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Tenting Screws versus Conventional Fixation Screws for Vertical Augmentation of Mandibular Ridge

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ABSTRACT:

Objectives: The purpose of this investigation was to compare clinically and radiographically between tenting screws and conventional fixation screws that used for vertical augmentation of posterior mandibular ridge, in combination with resorbable collagen membranes and mixture of autografts and xenografts.

Patients and methods: Patients with missing lower posterior teeth (sixteen tooth to be replaced) accompanied by large vertical alveolar ridge resorption were selected for vertical ridge augmentation with age range 20-40 and divided randomly into two equal groups. Group I: patients have undergone guided bone regeneration using conventional fixation screws. Group II: patients have undergone guided bone regeneration using tenting screws. The screws in both groups were surrounded by a mixture of autografts and xenografts and all covered by a resorbable collagen membrane. Clinical evaluation was assessed on the 1st, 3rd, and 7th days after surgery, while radiographic evaluation using cone-beam computed tomography was performed immediately postoperative and after 6 months follow up period and statistical analysis was applied.

Results: Clinical results: there was insignificant difference among two groups in terms of wound healing. Radiographic results: there was a statistically significantly higher bone gain and lower graft resorption in tenting vs. conventional group.

Conclusions: Based on the results obtained from this study with respect to its limitations, tenting screw technology is a reliable technique for vertical ridge augmentation compared to the traditional GBR technique by providing mechanical support to the membrane, increasing the stability of the graft particles below.

Key Words: GBR, tenting screws, tent pole technique, bone height, vertical ridge augmentation.

I. INTRODUCTION

The utilization of dental implants for the rehabilitation of edentulous regions as well as the establishment of optimum gingival shape and aesthetics is hindered by the increasing decrease in alveolar bone volume after tooth loss.[(1)] In the posterior regions of the mandible, the existence of the inferior alveolar nerve further complicates the optimal placement of dental implants.[(2)]

The most difficult advanced bone grafting technique is still vertical ridge augmentation (VRA). For the restoration of these extensive vertical defects prior to implant insertion, various approaches have been described including onlay block grafts,[(3)] inlays grafts, distraction osteogenesis,[(4)] porous titanium mesh tray,[(5)] guided bone regeneration,[(6)] or a combination of these.[(7)]

The surgical procedure known as guided bone regeneration (GBR) uses barrier membranes with or without bone substitutes to augment the alveolar ridge.[(8)] The basic idea behind GBR is that the barrier membrane will provide a space, excluding soft tissue cells and allowing the surrounding bone's cells to grow into that space and develop into new bone.[(9)] For the preservation of this space, bone plates, membranes, tenting screws, and bone replacements are indicated.[(10)]

Particulate grafting methods use fixation screws to hold the membrane in place and establish the geometry of the desired bone. As the screw head has a small diameter, these screws can occasionally get exposed leading to graft resorption. Therefore, it is shown to be crucial for predictable results to use a screw with a broad head, often known as a "tenting screw".[(11)]Tenting screws have a number of benefits, such as quick and simple screw installation, a single surgical site,

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reduced morbidity, and space preservation for GBR materials. [12]

Barrier membranes are classified as resorbable and non resorbable membranes. Bio absorbable membranes appear to offer some advantages over non resorbable membranes. Resorption avoids the need for additional surgery to remove the membrane, decreasing discomfort, and the expense of another surgery.[13]The best standard of care for GBR applications is the use of a bone substitute material. Autogenous bone grafts are regarded as the gold standard for bone grafting because they enable bone regeneration through principles of osteogenesis, osteoconduction, and osteoinduction.[14] They are also characterized by their non-immunogenic properties and their osteogenic ability.[15]

Xenografts are bone grafts derived from animals or other non-human species.[8] They are said to have enhanced connective tissue ingrowth, postponed vascularization, and slower rates of resorption.[16]Deproteinized bovine bone (DBB) can be combined with autogenous particulate bone and applied as a composite in difficult cases that call for more bone augmentation.[17] This technique can be used to improve graft conservation over time, treat patients while they are under local anesthesia, and lessen postoperative morbidity.[18]

Therefore, it was of interest to evaluate clinically and radiographically the efficacy of using tenting screws for reconstruction of vertical ridge atrophy of posterior mandible in comparison to conventional fixation screws, combined with resorbable collagen membranes and mixture of autografts and xenografts.

