One-Stage Maxillary Sinus Elevation Using A Bone Core Containing An Implant From The Mandibular Symphysis: A Randomized Controlled Trial

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Abstract

Objective: The aim of this study is to evaluate the success rate of simultaneous implant placement with bone ring for sinus augmentation and to decrease the time of procedure. **Materials and methods:** A total of forty implants were placed with sinus augmentation. Twenty implants were placed simultaneously with chin bone ring (study group) and twenty implants were placed after the two stages lateral sinus lift approach. The success rate of implants was evaluated, Also schneiderian membrane perforation was reported at time of surgery.**Result:** The study was conducted on 20 patients showing no statistically significant in the success rate between groups (p value = 0.59). One implant failed in study group (5%) and 3 implants in control group (15%). **Conclusion**: Using the chin bone ring was a reliable technique, although it was technique sensitive but with high rate of success for augmenting atrophic posterior maxillary ridge three dimensionally with simultaneous implant placement.

Keywords: sinus augmentation, Sinus lift, chin bone ring, implant placement.

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1. Introduction

An adequate bone level is required for implant placement in posterior maxilla which is often affected by progressive bone resorption as a result of lowest density of bone. [1] Restoring posterior maxilla could possibly be hindered by the insufficient bone volume, poor bone quality or both. [2,3] Maxillary alveolar ridge atrophy is a long-standing problem that prevents a lot of patients from receiving dental implants. After maxillary tooth extraction bone resorption occurs with extensive loss of its vertical, horizontal or both dimensions. [4]

Several techniques have been reported to manage reduced vertical bone height with simultaneous or delayed implant placement, including distal cantilever, short implant, tilted implant, zygomatic implant or sinus lift which include either crestal approach (closed sinus lift or osteotome sinus floor elevation) or lateral

approach (open sinus lift). [5- 8] In this study, chin bone ring was evaluated clinically and radiographically as a technique for management of defective posterior maxillary ridge less than 4 mm with simultaneous implant placement in a one-stage procedure.

2. Material and methods

2.1. Patients recruitment and allocation

This study was conducted on twenty patients selected from the oral and maxillofacial surgery outpatient clinic of the academic hospital of the Faculty of Dentistry - Cairo University. Forty implants were placed in their deficient maxillary ridges. Patients were randomly distributed among two groups (Study and Control groups) using the online randomization website (http://www.Random.org) which generated a two-sided table of the number of cases. Both groups underwent sinus floor elevation, in which the intervention group used bone ring with simultaneous dental implant insertion (study group) while the control group followed the two stages open sinus lift using autogenous bone.

2.1.1 Eligibility criteria

All ages and both sexes with at least a unilateral maxillary sinus pneumatization indicated for open sinus lift and were included in this study. The patients were selected to be free from any systemic disease that may affect normal healing of bone with predictable outcome and with good general condition allowing surgical procedure under general anesthesia. Patients with high risk of systemic diseases like uncontrolled diabetes mellitus were excluded. [9] Also, patients with chronic sinusitis, maxillary sinus tumor or cyst were excluded as they will affect accuracy of the procedure. [10]

2.2. Preoperative planning and procedures

After thorough diagnosis and recruitment, all the patients underwent CBCT examination for assessment of the residual bone height, number of implants needed and for assessment of chin bone before harvesting bone graft either in form of ring in the test group or particulate bone in the control group. (Fig. 1a,1b)

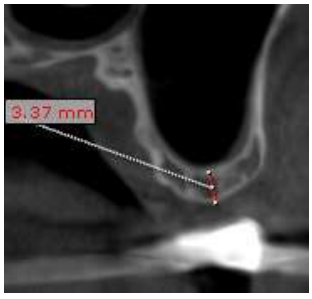

Figure (1a): Reformatted cross sectional CBCT showing the residual height of the alveolar ridge.

Figure (1b): Reformatted cross sectional CBCT showing the dimension of the donor site.

2.3. The surgical protocol

The first surgery for both groups was performed under general anesthesia. I.V. antibiotics were administered at the time of surgery. Scrubbing using povidone iodine 10% surgical scrub and draping of the patient was carried out in a standard sterile fashion. Local anaesthesia (Articaine HCL 4%, Epinephrine 1:100,000) was injected at the site of the planned incision for haemostasis.

2.3.1. Preparation of the donor site

To harvest the bone graft from the symphysis of the mandible, a vestibular incision was made 5–8 mm below the attached gingiva in the symphysis region. (Fig. 2)

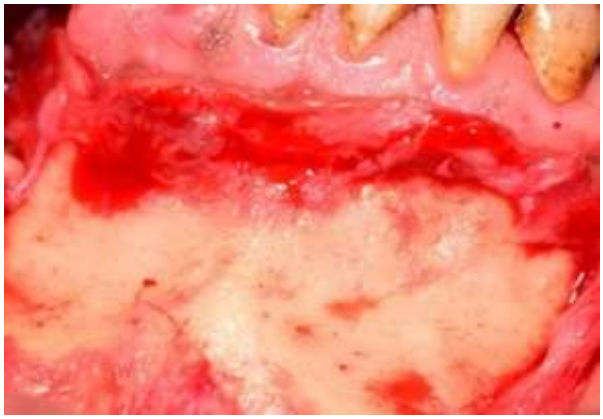

Figure (2): A clinical photograph showing the exposure of the symphysis of the mandible after reflection of the vestibular incision.

