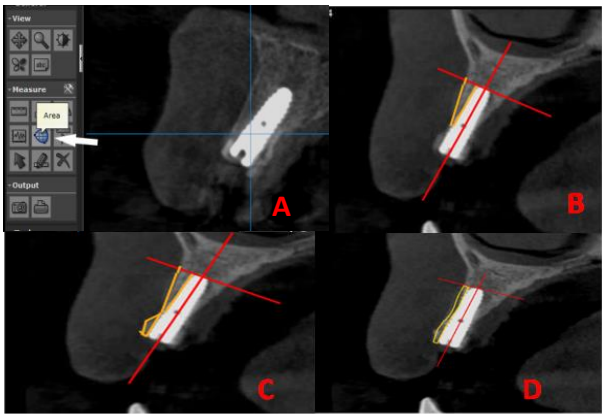

Figure (3): Area button(A) Residual buccal bone at T0 (B) Buccal bone at T0 (C)Buccal bone at T6 (D).

abutment was removed, and the transfer capping was secured. After that, the imprint was utilized to construct the final restoration. Finally, the ceramo-metallic crown was cemented to the final abutment.

Statistical analysis: Data were fed to the computer and analyzed using IBM SPSS Corp. Released in 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Simple random sampling was followed up by computer-generated random tables

Results:

This prospective randomized comparative clinical study was conducted on 14 patients. They were randomly divided into two groups 3 females and 4 males in group I. 2 females and 5 males in group II.

Their ages ranged between18 to 45 years old with a mean age of 31 years. There was no sex or age predilection. In group I there was failed case after 3 weeks which was replaced by another case.

A.Clinical Evaluation:

1-Assessment of implant stability

Table (2) shows the comparison of implant stability between groups I and II using the student t-test and illustrates the non-statistically significant difference between them. Among group I; there was a statistically significant increase in implant stability between T0 and T6 (61.57 & 75.14, $p<0.001$,) respectively. In group II; there was a statistically significant increase in implant stability T1 and T6 (61.86 & 76.57, $p<0.001$) respectively. A higher percent of change was detected among group I than group II (23.8% & 22.03%) respectively, with no statistically significant difference.

2 – Assessment of soft tissue healing using the Landry index.

No statistically significant difference was found between both groups at all follow-up periods (at 1 month, 3 months, and 6 months) with P value =($p=0.097$), ($p=0.392$), and ($p=0.565$) respectively.

Friedman test was used to compare change through follow-up periods and illustrates that there was a statistically significant difference as a whole. Wilcoxon signed rank test for each group shows a statistically significant difference between every 2 follow-up periods except for the allogeneic bone ring between 1&3 months ($p=0.705$), and between 3&6 months ($p=0.059$).

The dehiscence occurred in one case in group I after 3 weeks and in group II occurred in one case after 3 months. After the removal of sharp edges and application of a local antiseptic such as H_2O_2 mouthwash and chlorhexidine gel, the first case was not responded to local measurement and was failed and replaced by another case. Figure 6. The second case in group II responded to local measurement with accepted healing. Figuer 7.

B. Radiographic Evaluation:

1- Assessment of relative buccal bone volume: Table (4) shows that there was a statistically significant increase in relative buccal bone volume from21.4 mm^2 to 24.94 mm^2 at T0 and then decreased to 23.33 mm^2 at T6 for group I. Similarly, for group II; there was a statistically significant increase in relative buccal bone volume from a pre-operative value of 20.2 mm^2 to 24.57 mm^2 at T0 and then decreased to 23.36 mm^2 at T6 with a statistically significant difference between them

Table 5 illustrates that there was no statistically significant difference in relative buccal bone volume between groups 1&2 measured pre-operative, at T0 and T6($p>0.05$)

2- Assessment of bone gain and loss: Table 6 illustrates a non-statistically significant difference between the studied groups as regards bone gain and bone loss. Higher bone gain at T0 and T6 was detected for group 2 than in group 1 (4.37 mm^2 & 3.16 mm^2 versus 3.51 mm^2 &1.89 mm^2, respectively). Higher bone loss is detected for group 1 than group 2 (1.61 mm^2 versus 1.21 mm^2) figure 8 and 9

3-Assessment of relative bone density: Table 7 shows the comparison of bone density after 6 months between groups I and II using the student t-test and illustrates the non statistically significant difference between them ($p>0.05$).