II. PATIENTS AND METHODS

Patients with missing lower posterior teeth (sixteen tooth to be replaced) accompanied by large vertical alveolar ridge resorption, seeking future prosthetic rehabilitation were chosen from the Out-patient Clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University.

This study was approved from the Dental Research Ethical Committee Faculty of Dentistry, Mansoura University. All study participants were chosen at random and told of the study's methodology, goal, advantages of the interventions, and potential dangers before enrollment. All patients were asked to sign an informed written consent about the research procedures. Additionally, they were informed of their freedom to leave the study whenever they want.

♦ **Criteria of Patient Selection:**

Inclusion Criteria

1. Patients with missing lower posterior tooth or teeth with related large vertical bone loss, with about 7mm residual bone height (from the crest of the ridge to the roof of the inferior alveolar canal).
2. Age range of 20 - 40 years old.
3. Proper oral health.
4. Patients who have enough space for prosthesis rehabilitation.

Exclusion Criteria

1. Presence of local infection or lesions.
2. Medically compromised patients with diseases that might affect passively the clinical procedure or result.
3. Patients with parafunctional habits (bruxism and clenching).
4. Uncooperative patients.
5. Heavy smokers(>20 cigarettes/d).[19]
6. Current radiation or chemotherapy.

♦ **Methods:**

I. Preoperative Phase:

1 Personal Data

2 Past Medical and Dental History

3 Preoperative Preparation

- Study casts were made and then mounted on simple hinge articulators
- Baseline intraoral pictures were taken as a record before beginning the suggested treatment approach.
- Preoperative clinical examination through visual examination and palpation.
- Radiographic examination through panoramic x-ray as a screening tool for detection of the selected criteria in the area of operation. Afterwards, cone beam computed tomography (CBCT) was made for cases showing vertical ridge atrophy (about 7mm residual bone height from the crest of the ridge to the roof of the inferior alveolar canal) to evaluate the residual bone height and width.

II. Surgical Protocol:

- The oral cavity was prepared by 0.12% chlorhexidine[1]mouth rinses solution for thirty seconds.
- All surgical procedures were done under local anesthesia. After successful inferior alveolar and buccal nerve blocks using 4% articaine[**]

[1]Hexitol; the Arab Drug Company, Cairo, A.R.E.
[**]Articaine; Alexandria Co. For Pharmaceuticals and Chemical Industries, Egypt.

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with 1:100,000 epinephrine), a three-cornered (triangular) full thickness incision down to the bone was made.

- After that, a full mucoperiosteal flap was reflected and elevated by mucoperiosteal elevator.
- Particulate bone was harvested by the use of autogenous chip maker (ACM) drill from the ramus of the mandible close to the site of operation. Then, a mixture of 1:1 of autografts and xenogafts was created.
- The buccal and lingual cortical plates were perforated.

Group 1: Placement of the conventional fixation screws.

Group 2: Placement of the tenting screws.

- In both groups, a resorbable pericardium collagen membrane was hydrated by saline and fixed buccaly by bone tacks. Then, filling and adaptation of the biomaterial mixture over the screws to completely cover their heads. The resorbable membranes were then adapted over the grafted sites and extended lingually.
- To achieve tension-free flap closure, both buccal and lingual flaps were released enough to obtain complete passive coverage of the graft.
- The flap was repositioned using 4/0 non-resorbable vicryl suture material.
- The sutures were removed 10 to 14 days postoperatively.

All patients were instructed to take Augmentin* (oral antibiotic) 1 tablet every 12 hours for 5 days. A non-steroidal anti-inflammatory drug Cataflam** tablets 2 times daily for 5days. Patients were asked to use chlorhexidine HCL (0.12%) as a mouth wash from second day postoperative and twice daily for 2 weeks to maintain optimal oral hygiene, and to avoid chewing solid textured food or even eating on the site of surgery for 6 months to avoid screws exposure and subsequent loss of bone graft.

IV. Evaluation and follow up:

A. Clinical evaluation:

A careful follow-up was performed for the assessment of the following clinical parameters**:**

1. Wound healing

The area of operation was examined by using healing index by **Landry et al.** on the 1st, 3rd, and 7th days after surgery, [20, 21] this index scores clinical signs and symptoms of infection as redness, hotness, pus discharge, bleeding and pain. In addition to that, any manifestations of wound healing disturbance including wound dehiscence and exposure of underlying bone graft were recorded carefully.[22]

2. Sensory disturbance

Sensory disturbance regarding the inferior alveolar nerve was also recorded.