2.3.1.1. Bone harvesting in the study group

The selected area was outlined monocortically using a trephine bur.Then, an implant preparation was performed in the center of the bone ring, corresponding to the planned implant length and diameter, and at least 1.5 mm of intact bone was preserved around the implant preparation. Subsequent to preparation, the same trephine bur was used to penetrate into the bone, and cutting was completed by pulling the bur up and down under adequate cooling. Following the bone cut, the entire ring was pulled out simultaneously with the trephine bur or by the final implant drill and placedinsalinesolution.(Fig.3a,3b)

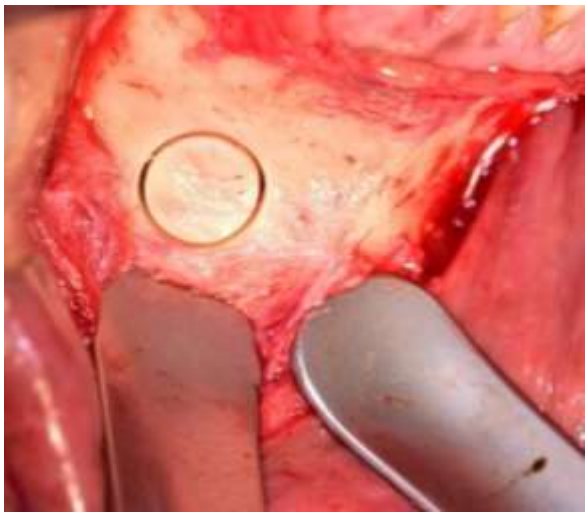

Figure (3a): A clinical photograph showing the outlining of the bone ring using trephine bur.

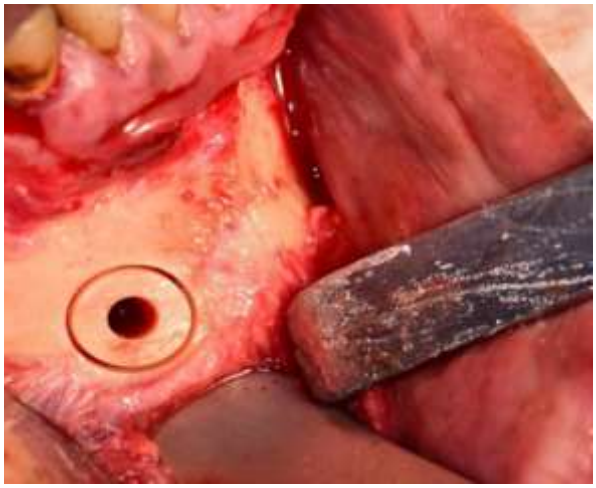

Figure (3b): A clinical photograph showing the osteotomy preparation for implant in the center of bone ring

2.3.1.2. Bone harvesting in the control group

Bone harvesting was performed using either ACM bur or trephine bur to obtain bone graft either in the form of particulate or block. Bone block was grinded using bone mill. (Fig. 4a,4b)

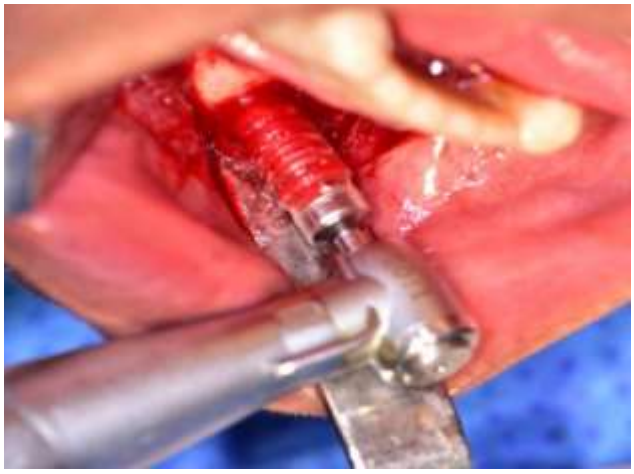

Figure (4a): A clinical photograph showing the use of ACM bur to harvest particulate bone graft.

Figure (4b): A clinical photograph showing the harvested bone graft.