Discussion:

A dental implant needs adequate alveolar bone height and width (bone volume) which can be compromised by trauma, periodontal disease, or pathological deformity causing unwanted inter-arch relationships. Insufficient bone volume demands bone augmentation, which can be challenging and time-consuming for both the patient and the doctor depending on the location and extent of the bone deficiency, as well as the therapeutic approach chosen.[13,14] Several techniques have been used for three-dimension.

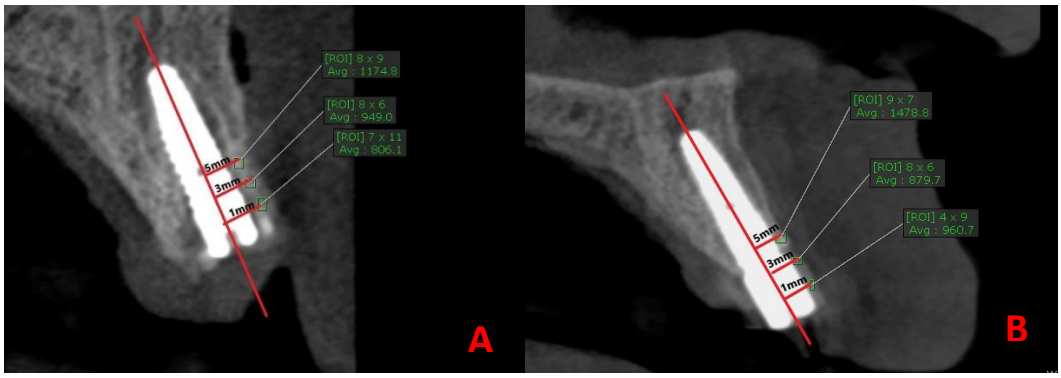

Figure (4): Relative bone density at T0 (A) and at T6 (B).

Table 2: Comparison of implant stability using OSSTELL between studied groups

	Group I (autogenous bone ring)	Group II (allogeneic bone ring)	Test of significance (Student t-test)	P value
Immediate	61.86±2.19	61.57±2.99	t=0.204	P=0.842
At 6 months	76.57±3.26	75.14±3.53	t=0.786	P=0.447
Comparison of follow-up data (Paired t-test)	t=11.61 P<0.001*	t=9.39 P<0.001*		
% of change	23.8%	22.03%		

Table (3): Comparison of soft tissue healing between studied groups and during follow-up periods

time of follow up	**soft tissue healing index**	**An autogenous bone ring. N=8(%)**	**An allogenous bone ring. N=7(%)**	**test of significance**
At 1 month	Dehiscence Very poor Poor Good Very good Excellent	1(12.5) 2(25.0) 3(37.5) 1(12.5) 0 1(12.5)	0 0 1(14.3) 2(28.6) 4(57.1) 0	χ^{2MC}=9.31 P=0.097
At 3 months	Dehiscence Very poor Poor Good Very good Excellent	0 0 0 3(42.9) 3(57.1) 1(14.3)	1(14.3) 0 0 1(14.3) 4(57.1) 1(14.3)	χ^{2MC}=3.0 P=0.392
At 6 months	Dehiscence Very poor Poor Good Very good Excellent	0 0 0 0 4(57.1) 3(42.9)	0 0 0 1(14.3) 3(42.9) 3(42.9)	χ^{2MC}=1.14 P=0.565
Friedman Test		P=0.02* p1=0.047* p2=0.025* p3=0.034*	P=0.029* p1=0.705 p2=0.034* p3=0.059	

MC: Monte Carlo test, *statistically significant
P1: difference between 1 & 3 months, p2: difference between 1 & 6 months, p3: difference between 3&6 months.