B. Radiographic evaluation:

A CBCT was performed immediately postoperative **(Baseline, T_0)** and after 6 months of follow up **(T_6)** then the images were interpreted by both radiologist and clinician to diminish any possible errors (double blind interobserver).

The CBCT was carried out in order to assess the height of the gained bone regarding the screws as reference point of measurement and determine the amount of graft resorption after 6-months of follow up.

Statistical Analysis

Data were entered and analyzed using IBM-SPSS software (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Using the Shapiro-Wilk test, quantitative data were firstly checked for normality; if $p>0.050$, the data were considered to be normally distributed. Boxplot inspection was used to check for the presence of significant outliers (extreme values). Quantitative data that were normally distributed were expressed as mean, standard deviation, and standard error, while data that were not normally distributed were expressed as median, minimum, and maximum.

To compare normally distributed quantitative data between two groups, the independent-samples t-test was performed. Paired-samples t-test was used to compare normally distributed quantitative paired data in a group. One-way ANCOVA was used to compare normally distributed quantitative data between two groups using another variable (immediate reading) as a covariate. Two-way mixed ANOVA was used to compare repeatedly measured data over time between two groups. To compare non-normally distributed quantitative or ordinal data collected over several time points in a group, Friedman's test was applied. Results were deemed statistically significant for any of the applied tests if the P value ≤ 0.050.

* Augmentin (Amoxicillin 875 + Clavulanic Acid 125): Manufactured by GlaxoSmithKline.

** Cataflam (Diclofenac Potassium 50mg): Manufactured by Novartis (Swiss Multinational Pharmaceutical Company). Www. Novartis .com.

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III. RESULTS

♦ **Demographic data**

This study was conducted on patients with missing lower posterior teeth (sixteen tooth to be replaced) accompanied by large vertical alveolar ridge resorption, and need vertical ridge augmentation to enable future implant placement. All surgeries were done under local anesthesia and there were no recorded complications during the surgeries. Patients were clinically evaluated on the 1st, 3rd, and 7th days after surgery and radiographically evaluated immediately postoperative and after 6 months follow up period.

I. Clinical Evaluation:

1. Wound healing

The area of operation was evaluated by using healing index by **Landry et al.** on the 1st, 3rd, and 7th days after surgery. The results of postoperative wound healing of both groups were revealed in table (3). In group 1, median of wound healing score was 3 on day 1, 3 on day 3 and 4 on day 7. In group 2, median of wound healing score was 4 on day 1, 4 on day 3 and 4 on day 7.

There was no statistically significant difference in wound healing score between the three time points in each group as well as between the two groups.

Three out of eight implant sites in the conventional screw group showed wound dehiscence and screw exposure. However, wound dehiscence occurred in only one implant site in the tenting screw group. These sites were handled by resuturing and tension free flap closure in addition to 0.5% chlorhexidine gel, 0.12% chlorhexidine rinse, and amoxicillin/clavulanic acid (875/125 mg) twice a day for 7 days.

Table (1): Wound Healing Score over Time in Each Group

Group	Day 1			Day 3			Day 7			p-value
	Median	Minimum	Maximum	Median	Minimum	Maximum	Median	Minimum	Maximum	
Conventional	3	3	4	3	2	4	4	1	4	0.867
Tenting	4	4	4	4	3	4	4	2	4	0.368

Notes: Test of significance is Friedman's test.

2. Sensory disturbance

The patients did not report any sensory disturbance along the course of the inferior alveolar nerve.

II – Radiographic Evaluation:

● **Residual Ridge height (RRH):**

During preoperative assessment, the residual ridge height was measured by getting the average of three lines (buccal, lingual and midlines) drawn from the roof of the inferior alveolar canal to the alveolar crest at the planned implant site in the cross-sectional cut. The mean value of **RRH** was 7.36 ± 0.76 mm in group 1. While in group 2, the mean value of **RHH** was 7.27 ± 0.53 mm.

Comparing the residual ridge height between the two groups, there was no statistically significant difference.

Table (2): Residual Ridge Height in Conventional vs. Tenting Group

Group	Residual ridge height			t-value	p-value
	Mean	**SD**	**SE**		
Conventional	7.36	0.76	0.27	0.267	0.794
Tenting	7.27	0.53	0.19		

Notes: SD = standard deviation. SE = standard error. Test of significance is independent-samples t-test.