2.3.1.3. Donor site suturing

The flap was closed tightly in layers using 3\0 vicryl and resuspension of the mentalis muscle to provide continued soft tissue support followed by the application of a pressure bandage to the chin to minimize postoperative edema. (Fig. 5)

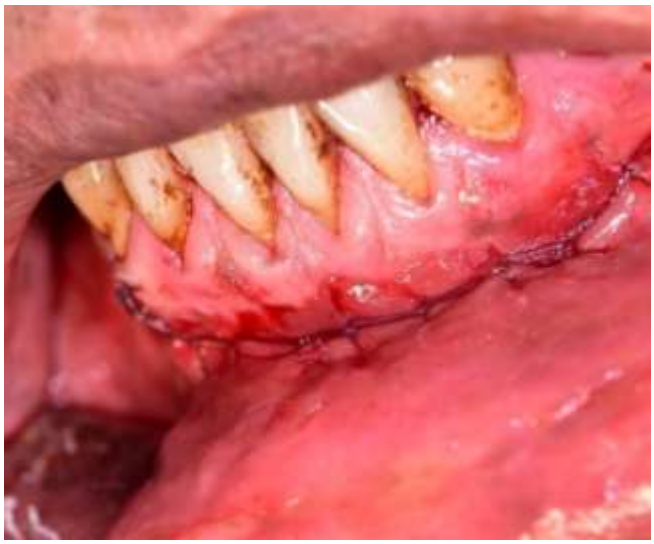

Figure (5): A clinical photographshowing flap closure using continuous with lock vicryl 3\0 suture

2.3.2. Preparation of the recipient site in study group

An incision was made in the mid of the alveolar crest in the edentulous area. And the releasing incision was performed mesial to the last tooth before the edentulous area. The bony window was obtained using large diamond round bur removing all cortical bone up to the sinus membrane. Once the membrane was exposed, it was elevated with flat blunt-edged metal instruments. The sinus was lifted at least 12 mm to allow placement of implants of sufficient length. (Fig. 6a,6b)

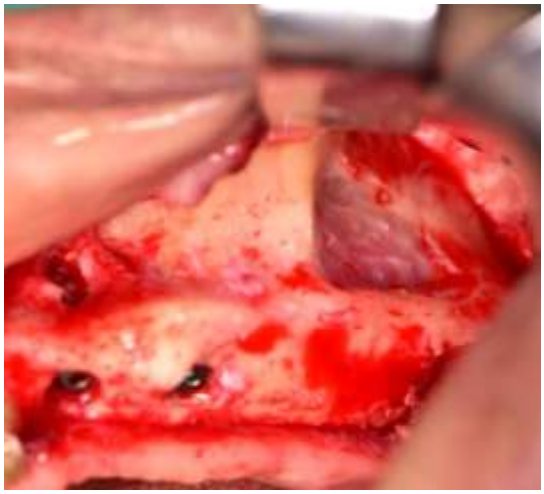

Figure (6a): A clinical photograph showing exposure of the sinus membrane after removal of the bone of the lateral wall of maxillary sinus.

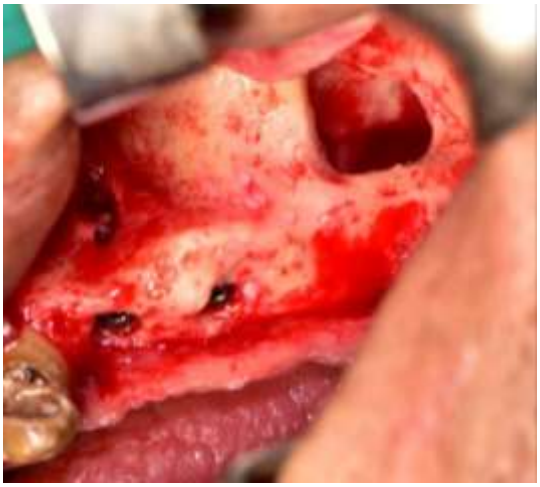

Figure (6b): A clinical photograph showing the elevated maxillary sinus membrane.

Simultaneous implant placement within the bone ring

The implant bed on the alveolar crest was prepared to be compatible with an implant that was one size smaller than that of implant to be placed, in order to enhance primary stability.

During implant [1] insertion, the bone ring was immobilized inside the sinus with a haemostat,payingattention to avoid excessive holding force to avoid fracture or damage of the ring.

The bone ring was placed in the sinus and adapted to the alveolar crest. After proper overlapping of the implant bed on the graft and the alveolar crest, the bone ring inside the sinus cavity was locked to the alveolar crest using the rotational forces of the implant (Fig.7a).

Primary stability of implant and bone ring were gained from the remaining residual bone except in two cases as residual height less than 2 mm and mini titanium screws were used to aid in the stability of fixation of the bone ring (Fig.7b).

(1) Neobiotech,IS Implant System, Guro-gu Co, Seoul, Korea.

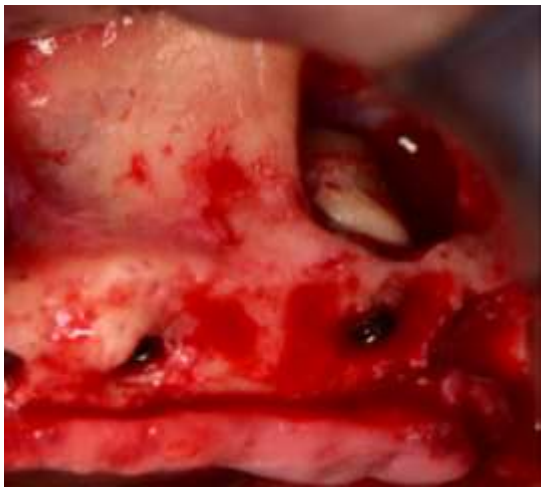

Figure (7a): A clinical photograph showing bone ring with implant inside the sinus cavity.