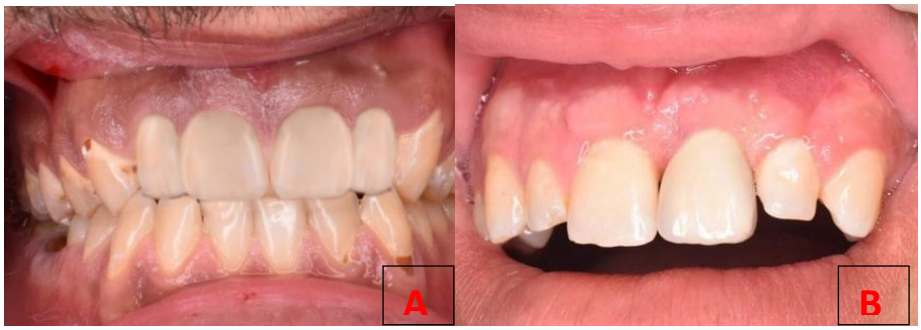

Figure (5): Final porcelain fused to metal crown insertion in control group (A) and study group (B).

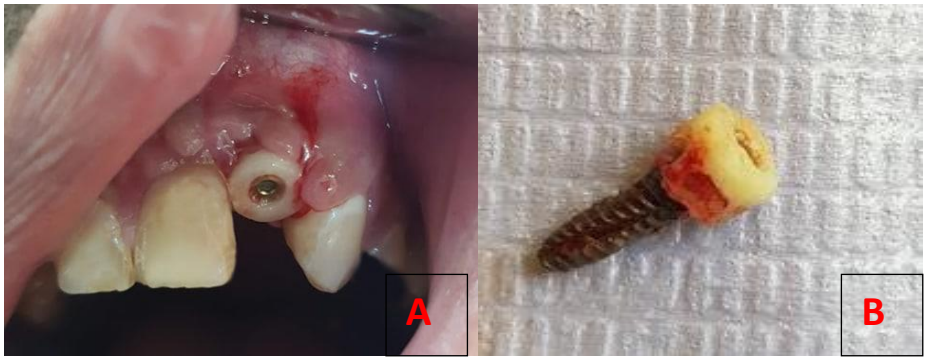

Figure (6): Failure of soft tissue healing (A) Implant and bone ring failure (B)

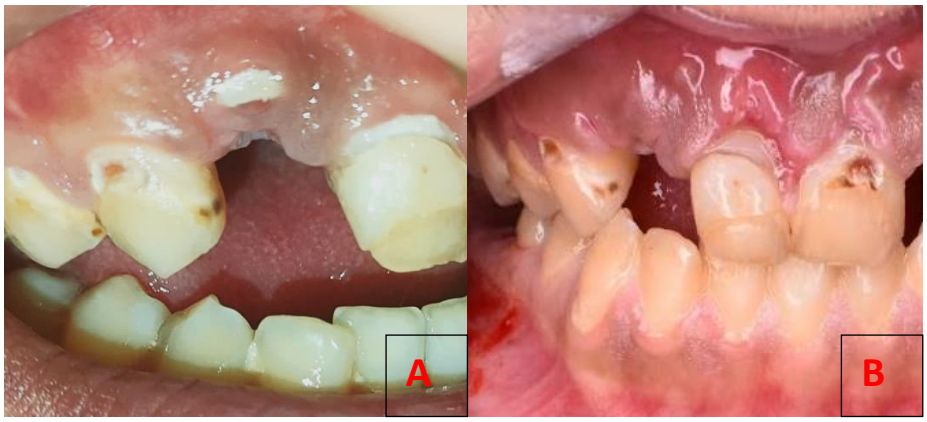

Figure (7): Dehiscence after 3 months (A) soft tissue healing after application of local measurement (B)