● **Immediately Postoperative Residual Ridge height (H_1):**

The original ridge height was measured immediately postoperative (**T_0**) regarding the screws as reference point by getting the average of three lines (buccal, lingual and midlines) drawn from the roof of the inferior alveolar canal to the crest of the original ridge.

●**Immediately Postoperative Total Bone Height (H_2):**

The total bone height was measured immediately postoperative (**T_0**) regarding the screws as reference point by getting the average of three lines (buccal, lingual and midlines) drawn from the roof of the inferior alveolar canal to the crest of the augmented bone. The mean value of immediately postoperative total bone height was 12.04 ± 0.58 mm in group 1and 11.88 ± 0.59 mm in group 2.

● **Postoperative Total Ridge Height at T_6 (H_3):**

The total ridge height was measured after 6 months of follow up after grafting (**T_6**) regarding the screws as reference point by getting the average of three lines (buccal, lingual and midlines) drawn from the roof of the inferior alveolar canal to the

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crest of the remaining bone. The mean value of total ridge height after 6-months postoperative was 10.85± 1.12 mm in group 1and 11.33 ± 0.73mm in group 2.

Comparing total ridge height immediately and 6-months postoperative, there was a statistically significantly lower postoperative total ridge height at 6-months vs. immediate in both conventional and tenting groups.

Comparing total ridge height between the two groups at each time point (table 6), there was no statistically significant difference in total ridge height between the two groups both immediate and at 6-months.

Table (3): Comparison of Immediate vs. 6-Months Postoperative Total Ridge Height

Group	Immediate			6-months			t-value	p-value
	Mean	**SD**	**SE**	**Mean**	**SD**	**SE**		
Conventional	12.04	0.58	0.21	10.85	1.12	0.40	5.855	**0.001**
Tenting	11.88	0.59	0.21	11.33	0.73	0.26	4.398	**0.003**

Notes: SD = standard deviation. SE = standard error. Test of significance is paired-samples t-test.

Table (4): Comparison of Total Ridge Height between the Two Groups at Each Time Point

Group	Conventional			Tenting			t-value	p-value
	Mean	**SD**	**SE**	**Mean**	**SD**	**SE**		
Immediate	12.04	0.58	0.21	11.88	0.59	0.21	0.545	0.595
At 6-months	10.85	1.12	0.40	11.33	0.73	0.26	-1.026	0.322

Notes: SD = standard deviation. SE = standard error. Test of significance is independent-samples t-test.

Comparing of 6-months total ridge height between the two groups adjusted with immediate reading as a covariate, 6-months total ridge height was statistically significantly higher in tenting vs. conventional group.

Table (5): Comparison of 6-Months Total Ridge Height between the Two Groups Adjusted with Immediate Reading as A Covariate

Group	Unadjusted		Adjusted		F	p-value	Partial η^2
	Mean	**SD**	**Mean**	**SE**			
Conventional	10.85	1.12	10.73	0.15	11.699	**0.005**	0.474
Tenting	11.33	0.73	11.45	0.15			

Notes: SD = standard deviation. SE = standard error. Test of significance is one-way ANCOVA.

● **Amount of Bone Gain (BG):**

The vertical bone gain resulted from the ridge augmentation was calculated by subtracting the residual bone height **(H_1)** at **T_0** (immediately postoperative) from the total bone height (**H_3**) at **T_6** (after 6 months of follow up after grafting). In group 1, the mean value of bone gain was 3.49 ± 0.44 mm. while, the mean value of bone gain in group 2 was 4.06 ± 0.52 mm.

BG = (**H_3 - H_1**).

Comparing the amount of bone gain between the two groups, there was a statistically significantly higher bone gain in tenting vs. conventional group.

Table (8): Comparison of Amount of Bone Gain between the Two Groups

Group	Amount of Bone Gain			t-value	p-value
	Mean	**SD**	**SE**		
Conventional	3.49	0.44	0.16	-2.372	**0.033**
Tenting	4.06	0.52	0.18		

Notes: SD = standard deviation. SE = standard error. Test of significance is Independent-samples t-test.

● **Amount of Graft Resorption (GR):**

The amount of graft resorption after ridge augmentation was calculated by subtracting the total bone height at **T_6** (after 6 months of follow up after grafting) from the total bone height at **T_0** (immediately postoperative). In group 1, the mean value of graft resorption was 1.20 ± 0.58 mm. while, the mean value of bone gain in group 2 was 0.55 ± 0.36 mm.