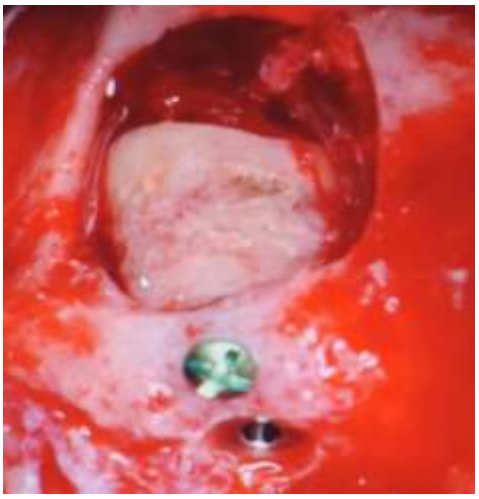

Figure (7b): A clinical photograph showing stabilization of bone ring with implant inside the sinus cavity with titanium mini-screw.

Finally, the covering screw was secured, Then the flap closed with vicryl 3/0 interrupted sutures. (Fig.8)

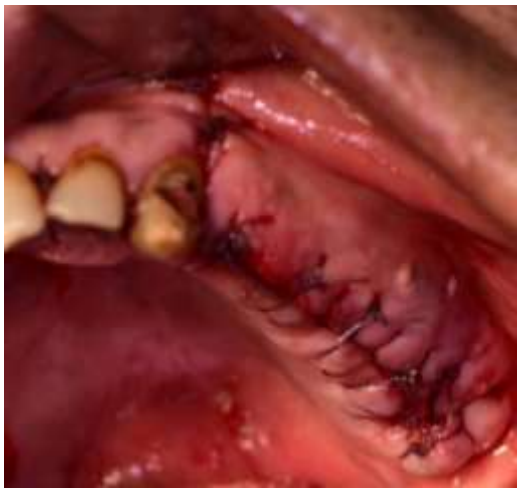

Figure (8): A clinical photograph showing flap closure with interrupted 3-0 vicryl suture.

2.3.3. Preparation of the recipient site in study group

The same procedure of sinus lifting in study group was done (Fig. 9a,9b)

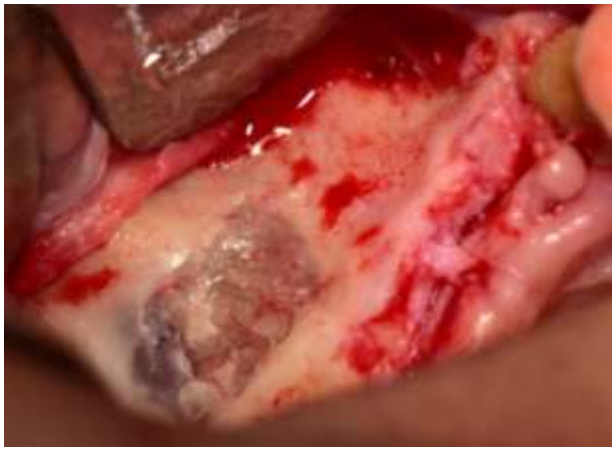

Figure (9a): A clinical photograph showing exposure of the sinus membrane after removal of the bone of the lateral wall of maxillary sinus.

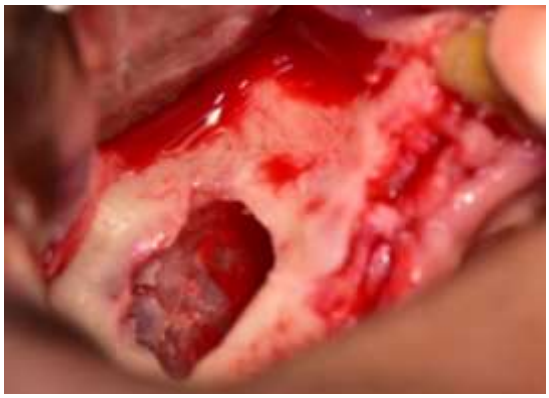

Figure (9b): A clinical photograph showing the elevated maxillary sinus membrane.

Then grafting the maxillary sinus with autogenous bone graft and then the flap closed using continuous with lock black silk 3\0 suture (Fig. 10-11).

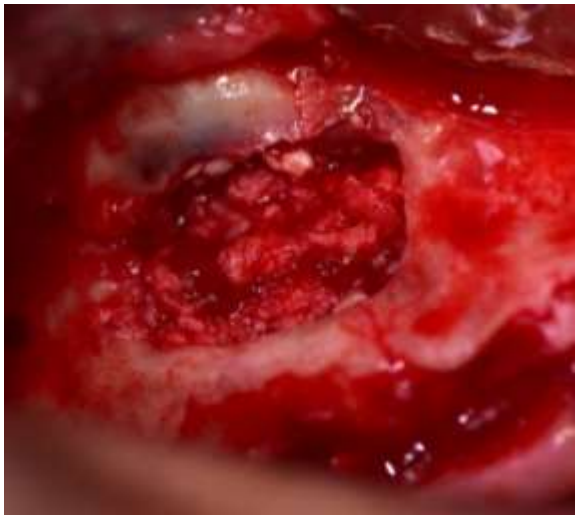

Figure (10): A clinical photograph showing the graft inside the maxillary sinus.

