

Evaluation of Two Treatment Modalities for Patients with Combination Syndrome Suffering From Narrow Anterior Maxilla

Tamer Omar Ibrahim¹ and Riham Omar Ibrahim²

¹Department of Prosthodontics, Faculty of Dentistry, Ain Shams University, Cairo, Egypt

²Department of Oral Medicine, Periodontology and Oral Diagnosis, Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt
drtamomar@yahoo.com

Abstract: Background: The success of a single maxillary denture in Combination syndrome relies on the principles of retention, stability and support. Severely resorbed maxillary edentulous ridges that are narrow and constricted with increased inter ridge space will affect this success. Subjects and Methods: Ten patients with a Combination syndrome suffering from narrow anterior maxilla and mandibular Kennedy Class I were included in this prospective clinical study. Patients were randomly divided into two groups. Group I received four Xive implants supported and retained complete maxillary overdenture with the anterior maxilla augmented with autogenous bone block chin graft. Group II received four Xive implants supported and retained complete maxillary overdenture with the anterior maxilla augmented with vertical ridge splitting and heterogenous bone fill particles of lyophilized deantigenized animal equine collagen, and biocollagen resorbable membrane. Results: The results of this study revealed non-significant increase in the mean bone height loss after 6, 12 and 18 months follow up period in group I and group II. There was a non-significant difference in the mean bone height loss between group I and group II at different follow up periods. Conclusions: After one and a half years of implant retained and supported overdenture, clinical and radiographic data demonstrated that implants can be successfully placed in either alveolar ridges augmented with autogenous bone or ridge splitting with Bio-Gen and Biocollagen membrane. Also, this study exhibited peri-implant stability with high survival, healthy peri-implant tissue and the marginal bone ridge values were satisfactory around implants.

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1. Introduction:

Combination syndrome is a well known phenomenon which occurs when anterior edentulous maxilla is opposed by natural mandibular anterior teeth. Combination syndrome characteristic features include loss of bone from the maxillary anterior ridge, overgrowth of the tuberosities, papillary hyperplasia of the hard palatal mucosa, extrusion of mandibular anterior teeth, and loss of alveolar bone and ridge height beneath the mandibular removable partial denture bases, also called anterior hyperfunction syndrome.⁽¹⁾ “The early loss of bone from the anterior part of the maxillary jaw is the key to the other changes of the combination syndrome.”⁽²⁾

Bone resorption is inevitable and has been called “a major oral disease entity.”⁽³⁾ Bone resorption that occurs under dentures can affect not only the alveolar bone but also the basal bone.⁽³⁻⁶⁾

Prosthodontist try overcoming this Combination syndrome by careful treatment planning, using preventive, therapeutic and functional treatment modalities which may require a multi disciplinary approach involving surgical

intervention such as planned extractions followed by immediate dentures, vestibuloplasty, excision of flabby tissue followed by metallic denture base prosthesis, implant supported fixed prosthesis, implant supported over dentures. Treatment planning for the completely edentulous maxillary arch is by restoring a stable posterior occlusion, while minimizing occlusal pressures on the anterior maxilla. Prevention of the combination syndrome must be our primary objective.

Implant Placements can be used in rehabilitating a completely edentulous maxilla using implants like implant supported fixed ceramo-metal prosthesis with gingival ceramic, implant supported fixed ceramo-metal prosthesis, implant supported overdenture or an implant and tissue supported overdenture.⁽⁷⁾

Autogenous block graft is considered the “gold standard” in ridge augmentation procedures because of its osteogenic, osteoinductive and osteoconductive properties. Intraoral autogenous grafts have several benefits, such as, less bone resorption after healing when compared to extraoral sites⁽⁸⁾ and graft

harvesting can be performed under local anesthesia.⁽⁹⁾ Their limitations, on the other hand, are donor site morbidity and limited availability.

In 1992, Simion *et al.*⁽¹⁰⁾ introduced a split-crest technique to widen the edentulous ridge and put the implant in place simultaneously. In this procedure, the bone is spread apart to create a wedge-shaped space-making defect, and the implant is placed between it.