GR = (**$H_2 - H_3$**)

Comparing the amount of graft resorption between the two groups, there was a statistically

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significantly lower graft resorption in tenting vs. conventional group.

Table (9): Comparison of Amount of Graft Resorption between the Two Groups

Group	Amount of graft resorption			t-value	p-value
	Mean	**SD**	**SE**		
Conventional	1.20	0.58	0.20	2.680	**0.018**
Tenting	0.55	0.36	0.13		

Notes: SD = standard deviation. SE = standard error. Test of significance is Independent-samples t-test.

IV. DISCUSSION

Bone remodeling following tooth extraction frequently results in insufficient ridge dimensions for the appropriate three-dimensional implant placement.[23]The deficiency of bone volume, which is frequently accompanied with deficit soft tissues, constitutes a significant obstacle for the clinician. Bone augmentation (horizontal and/ or vertical) using different techniques, based on different biological principles, is often performed to overcome these deficiencies.[24]

GBR has been successfully employed in dental practice since it provides clinicians with sufficient amount of bone needed for implant site development. This procedure relies on the "cell exclusion" concept, which confines connective/epithelial soft tissue cells outside of the defect area so that only osteoprogenitor cells may colonize it.[25] However, it is challenging to reconstruct a vertical defect because the graft migrates and resorbs as a result of the surrounding soft tissue matrix contraction, leading to a net loss of bone. When surgically expanded, soft tissue matrix maintains the gap and so inhibits graft resorption.[1, 26]

The use of tenting screws or tent poles has been suggested to overcome the limitations of GBR for the reconstruction of vertical bone deformities. The "tent-pole" grafting technique's rationale is that utilizing screws will assist avoid graft collapse up to the level of the screw heads.[27] To prevent graft materials from collapsing during this procedure, the membrane and supporting screws are the essential elements supporting the reconstructed area. In order to provide the safe dissipation of masticatory forces over the grafted area, the stability of the membrane and tent pole screws are crucial.[9, 28]

The present study assessed the clinical and radigraphical outcomes of GBR in vertical bone regeneration of atrophic human posterior mandibles using tenting screws comparing them with conventional fixation screws, in combination with resorbable collagen membranes and mixture of autografts and xenografts. Six patients were included and completed the study for a total of 16 sites for future implantation. This is certainly not a large sample size; however, as the two techniques were performed in the same site (posterior mandible), the variation within patients was minimized; hence, this sample size can be considered enough for a preliminary study.

Our hypothesis was that using tenting screws in conjunction with GBR exerted a favorable impact on vertical ridge height to support the bone graft and resulted in much more gain in bone height as well as less graft resorption in comparison with the conventional fixation screw group.

The outcomes clearly demonstrated that both techniques were successful for vertical ridge augmentation as they both allowed proper bone remodeling within six months from the grafting procedure.

In the current study, we used a mixture of autogenous particulate and xenograft beneath a pericardium collagen membrane to benefit from the slow resorption rate of xenograft material along with the osteogenic potential of the autogenous particulate grafts. This comes in accordance with **Boyne (1990)**[29] who compared autogenous iliac bone with a mixture of 1:1 autograft and DBB. A radiographic assessment demonstrated a bone height reduction of more than 60% with the autograft and of only 20% for the 1:1mixture. **Simion et al.**[30] also supported the use of DBB in a 1:1 combination with autogenous bone chips for vertical augmentation of atrophic ridges by means of GBR techniques. Recent studies have also severely supported the idea of using autogenous bone graft (ABG) in combination with biomaterials such as particulate low resorption rate bone substitutes (xenografts) and resorbable membranes to provide a dependable and successful approach for the restoration of severely resorbed ridges.[31]

Pericardium collagen membranes were used in this study to eliminate membrane removal after healing, resulting in reduced morbidity which often associated with nonresorbable membranes and therefore improved primary wound healing.[32]**Urban et al.**[33] showed that collagen membranes could be used successfully over mixture of auto and xenograft for horizontal ridge augmentation. Titanium tacks were used in our

study to fix the membranes to the normal bone to inhibit graft migration and soft tissue invasion. Tacking membranes also made suturing easier because the membrane did not move while being stitched.