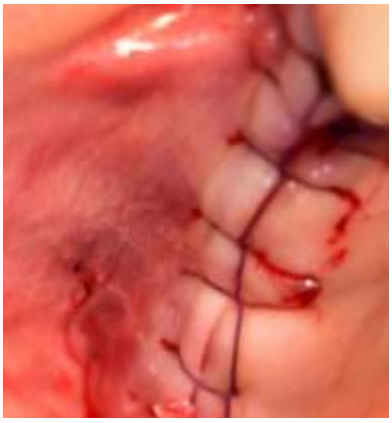

Figure (11): A clinical photograph showing flap closure using continuous with lock black silk 3\0 suture.

2.4. Post-operative care and follow up

After closure of the wound a pressure band was then applied at the chin and cheek areas for 48 hours postoperatively. Immediate postoperative instructions included the use of ice packs that were placed for 20 minutes every hour for 12 hours postoperatively.A liquid diet was initiated on the first postoperative day, followed by instructions for a soft diet for the few days. The patients were also instructed to avoid blowing their nose.Strict oral hygiene measures including brushing and rinsing their mouth using warm saline solution the second day after surgery three times per day during the first week postoperatively. In addition to prescribing the appropriate postoperative medications. Then the suture was removed after 10 days postoperatively.

2.5. Second stage surgery in the control group

After 6 months the implant was inserted with the standard protocol using simple pyramidal flap under local anesthesia. (Fig. 12,13)

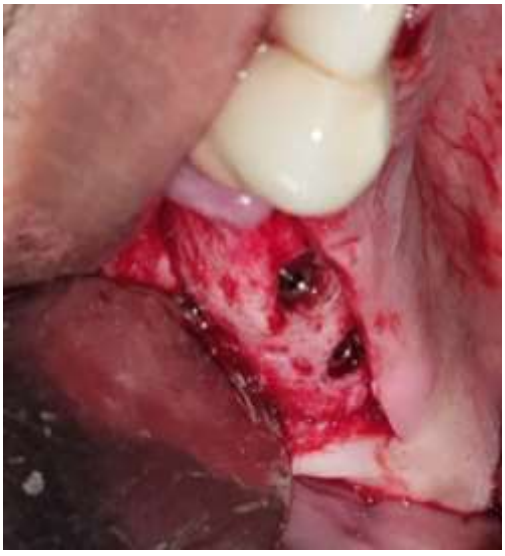

Figure (12): A clinical photograph showing flap and implant insertion for the right side.

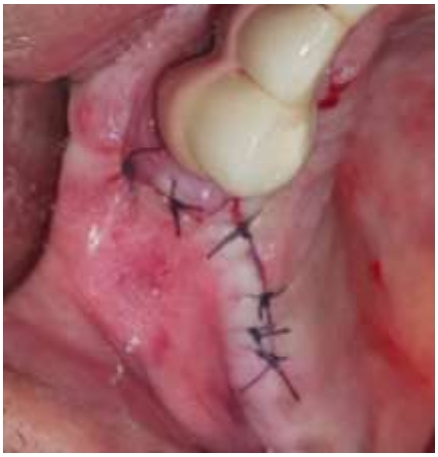

Figure (13): A clinical photograph showing flap closure using intreuptted 3\0 vicryl suture.

2.6. Prosthetic Phase for both groups

After six months postoperatively, a minimal crestal incision was performed and a small flap was reflected to expose the covering screw under local anesthesia, then the healing abutment was secured and the flap was closed around it in order to give natural gingival appearance after healing. Two weeks postoperatively the healing abutment was removed and the transfer abutment was secured, then the impression was taken in order to construct the final ceramo-metalic restoration. (Fig.14,15,16,17)