Bone-graft materials, used in ridge preservation cases, maintain space and promote bone growth primarily by their osteoconductive activity.⁽¹¹⁾ Graft resorption and new bone formation may differ significantly between different osteoconductive materials.⁽¹²⁾

Barrier membranes were generally used to exclude unwanted cells (fibroblasts) from populating the surgical site thus promoting bone regeneration. BioCollagen absorbable membranes have some biologic advantages such as the higher stimulation of DNA synthesis over non-resorbables membranes.⁽¹³⁾ A collagen membrane contains and protects the particulated graft particles placed and also the membrane could potentially retard graft resorption.

Both implant-retained and implant supported prosthesis have become increasingly popular in the past 30 years and have been proven to be a successful prosthetic rehabilitation for partially and completely edentulous maxilla and mandible.^(14,15)

Implant-retained overdentures are supported, retained, and stabilized by both implants and mucosa; therefore they generally require fewer implants than fixed implant prostheses. In the maxilla, four endosseous implants, are considered the minimum number needed for overdenture treatment with the palatal coverage and proper extension of the overdenture.⁽⁷⁾

The aim of this study was to compare the difference in bone height and width of narrow maxillary ridge augmented with autogenous bone graft versus ridge splitting with bone fill allograft and biocollagen membrane in the treatment of combination syndrome with implant supported overdenture.

2. Subjects, Materials, and Methods

This prospective clinical study was conducted on ten patients requiring multiple implant replacement in the maxillary anterior region, admitted to the outpatient clinic of the Prosthodontics Department, Faculty of Dentistry, Ain Shams University and Oral Medicine and Periodontology Department, Faculty of Oral and Dental Medicine, Cairo University between August 2010 and April 2011.

Criteria for Patients selection:

Inclusion Criteria:

- 1) Patients with narrow completely edentulous maxillary arch and mandibular bilateral distal extension edentulous area (Kennedy class I) with the anteriors and first premolars or canines as the last standing teeth.
- 2) Recipient site of implant should be free from any pathological conditions.
- 3) Males age ranged between 45 to 55 years.
- 4) Systemic condition of the subjects evaluated according to Modified medical Cornell index.⁽¹⁶⁾
- 5) Patients should be cooperative, motivated and hygiene conscious.
- 6) All selected patients had at least 11mm residual bone height from the crest of the ridge up to the maxillary sinus.
- 7) Patient with resorbed buccolingual residual maxillary ridge and covered with dense fibrous connective tissue firmly attached to underlying bone with no signs of inflammation or ulceration.
- 8) Patients had normal ridge relationship (Skeletal Angle's class I maxillomandibular relationship) and adequate inter-arch space.
- 9) The remaining teeth were free from periodontal disease.
- 10) Patients had their last tooth extraction at least three months before commencing treatment.

Exclusion criteria:

- 1) Patients with history of drug abuse or catabolic drugs or psychiatric disorder.
- 2) Patients unable to undergo minor oral surgery.
- 3) Patients with unrealistic expectations about esthetic outcome of implant therapy.
- 4) Patients with habits that might jeopardize osseointegration process such as heavy smokers and alcoholism.
- 5) Patients with impacted teeth or remaining roots.
- 6) Patients free from neuromuscular disorders and suffering from temporomandibular joint disorders.
- 7) Patients with no history of chemotherapy and radiotherapy.

Patients grouping

Patients participating in this study were randomly divided into two equal groups

Group I:

Patients in this group received four implants supported and retained complete maxillary overdenture with the anterior maxilla augmented with autogenous bone block chin graft and mandibular tooth-tissue supported partial denture.

Group II:

Patients in this group received four implants supported and retained complete maxillary overdenture with the anterior maxilla augmented with vertical ridge splitting and heterogenous bone

particles of lyophilized deantigenized animal equine collagen, and biocollagen resorbable membrane.

Each patient was instructed to sign a Medico-Legal written consent with detailed information about: The Surgical, Prosthetic, Radiographic, Photographic and Laboratory procedures. The possible post-operative complications and implant failures. The recall visits for follow-up and the parameters that would be assessed. All the patients were motivated to the treatment and were informed that they will be a part in a study that needs their best co-operation.

I Pre-operative Phase:

Patients examination

1. Medical examination:

Past and present medical and dental history were collected from all patients through questionnaire to ensure absence of cardiovascular diseases, diabetes, metabolic disorders, allergy, osteoporosis and impaired psychological conditions. Laboratory investigations including complete blood picture and blood glucose level.