Incision line opening and soft tissue dehiscence is the most frequently reported postoperative complication during ridge augmentation especially in VRA in the posterior mandible due to the higher cortical bone content in this region and the difficulty in achieving tension-free primary flap closure leading to a compromised blood supply in this area.[34] **Le et al.**[27] reported wound dehiscence and screw exposure occurred in 4 patients (26.7%), resulting in partial loss of graft material. They attributed the cause of this complication to the large vertical defect (15 mm) and large span defects. **Leong, Daylene Jack-Min et al.**[35] also reported that incision line opening and wound dehiscence had occurred in 30% of the cases in his GBR group comparing them with allogenic block graft group of vertical ridge augmentation.

However, these studies are not in agreement with the results of our study where the soft tissues healed uneventfully during the 6 months after surgery except 37.5% of the cases in the conventional screw group and only 12.5% of the cases in the tenting screw group where wound dehiscence and screw exposure occurred. The effect of muscle pulling and the quality and quantity of the soft tissue could contribute to this complication, but the reduced rate of dehiscence in the test group compared with the control group might be explained by the broad head of the tenting screws which provided more tenting action within the overlying soft tissue without being exposed.

The lower rate of wound dehiscence in this study in comparison with **Le et al.** and **Leong, Daylene Jack-Min et al.** studies could be due to the sufficient release in the buccal and lingual flaps to achieve passive closure over the graft. The lingual flap was released by using digitoclastic technique which was described by **R Pistilli et al.**[36] to allow progressive atraumatic detachment of the periosteum and the vertical fibers of the accessory mylohyoid muscle and coronal displacement of the lingual flap without any tension. Also, using two lines of suturing (horizontal mattress and interrupted suture) could aid in reducing wound dehiscence complication in this study. This complication was handled by re-suturing and tension free flap closure in addition to 0.5% chlorhexidine gel, 0.12% chlorhexidine rinse, and amoxicillin/clavulanic acid (875/125 mg) twice a day for 7 days.

During the harvest of particulate bone graft, particularly at the distal area of the donor site, iatrogenic damage to the inferior alveolar nerve is a potential.[37]**Khoury et al.**[38] observed that 0.5% of individuals had minor sensory disturbances that persisted no longer than six months. In the current study, no sensory impairment was reported due to meticulous planning and the ACM's limited depth of cut.

In this study, CBCT was done immediately postoperative and after 6-months of follow up after surgery to evaluate the amount of bone gain as well as graft resorption in both conventional fixation and tenting screws groups.

Regarding to bone height, there was a statistically significantly higher bone gain in tenting group (mean bone gain was 4.06 ± 0.52 mm) vs. conventional fixation screw group (mean bone gain was 3.49 ± 0.44 mm). Also, there was a statistically significantly lower graft resorption in tenting vs. conventional group. This could be related to the broad head of the tenting screws providing effective space maintenance by creating a support for the barrier membrane against external forces, thereby helping the membrane hold its volume and shape during the healing period.[39] the higher rate of wound dehiscence in the conventional fixation screw group also might result in the increased amount of graft resorption.

This agreed with **Le et al.**[27] study**,** who concluded that it is possible to augment large vertical ridge defects by appropriately placing titanium screws interposed by particulate graft. **Rocchietta I, et al**[40] also demonstrated mean height gains of 2.91 mm and 4.36 mm from baseline for the autogenous block and particulate grafts, respectively, when the grafts were covered by an ePTFE membrane.

On the other hand, **Chasioti et al**[39] and **Caldwell et al.**[41] disagreed with the present study as they suggested that tenting screw may be the best technique to augment the width of a short-span alveolar ridge before the placement of implants. As bony resorption is relatively high, the technique is not appropriate for vertical augmentation, or the horizontal augmentation of atrophic ridges (3 dimensional reconstruction), or large defects.[39, 41]

Within the limits of this study, it is possible to identify that the adjunctive use of tenting screws enhanced the outcomes of hard tissue regeneration when compared to the traditional GBR technique by providing mechanical support to the membrane, increasing the stability of the graft particles below. Tenting screw technology has additional benefits, such as quick and simple

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screw insertion, low morbidity, a single surgical site, and space preservation for GBR materials.

V. CONCLUSIONS:

Based on the results obtained from this study with respect to its limitations, tenting screw technology is a reliable technique for vertical ridge augmentation compared to the traditional GBR technique by providing mechanical support to the membrane, increasing the stability of the graft particles below.