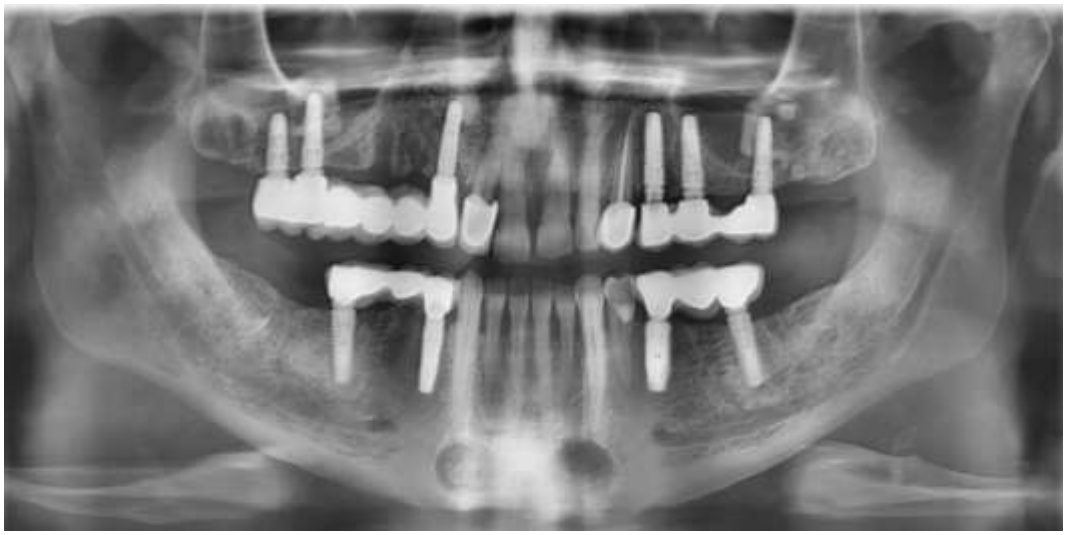

Figure (14): Snapshot of the panoramic screen revealing the final post-operative restoration showing the implant inside bone ring. (study group)

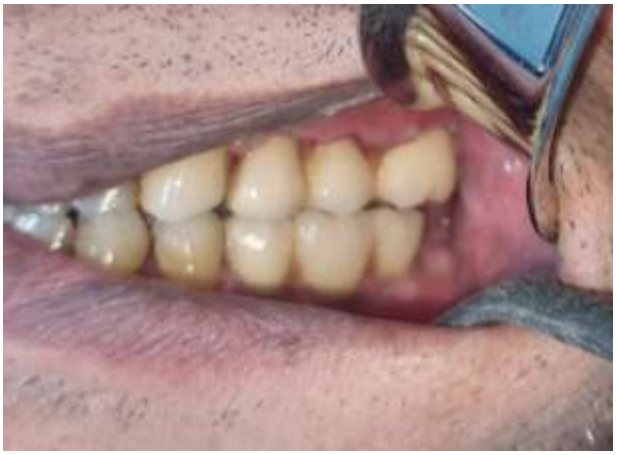

Figure (15): A clinical photograph show the final ceramo-metallic prosthesis in the study group.

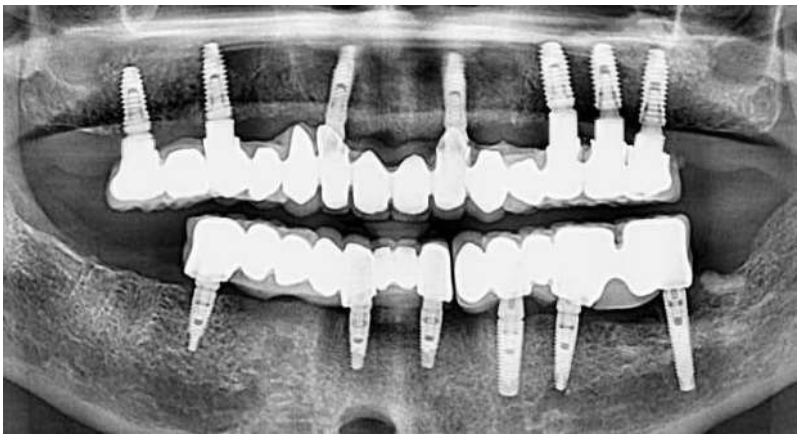

Figure (16): Snapshot of the panoramic screen revealing the final post-operative restoration showing the implant inside the grafted maxillary sinus.(control group)

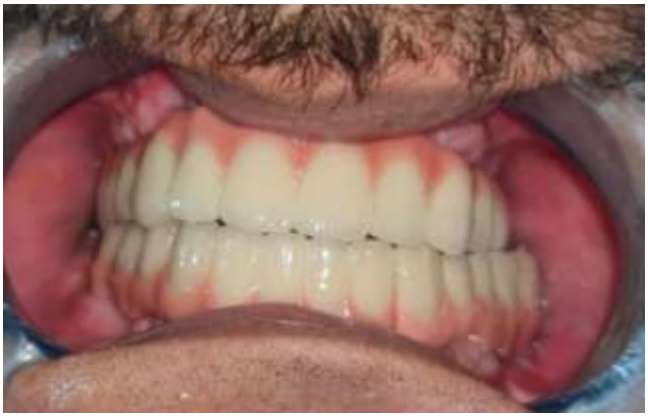

Figure (17): A clinical photograph show the final ceramo-metallic prosthesis in the control group.

Outcome measures and postoperative evaluation

Clinical assessmentwas carried out every other day for the first week, then, every month for 6 months to evaluate the wound healing at both

donor and recipient sites.Also, all patients were checked for the presence or absence of pain, numbness (neurosensory assessment), swelling, infection, hematoma and bleeding at both donor and recipient sites.