Table (4): Comparison of Relative buccal bone volume changes during follow-up

	Residual buccal bone pre-operative (mm^2)	Relative buccal bone volume at T0 (mm^2)	Relative buccal bone volume at T6 (mm^2)	Repeated Measures ANOVA test
Group 1	21.43±6.85	24.94±7.66	23.33±7.69	p<0.001*
Group 2	20.20±4.31	24.57±5.32	23.36±5.39	p<0.001*

Table (5): comparison of Relative buccal bone volume between studied groups

	Group I	Group II	test of significance
Residual buccal bone pre-operative (mm^2)	21.43±6.85	20.20±4.31	t=0.402 p=0.695
Relative buccal bone volume: At T0 (mm^2)	24.94±7.66	24.57±5.32	t=0.105 p=0.918
Relative buccal bone volume: At T6 (mm^2)	23.33±7.69	23.36±5.39	t=0.008 p=0.993

Table (6): Comparison of bone gain and loss between studied groups

	Bone gain at T0 (mm^2)	Bone gain at T6 (mm^2)	bone loss (mm^2)
Group 1	3.51±1.15	1.89±1.35	1.61±1.14
Group 2	4.37±1.46	3.16±1.62	1.21±0.56
Student t test	t=1.23 p=0.243	t=1.58 p=0.139	t=0.824 p=0.426

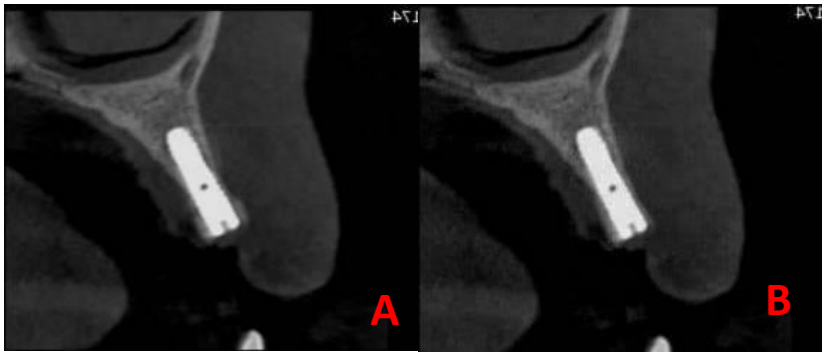

Figure (8): Control group CBCT Immediate Postoperative Cross-sectional view (A) and After 6 months CBCT Cross sectional view (B).

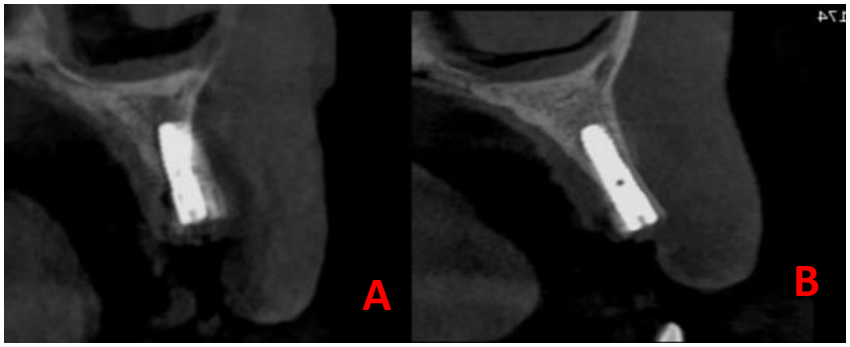

Figure (9): Study group CBCT Immediate Postoperative Cross-sectional view(A) and After 6 months CBCT Cross sectional view (B).

Table (7): Comparison of bone density between studied groups at T6

Bone density 6M	Group 1 (Autogenous bone ring)	Group 2 (Allogeneic bone ring)	Test of significance (Student t test)	P value
1 mm	1354.37±153.84	1334.27±110.83	t=0.280	P=0.784
2mm	1094.76±77.18	1057.59±119.88	t=0.690	P=0.503
5mm	1123.90±154.98	1091.08±231.15	t=.312	P=0.760
AVERAGE	1191.01±94.21	1160.98±123.89	t=0.510	P=0.619

ridge augmentation including GBR, distraction osteogenesis, bone blocks, and rings. Most three dimension bone grafting procedures are utilized in two-stage implant processes, there are only a few one-stage implant solutions that incorporate the implant with the bone substitute[15], one of them is the bone ring technique. The advantages of the bone ring technique are reduction of treatment time, both vertical/horizontal augmentation, thereby simplifying the surgical treatment of three-dimensional bone defects and preventing further bone resorption and soft tissue shrinkage with subsequent loss of attached gingiva due to a second surgery if a two-staged procedure is used.