Cases presentation.

Group 1(Conventional Fixation Screw Group):

A 35-year-old female presented to the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University requesting to replace missing teeth #35, 36, and 37 with dental implants.

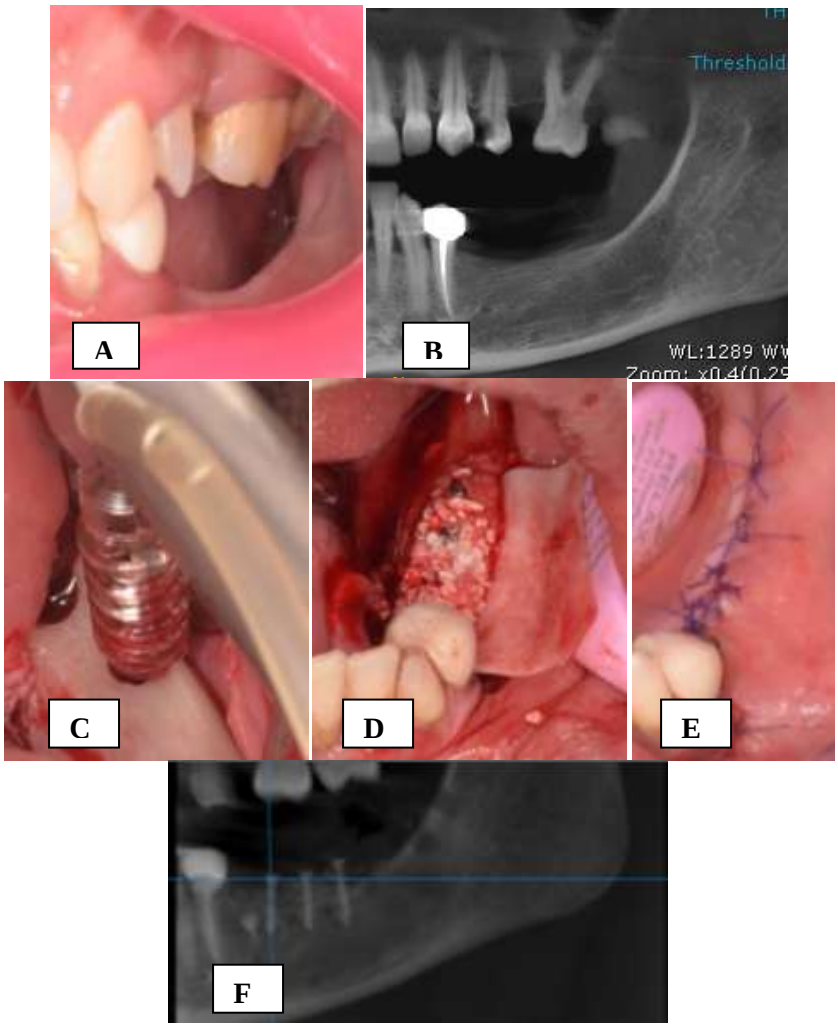

Figure 1: A) Clinical preoperative photographs showing #35, 36, and 37 from direct lateral view. B) Preoperative panoramic radiograph showing missing #35, 36, and 37. C) Intraoperative clinical photograph showing harvesting autogenous bone graft using ACM from the left mandibular ramus as the donor site in the same area of surgery. D) Intra-operative clinical occlusal photograph showing the mixed bone graft tightly packed underneath the membrane. E) An intraoperative clinical photograph showing primary, tension-free flap closure. F) A postoperative Radiograph showing immediate post-operative panoramic view.

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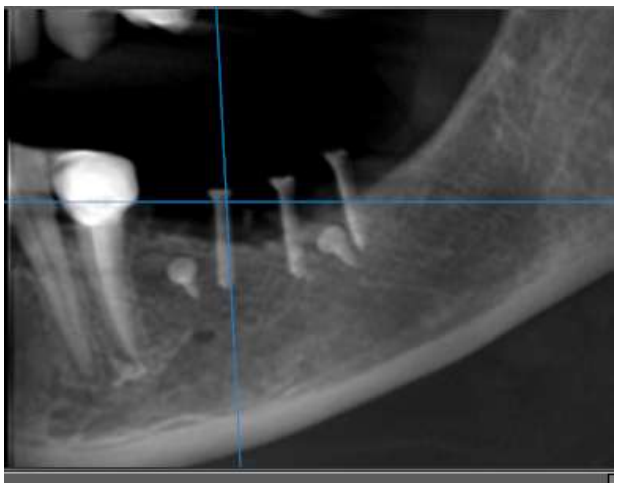

Figure 2: A 6-months follow up radiograph showing the vertical amount of bone gain.