Statistical analysis

Statistical analysis was performed using SPSS (Statistical package for the social sciences) version 20, IBM corp., U.S.A. Continuous quantitative data were represented as mean + standard deviation, nominal qualitative data were represented as frequencies and percentages. Data distribution was examined using one sample Kolmogorov-Smirnov test. Paired Student t-test was used to compare continuous variables within the same group. Independent samples t-test was used to compare continuous variables between the two studied groups. Chi square test was used to compare nominal data between the two studied groups. In all tests, result was considered statistically significant if the P- value was equal or less than 0.05.

3. Results

3.1 Demographics

In this study, a total of twenty patients (12 males and 8 females) with an average age of 47.5 years (range of 30-65 years) were selected with atrophic posterior maxillary ridges and a residual bone height of less than 4 mm. According to One-Sample Kolmogorov-Smirnov Test all data was normally distributed. Asymptotic significances are displayed. (The significance level is 0.05)

For the study group (group 1) a total of twenty chin bone rings were harvested with immediate implant placement in a one stage procedure (Table 1), for the control group (group 2) eleven sinuses were utilized through lateral approach (Table 2) and then evaluated clinically. All patients were included for statistical analysis. The difference of ages between the two groups was not statistically significant (p value = 0.180) (Table 3).

Table (1): Showing the demographic characters of the studied patients in the control group.

Patient number	Gender	Age	Number of sinuses and implants
1	F	65	One sinus and one implant.
2	F	51	Two sinuses and three implants.
3	F	38	One sinus and two implants.
4	M	40	One sinus and two implants.
5	M	43	Two sinuses and three implants.
6	M	42	One sinus and two implants.
7	M	48	One sinus and one implant.
8	M	53	Two sinuses and six implants.

Table (2): Showing the demographic characters of the studied patients in the study group.

Patient number	Gender	Age	Number of sinuses and rings
1	M	50	Two sinuses and two rings.
2	M	40	Two sinuses and two rings.
3	M	41	One sinus and one ring.
4	M	36	Two sinuses and two rings.
5	M	30	One sinus and two rings.
6	M	37	One sinus and two rings.
7	M	51	Two sinuses and two rings.
8	F	53	One sinus and one ring.
9	F	48	One sinus and one ring.
10	F	42	Two sinuses and two rings.
11	F	34	One sinus and one ring.
12	F	44	Two sinuses and two rings.

Table (3): Showing summary of statistics of the demographic data of the patients selected for the study group.

Group	N	Minimum	Maximum	Mean	Std. Deviation
Study Group	12 12	30.00	53.00	42.1667	7.25927
Control Group	8 8	38.00	65.00	47.5000	8.83176

3.1 Clinical findings

3.1.1 Intra-operative donor site findings

All bone rings were harvested from the mandibular symphyseal region using trephine bur. A total of twenty-one rings were harvested. Seven rings were passively pulled out of their place simultaneously with trephine bur withdrawal. Fourteen rings were not withdrawn by the bur necessitating their removal by the aid of the anchored final taping drill, where ten of them were found attached to the genial muscles and were dissected using a sharp periosteal elevator. One ring showed cleavage at the junction between the outer cortical bone and intermediate spongy bone during trephine bur withdrawal which made it imperative to harvest another ring from the contra lateral side based on the radiographic data obtained from the CBCT.

3.1.2 Intra-operative recipient site finding

Twenty-nine sinuses were utilized in this study, eleven in the control group and eighteen in the study group. The total number of membrane perforation was nine, three in the control group and six in the study group (Table 4). In control group resorbable collagen membrane were used to manage membrane perforation and prevent leakage of the graft into the sinus cavity, while in the study group no need for using collagen membrane as the graft was already in form of block (bone ring). However, the difference in membrane perforation between the two groups was not statistically significant (p value = 0.9403).

Table (4): Showing summary of statistics of the membrane perforations for both groups.

	Study Group		Control Group
Total number of sinuses	18		11
Sinus perforation	6		3
Proportion (%)	33%		27%

3.1.3 Immediate post-operative donor site findings

The wound healing at donor site was uneventful in all patients with no signs of infection, bleeding, or wound dehiscence except in five cases that showed soft tissue dehiscence within first week postoperatively and were managed by chlorhexidine mouth wash and daily irrigation. Mild postoperative edema was notice in all patients, which spontaneously resolved within one week postoperatively. Two patients suffered from transient numbness in lower lip and gingiva of lower anterior teeth which spontaneously disappeared within two months postoperatively.

3.1.4 Immediate post-operative recipient site finding

The wound healing was uneventful in all patients without any signs of infection or wound dehiscence.

3.1.5 Six months post-operative recipient site finding

The implant sites were surgically exposed to access the healing screws for supra-structure construction. All implants showed an excellent healing appearance except three implants in the control group and one implant in the study group that failed during the loading phase. The difference in implant failure between the two groups was not statistically significant (p value = 0.5982). (Table 5)

Table (5): Showing summary of statistics of the survival rate of implants (implant failure) for both groups.