2. Clinical examination:

Visual and digital intraoral examination were carried out for the mucosa covering the residual ridge to ensure that the mucosa was firm, healthy and free from signs of inflammation, infection, or irritation. Also, to detect presence of any thin, flabby tissues, sharp ridges, bony spicules, enlarged tuberosity, or papillary hyperplasia. The alveolar ridges at the prospective implants sites were palpated to ensure the absence of any flabby tissues, bony undercuts.

Thorough periodontal therapy of all the remaining teeth including supra-gingival and sub-gingival scaling and root planning was performed. Carious teeth were restored. All patients were motivated to follow proper oral hygiene measures.

Examination of the T.M.J was carried out to detect any disorders as clicking, dislocation or pain. The tongue was also examined to detect tongue size and position

3. Evaluation of diagnostic cast

a. Preliminary impressions for both arches were made using irreversible hydrocolloid impression material (Cavex, Holland) in properly adjusted stock trays and poured into dental stone (Type III dental stone. Lascod SpA, Sestofino (fl), Italy) to produce study casts.

b. The upper and lower diagnostic casts were mounted on fixed condylar path articulator (Rational, Detery, Germany) according to a provisional inter occlusal wax record to evaluate the available inter arch space, and determining the presence of any over-erupted or tilted teeth, and the required occlusal adjustments. Over erupted teeth were reduced and marked on the diagnostic cast to be

used as a guide for performing the needed adjustments intra-orally.

4. Construction of preoperative radiographic template

A duplicate of the diagnostic casts were used for construction of the diagnostic radiographic stents. Self-cured acrylic resindough (Acrostone, Self-Cured, Acrostone Dental factory, Egypt, under Exclusive License from WIW, England) was mixed and adapted to the upper cast and the edentulous areas of the lower cast. After polymerization of acrylic resin, the templates were finished, polished and checked in the patient's mouth. Trial setting up of teeth was made to help in determining the proposed implant sites. Then acrylic template was flaked and processed with clear heat cured acrylic resin (Acrostone, Heat-Cured, Acrostone Dental factory, Egypt, under Exclusive License from WIW, England).

Two metallic balls 4 mm in diameter were fixed bilaterally in the canines and first molar area of the upper template. The stents with the metallic balls were positioned in patient's mouth during the radiographic evaluation.

5. Radiographic evaluation

Conebeam CT(CBCT):

Pre-operative CBCT was made for patients. The maxillary residual ridge was radiographically evaluated to determine the available bone height by measuring distance between marginal bone and nasal floor and the bucco-lingual width at the proposed implant sites.

Preoperative panoramic radiographs were made for the mandibular abutment teeth that were radiographically evaluated to determine the amount of bone support, crestal bone height, periodontal membrane space, crown/root ratio root form and the presence of any periapical pathosis in the mandibular arch.

II Surgical phase:

For patients of group (I) and (II): Patient management protocol was followed in this study.

Pre- surgical patient management

Prophylactic antibiotic (Augmentin 1 gm Tablets. (Medical union pharmaceuticals Co., Abu Sultan, Ismailia, Egypt) was prescribed two times per day and anti-inflammatory and analgesic Catafast (50 mg. (Granules for oral solution. Diclofenic potassium. Novartis pharma. SAE) was prescribed twice daily 24 hours before surgical operation and was continued for five days after surgery. The patient was asked to rinse with Antiseptol mouthwash (Chlorohexidine gluconate 0.1% Kahira, Egypt) immediately before the operation and one week after operation.

For patients of group (I) and (II): Four occlusal drills were made to remove the metal balls from the radiographic templates, which will be used as surgical stents during implant installation procedures after removal of the labial flange. The surgical stent was tried in the patient's mouth, disinfected with 70% alcohol. Two-stage surgical protocol was followed in this study.

Implant placement surgical phase and anterior maxillary ridge augmentation for group I:

Incision and flap elevation: Strict sterilization rules were followed during the surgical procedures. Patients were anesthetized at the surgical sites by infiltration and bilateral block nerve in the maxilla and mandible using Articaine hydrochloride 4% (Septocaine ® 1.8 ml. Septodont, USA).

Maxillary Bone width was assessed at the implants placement points using a bone caliper.