Group 2(Tenting Screw Group):
A 40-year-old female presented to the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University requesting to replace missing teeth #36, and 37 with dental implants.

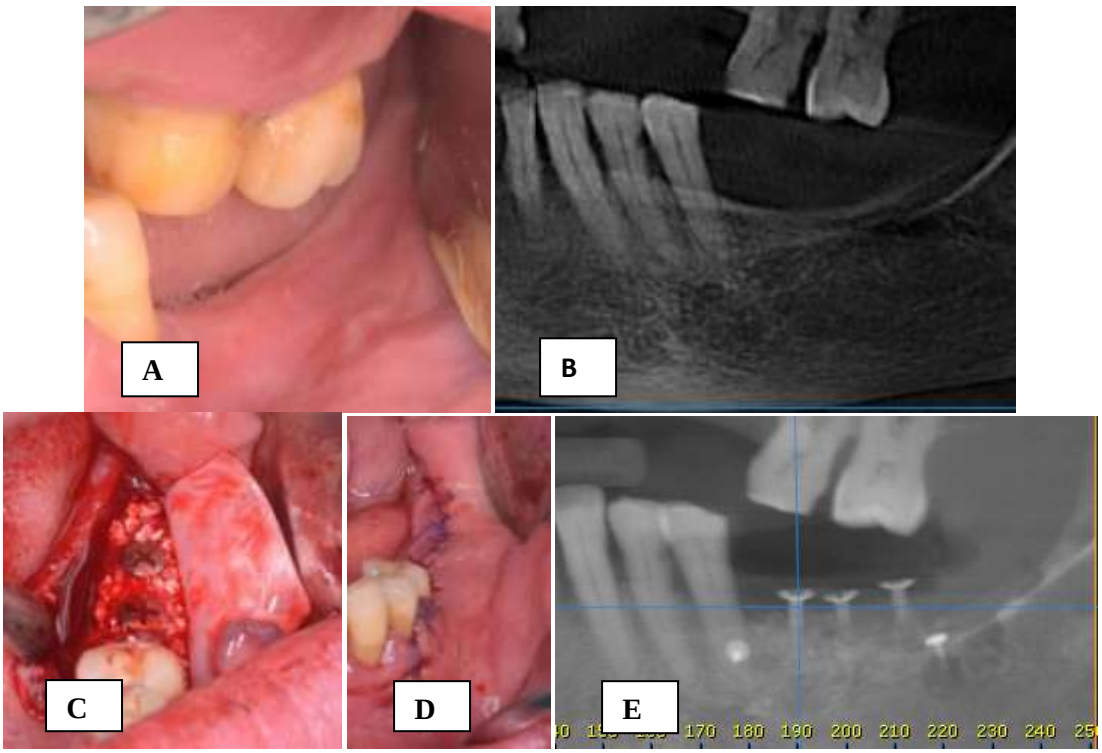

Figure 3: A) Clinical preoperative photographs showing #36, and 37 from direct lateral view. B) Preoperative panoramic radiograph showing missing #36, and 37. C) Intra-operative clinical occlusal photograph showing the mixed bone graft tightly packed underneath the membrane D) An intraoperative clinical photograph showing primary, tension-free flap closure. E) A postoperative Radiograph showing immediate post-operative panoramic view.

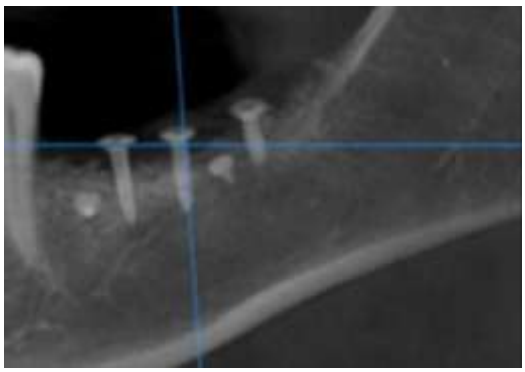

Figure 4: A 6-months follow up radiograph showing the vertical amount of bone gain.

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