Nakahara et al. [16] compared one-stage and two-stage surgery models for implant placement. Their findings showed that a single-stage implant placement is just as effective as a two-stage surgery; moreover, the one-stage surgery may be effective in reducing the length of a patient's treatment. One drawback of the one-stage bone ring–implant treatment is that graft failure leads to implant failure, and osseointegration in the bone ring area may be insufficient. In addition to the danger of fracture during autogenous bone ring harvesting or

implant insertion with autogenous or allograft bone ring. [17]

Autogenous bone grafts can be harvested from intraoral or extraoral sites. The bone grafts from intraoral donor sites offer several benefits like surgical accessibility, the proximity of donor and recipient sites, less discomfort for the patient, and less morbidity as compared with extraoral locations.[18] provides membranous bone so shows less resorption and early revascularization[19–22]

The most common site for intraoral autogenous bone grafts is symphysis (chin) and ramus of the mandible. [18] In the current study, bone rings were harvested from the chin bone because they are easier to access, less stressful for the patient, and more cancellous than other intraoral donor sites resulting in a larger concentration of osteoprogenitor cells and giving more bone thickness to form bone rings of 5-7mm length.[23,24]

As the autogenous bone graft might lead to complications related to harvesting and its limitation in terms of graft amount from the patient, the allograft has served as a good alternative. With the development of donor screening tests, the risk of infection has been minimized.[25] Therefore, there are several benefits of using an allograft bone ring technique over an autogenous bone ring including easy use, improved safety profiles, shorter overall treatment time, availability in diverse sizes and shapes, and no donor-site morbidity. The disadvantages of autogenous bone transplants are prolonged operation times, limited graft acquisition, donor area flap exposure, bleeding and infection[26] and regarding morbidities such as teeth numbness, neurosensory disturbances, alteration of mucosa and skin sensitivity, postoperative discomfort (limited mouth opening, bleeding, swelling and pain) and aesthetic problems (contour changes in donor areas or soft tissues recession).[27,28]

In this study, the recipient site was prepared by using a trephine bur (7mm in diameter), slightly smaller than the trephine bur (8mm) used in the harvested bone ring from the chin in group I or preparation of allogenic ring in group II, that allowing the bone ring to be fitted snugly in its recipient site with adequate stability and maximum bony contact surfaces.[17] This was directly reflected in the early graft healing, with a subsequent decrease in graft resorption, and is consistent with Marx's.[29] who underlined the significance of graft stability during the early stages of bone healing and its impact on early vascularization and graft integration.

According to the study of Omara et al[17] in which a series of 10 patients with fresh defective extraction sockets in the mandibular premolar-molar region filled with an autogenous bone ring with simultaneous implant placement. All patients had uneventful wound healing at both the donor and recipient sites, with no postoperative infection. In the present study soft tissue healed normally.

However, two patients had wound dehiscence which may result from bad oral hygiene, the thinness of the soft tissue covering of the graft, or the presence of sharp edges of the bone ring. One occurred in group I, after 1 month postsurgical, and did not respond to local antiseptic measurement and consequently failed. The second, occurred in group II after 3 months post-surgically and proper soft tissue healing occurred after smoothing of the sharp edges and application of local antiseptic measures.

According to recent studies by Sáez-Alcaide et al.[30] Six bone ring failures were recorded with a mean bone ring survival rate of (97.26 %), and all of the reported failures were related to autogenous bone rings. They concluded that the allogeneic bone ring survival rate was 100%, whereas the autogenous bone ring survival rate was (95.04%). This was in agreement with the current study, in which one autogenous bone ring failure occurred out of a total of eight bone rings inserted, without any failure in allogenic bone rings.