Three lines pyramidal full thickness flaps (one crestal incision in a slightly lingual position and two buccal vertical releasing incisions). Two pyramidal flaps were reflected bilaterally using mucoperiosteal elevator extending up to the mucogingival line, exposing the alveolar bone at the canine and first premolar areas extending five millimeters mesial and distal the intended osteotomy sites.

Implants installation system:

Xive S plus implants (Dentsply-Friadent, Friadent GmbH, Steinzeugstrabe 50, D-68229 Mannheim, Germany) was used for this study.

The surgical stent was placed in the patient's mouth marking the drill in the proposed implant

sites. Drilling was made using the sequential drills and FRIOS® Unit S/i surgical motor (W&H Dentalwerk Bürmoos GmbH · A-5111 Bürmoos/Austria), the pilot drill (2.0 mm in diameter) was used for the planned depth (Length 11- 13 mm) measured from the crest of the ridge and extending apically in the wider bone ending before the floor of the maxillary sinus by minimum 3mm to ensure primary stability, and increasing the diameter of the drills gradually till the planned diameter (Diameter 3.4).

The implants surgical osteotomies were placed at equal distances from each other, and at equal distances from the midline at equally divided anteroposterior distribution (A-P), and had nearly parallel mesio-distal and bucco-lingual angulations to each other using the parallel pins.

Torque wrench was used for the insertion of the implants in the sites of the osteotomies, the cover screws were applied (Fig.1). Using the sterile paper found inside the suture package, it was outlined with a scissor to measure the amount of bone block bilaterally needed to fill the facial bone defects found around the implants in the maxilla.

After a horizontal incision in the mandibular labial vestibule, a labial full thickness mucoperiosteal flap was elevated, exposing the cortical bone of the chin, the previously outlined paper was held by finger against the chin, four drill holes were made in the corners by surgical fissure bur, successive holes were made to connect the corner holes to form two vertical and two horizontal osteotomies that were carried out using a chisels (Fig.2).

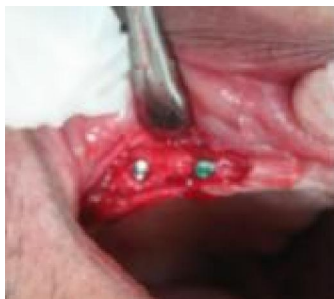


Fig.1 Right three lines pyramidal full thickness flaps reflected and the implants in the sites of the osteotomies



Fig.2 The four corner holes were connected to form two vertical and two horizontal osteotomies.

One chisel was used over another wedged inside the horizontal osteotomy. In this manner, an alveolar bone segment was cut into an inverted trapezoidal shape and separated from the basal bone completely (Fig.3). The transport segment was mobilized totally.

It was positioned and fixed in place with 1.5-mm titanium microscrews. The maxillary and mandibular flaps were closed using bioabsorbable 4-0 sutures adjusted to its formal position over the implant (Fig.4).



Fig.3 The bone block separated from the basal bone completely.



Fig.4 The maxillary flap was closed using bioabsorbable sutures

Implant placement surgical phase and anterior maxillary ridge augmentation for group II:

Incision and flap elevation: Strict sterilization rules were followed during the surgical procedures. Patients were anesthetized at the surgical site by infiltration in the maxilla using Articaine hydrochloride 4%.

Maxillary crestal incision was created in the surgical site, extending distal to the first molar area, split thickness mucoperiosteal flap was made using

No.15 sharp surgical blade. Maxillary Bone width was assessed at the implants placement points using a bone caliper.

A vertical cut was created on the crest of the bone using the ultrathin chisel (split chisel set MCT Mr.Currete Tech, Korea). The cut was done through the cortical bone to reach the spongy bone and extends through the anterior maxillary ridge (Fig.5). Slow separation of the buccal plate of bone was done by consequent thicker chisels.



Fig.5 Ultra thin split chisel was used to cut through the anterior maxillary ridge.



Fig.6 Biogen filling all the gaps around the implants

The surgical stent was placed in the patient's mouth marking drill was used through the stent in the proposed implant sites. Sequential drilling was made in the same manner as for group I regarding anteroposterior distribution (A-P), mesio-distal and bucco-lingual angulations. The implants were slowly tapped into the bone to further expand the bone until all threads were covered and the platform was flush with the crestal bone. Cover screws were placed on the implants.