	Study Group	Control Group
Total number of implants	20	20
Implant failure	1	3
Proportion (%)	5%	15%

4. Discussion

This Study was conducted to deal with atrophic posterior maxillary ridge with residual bone less than 4 mm. to compare the standard conventional two stage lateral sinus lift approach to one stage sinus lift using autogenous symphyseal bone ring with immediate implant placement. Based on studies using chin ring for augmentation with simultaneous implant placement in a one-stage procedure introduced by Peter D. Wang et al. (2002) as introduced a pre-osseointegrated implant from the mandibular symphysis with bone ring and used for grafting of the maxillary sinus. [11]

In another study introduced by A. Sindel et al. (2018) using the ring block technique at sinus perforations for simultaneous implant placement (intrasinusal locking technique). [12] Also there was other study to evaluate the use of chin bone ring in the esthetic zone as MO Yuce et al. (2019). [13] Other studies evaluated chin ring in defective socket of mandibular premolar-molar region as Stevens MR et al. (2010), Giesenhagen B. et al. (2010), Omara M. et al. (2016) and Ahmed H. and Bahaa El-Din A. Tawfik (2020). [14-17] The autogenous bone ring technique may be defined as a modification of autogenous bone blocks used for the three dimensional (3D) augmentation of alveolar defects and simultaneous implant placement. [18]

A minimum of 5-6 mms of residual bone height is recommend by some authors for the one-stage

surgical procedure of sinus lifting and implant placement [19], while others have concluded that if adequate primary stability can be gained by modified surgical techniques, a one-stage surgical technique that allows implant placement even with 1–2 mm of residual bone can be performed. [8,20] These findings are in general agreement with the current study as primary stability of implant and bone ring were gained from the remaining residual bone except in two cases as residual height was less than 2 mm and mini titanium screws were used to aid in the stability of fixation of the bone ring.

In this study using bone ring reduced the amount of bone volume needed in comparison to the use of particulate bone for grafting the sinus in the control group due to increase sinus uptake as documented by other studies. [21,22] In another study on maxillary sinus floor augmentation with simultaneous implant placement using autogenous block of bone grafts showed superior result regarding bone healing around dental implants compared to autogenous particulate bone grafts. [23]

The main advantages of a one-stage procedure include decreasing the number of surgical interventions required and reduced overall healing time and the bone graft stabilization is provided with implants. Generally, the single-stage approach has proven to be safe and effective. [24] An important disadvantage of the combined graft-implant procedure is that the graft failure also means implant failure.

In conventional two stages sinus lift procedure the healing period of graft up to 1 year. The overall required healing period from sinus elevation surgery until restoration could vary between 9 and 12 months. In a study introduced by Peter D. Wang et al. (2002) a pre-osseointegrated implant from the mandibular symphysis with bone ring and used for grafting maxillary sinus and the total treatment time reduced to 8 months, however in the current study as implant and ring inserted simultaneously with the sinus lift procedure the total time was reduced to 5-6 months. [11]

In the present study, selection of the chin as donor site for the bone rings, due to the greater capacity of osteoprogenitor cells compared to other intraoral sites. [25] Also, the harvesting procedure is more convenient, and bone rings of more than 6 mm in three dimensions can be obtained to perform augmentation. [26]

Another important factor to select chin bone graft that is derived from intramembranous bone, which means less resorption of the graft compared to the other grafts derived from endochondral bone e.g. iliac crest, fibula and tibia. Moreover, the harvested bone contains more cancellous bone than other intraoral sites, thus providing a greater amount of osteoprogenitor cells. [25,27]

As known that cancellous graft revascularized more rapidly than the cortical graft, although in cortical membranous bone the revascularization proceeded faster than endochondral cortical bone

with a thicker cancellous component by rapidly ingrowing local blood vessels. [28]

In the current study the selection of intra oral donor site because of the disadvantages of harvesting extraoral bone grafts such as greater resorption, morbidity at the donor site, extended surgical duration and prolonged hospitalization, intraoral donor sites have become more popular than extraoral donor sites. [29] In addition, intraoral harvesting of the donor bone is less stressful for the patient thus, intraoral donor sites are commonly preferred by surgeons for bone transplantation.

The selection of an intraoral donor site is generally depending on the required volume of needed bone and on the anatomical situation of the patient. In this study, we preferred the chin region as the donor site because of easier access and a lower morbidity incidence. [30]

Three to five bone rings for intraoral augmentation can be obtained from the chin region. However, attention must be paid to complications such as mental nerve injury, loss of vitality of the mandibular anterior teeth, chin ptosis, and loss of mentalis muscle support. [31] Careful preoperative diagnosis and meticulous surgical technique are required for a successful outcome.

In the current study, during the outlining of the chin ring it was extremely important to adjust the longitudinal axis of the trephine bur to be perpendicular to the outer cortex of the chin in order to obtain an absolutely cylindrical bone ring. The second important factor was the centralization of the implant osteotomy in the ring to be parallel with the longitudinal axis of the ring.

Conclusion

Overall, we can conclude that the chin bone ring was a reliable technique, although it was technique sensitive but with high rate of success for augmenting atrophic posterior maxillary ridge three dimensionally with simultaneous implant placement. It improves the osseointegration of both bone ring and implant together, thus reducing the period of treatment, if compared with any other technique using autogenous bone graft, from the time the patient decides to restore a tooth till the implant installation.

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