In the present study, there was no statistically significant difference in relative buccal bone volume between both groups in the different interval times of measurement (T0 and T6) but there was a statistically significant difference in comparing different interval measurement times in the same group with an increase of bone from 20.2 mm^2 to 24.57 mm^2 at T0 and then decreased to 23.36 mm^2 at T6 for group I and that same as of group II that increase from 21.43 mm^2 to 24.94 mm^2 and then decreased to 23.23 mm^2 at T6.

In concurrent with our study, Spin-Neto et al [31] compared autologous bone block with allogenic bone block for lateral ridge augmentation, they found no significant differences between them, and concluded that allograft is a good alternative to autogenous bone.

In addition, Wychowanski P et al. [32] in their study, compared the safety and efficacy of autogenous bone grafts versus xenograft implantations in vertical bone augmentation techniques, and they revealed a similar bone gain ratio.

In the present study, there was no statistically significant difference between both groups regarding bone loss, but with slightly higher bone loss in group I than in group II (1.61 versus 1.21 mm^2). The denser grafts showed less resorption than low-density grafts. Such a correlation was independent of graft embryologic origin, allogenic grafts had a wide density range, depending on the portion of tibia they were harvested from. Indeed, the tibia is a long bone that possesses a large epiphysis that tapers down into a narrower, denser diaphysis, mainly composed of thick cortical bone with high HU values. On the other hand, autogenous grafts harvested from intraoral sites (either mandibular symphysis or ramus) had a limited density range and this may have hampered the possibility to find a correlation between density and resorption.[33,34]

Consistent with the current study Omara M. et al[17] found that the difference in bone ring height measured immediately and at 6 months postoperative was not statistically significant, with a mean crestal bone loss of 0.2604 mm (P = 0.321).

Also**,** Spin-Neto and colleagues[35] Compared cortical and cortico-cancellous fresh-frozen block bone allografts to cortical block bone autografts of 24 patients, requiring ridge augmentation in the anterior maxilla, they found an (8.3 %) horizontal graft loss 6-8 months after cortico-cancellous fresh-frozen allograft insertion compared with the autografts block bone, where a slight increase was observed, on average (1.5%). In addition, Pereira et al[36] in their study a total of 98 onlay block allografts were used in 22 patients and found that mean horizontal bone loss of cortico-cancellous fresh-frozen allogeneic bone blocks between the augmentation procedure and re-entry for implantation was around (7.1%.).

In the current study, bone density after 6 months did not show a statistically significant difference between the two groups with p-value =0.619.

Concurrently with our study, Lumetti S et al [37] compared the outcome of fresh-frozen versus autologous bone block grafts for horizontal ridge augmentation, and they didn't find a statistically significant difference between both groups ($P = 0.52$).

On the contrary, the study of Omara M. et al[17] showed that the bone density at the ring–implant interface showed a statistically significant increase for both the mesial and buccal aspect (mean bone density change 393.21 HU mesially and 429.69 HU buccally), while the change was not statistically significant for the distal and lingual aspects (mean bone density change 282.60 HU distally and 263.86 HU lingually), and they concluded that autogenous chin bone ring augmentation technique was found to be a reliable alternative method for the management of severely defective sockets.

Conclusion:

The main limitations of this study are the short-term

follow-up period and the implants being evaluated before loading

The bone ring approach was shown to be a reliable option for reconstructing severe alveolar crest deficiencies and inserting a dental implant in a single-stage operation. The bone ring approach reduces treatment time for restoring function and aesthetics even in the severely atrophied alveolar bone.

Regarding complications, loss of bone, and second-site operation of autogenous bone augmentation, the allogenous bone rings can be considered a reliable alternative to autogenous bone rings. This technique showed promising and advantageous results, and thus, could be considered an alternative treatment to other

autogenous graft techniques.

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