Deantigenic Equine bone tissue material (Biogen ® Bioteck, Torino, Italy) was placed to fill in all the gaps around the implant (Fig.6), then Biocollagen membrane (Biocollagen ®. Bioteck, Torino, Italy) was used to cover both the graft and the implant (Fig.7). Closure of the flap was done by interrupted sutures using 4-O resorbable suture material adjusted to its formal position over the implant (Fig.8).



Fig.7 Biocollagen membrane used to cover both the graft and the implant



Fig.8 Closure of the flap using 4-O resorbable suture material

III Post- Operative Phase

1. Oral hygiene recommendations including the use of soft toothbrush.
2. Augmentin (1gm. Tablets) was prescribed twice daily for 5 days to avoid the possibility of infection.
3. Catafast (50 mg. Granules for oral solution) was prescribed twice daily for 5 days to reduce inflammation, oedema and pain.
4. Voltaren (IM 75mg/3ml. Diclofenac natrium. Novartis pharma. SAE)
5. Alphenrum (tablets chemotrypsin 14 katal and trypsin 5 katal, Amoun, Egypt.)
6. Antiseptol mouthwash was prescribed during the wound healing.
7. Patients were instructed to apply extra-oral ice bags after surgery.

IV Prosthetic Phase

Patients for both groups were rehabilitated with mucosa supported complete denture and tooth-tissue supported partial denture retained by RPI direct retainer. After eight weeks to ensure complete healing of the supporting mucosa in maxillary arch, Upper and lower primary impressions were made in properly selected and modified stock trays using alginate impression material, and the impressions were poured in dental stone to obtain the study casts. Preliminary surveying of the lower study cast was carried out using dental surveyor to locate retentive undercuts, determine the path of insertion, and detect any interference to this path. Self-cure acrylic resin special trays were constructed on the upper and lower diagnostic casts.

The required mouth preparations were carried out, as drawn on the surveyed lower study cast. Mesial rest seats and distal guiding planes were prepared on each abutment tooth adjacent to the edentulous areas. For the upper arch border molding was made with heavy body rubber base impression material (Zermack Company, Zetaplus, C-Silicone, Italy). Final wash impressions were made using medium body rubber base impression material. The secondary impression was inspected for production of fine details of denture foundation areas, disinfected and poured into improved stone to obtain the master casts. Secondary impression using alginate impression material was made for the lower arch. Impressions were poured in dental stone to obtain the master casts. The lower master cast was finally surveyed. Undesirable undercuts were blocked-out using block-out wax (Schuler-Dental, Ulm, Germany) and trimmed parallel to the path of insertion. Relief wax was also applied to the residual ridge areas to create space for the acrylic denture base. Refractory cast was obtained by duplicating the modified master cast using agar-agar hydrocolloid duplicating material and investment material (Bego,

Bremen, Germany). The framework was cast in Cobalt-Chromium alloy (Bego, Bremen, Germany) and tried in the patient's mouth and adjusted.

An acrylic resin special tray was constructed on lower residual ridge and attached mechanically to the mesh of the framework. The framework with the tray attached to it was tried in the patient's mouth, to ensure that the framework fits accurately. The borders are then shortened and border molded using green stick compound (Kerr Impression compound Kerr Italia Italy) was performed. The tray was then loaded with zinc oxide impression material (Cavex impression paste, Cavex, Holland) and the framework was seated in the patient's mouth. The rests are properly seated and maintained in position until complete setting of the impression material. After the impression has been made and was accepted, the distal extension areas on the master cast were sawed off. The framework with the impression was resealed on the cast, making sure that the framework was perfectly seated in position with no interference anywhere. The impression was beaded, boxed, and the edentulous ridge was poured with dental stone.

Upper and lower occlusion blocks were constructed. The maxillary master cast was mounted on a semi-adjustable articulator (Denatus articulator Type ARH. Jakobsdal. Svagen 14-16. S12653, Hagersten. Sweden) using a face bow (face bow, Type AFB. Jakobsdal. Svagen 14-16. S12653, Hagersten. Sweden) record. Centric occluding relation was recorded following the wax wafer technique to mount the mandibular cast. The horizontal condylar path of the articulator was adjusted using a protrusive record. The lateral condylar path was adjusted by mean of the Hanau's equation.

Modified cross-linked acrylic teeth (Vita-pan acrylic teeth, Vita Bad Sackingen- Germany) were arranged following the lingualized concept of occlusion.

The trial dentures were tried in the patient's mouth to ensure proper facial contour, aesthetic, harmony between centric occlusion and centric relation and simultaneous bilateral occlusal contact in centric, balancing and working sides jaw. The waxed up dentures were flaked and processed into heat-cured acrylic resin. Laboratory remounting was carried out to correct processing occlusal errors then dentures were finished and polished. Dentures were delivered to the patient. Any necessary adjustments were done and post insertion instructions were given to the patient. All patients were recalled after 24 hours, 3 days and one week to perform any needed adjustments. Clinical remounting was carried out and occlusal adjustment was performed to eliminate

occlusal interference and provide free gliding from centric to eccentric jaw positions. Patients were instructed to maintain strict oral and denture hygiene measures. Frequent follow-up appointments were scheduled to ensure proper oral and denture hygiene.

Second stage surgery was held after healing period of six months for both groups.

Local anesthesia was given to the patient at anterior maxillary area. The surgical stent was used to locate implant position with the tip of the probe. The top of the implant was exposed with a tissue punch manually forming a circular incision. The Implant cover screw was removed and the gingival height of ball attachment (FRIADENT, Ball and Socket Attachment) was determined according to the mucosal thickness overlying the implants measured with graduated and color coded periodontal probes and the available inter-arch space and over denture thickness.

The ball abutments with 3.4 mm diameter and gingival heights (1-3) mm were used according to the available interarch space and gingival thickness.

Pick-up of Ball attachments:

The ball attachments were unpacked and the male part had been carefully held and threaded into the implant internal hex (Fig.9).The female parts of the attachments, the nylon caps with their metal housings (the housing-cap assembly), were snapped onto the ball abutments.The fitting surface of the pre-existing maxillary denture of the patient was relieved at the areas of ball attachments.



Fig.9 The first right ball male part was threaded into the implant internal hex

Rubber dam application: two layers of rubber dam were cut, punctured and adapted around the neck of ball attachments to block-out the undercut underneath.

The housing-cap assembly was then placed over the ball abutments. Hard relining material (GC GERMANY GmbH, Seifgrundstr.2-D-61348 Bad Homburg, Germany) was utilized for chair-side picking up of the ball attachments. A special adhesive was painted with a special brush to those areas, and then hard relining material was mixed according to the manufacturer instructions and applied into the

fitting surface at the prepared areas while it is in the sticky stage.

The patient was instructed to close in the centric occluding relation.The maxillary dentures were firmly seated over the metal housings with firm controlled pressure for 3- 5 minutes until initial setting took place then repeated removal and insertion (seating) movements were done until complete setting took place. After hardening of relining material, the denture was removed from the patient mouth.The excess (flashes) of the relining material were removed and the overdentures were finished and polished.

Evaluation of Patients:

Patients were frequently recalled for post insertion adjustments and inspection of the mucoperiostium covering the residual ridge that was digitally examined to detect any flabbiness of mucosa and fibrous tissue. Follow up visits were scheduled at time of denture insertion, six, twelve and eighteen months after denture insertion for making radiographic records required to evaluate bone height and thickness in premaxilla and to measure mucosa l thickness.

Radiographic evaluation :

Radiographic evaluation was made using the linear measurement system supplied by the cone beam computed tomography (CBCT) (kVp.85, mA. 16, Field of view 7x14.5x14.5 cm). Patients were instructed to remove their dentures before entering in the cone beam machine. The patient was seated in upright position in the middle of the chair with the back pushed against the backrest.

The patients were instructed to place their chin on the chin cup. The head support was adjusted up/down to level the angle of the patient's head. The temple supports of the machine was adjusted towards the patient so that they were positioned on both sides of patient's head and closed to grip patient's head preventing patient from moving during radiographic exposure.

The patients were instructed not to move during the duration of the exposure.

Image analysis

Measurement of bone height

Bone height was carried on using liner measurement system supplied with cone beam CT.Bone height measurements were recorded at mid line and inter implant area.From axial view horizontal plane was adjusted to pass through inferior border of zygomatic process (Fig.10).

At sagittal view a line drawn from crest of ridge perpendicular to line representing horizontal plan pass through inferior border of zygomatic process. Length of this line was calculated and

recorded(Fig.11). The procedure was repeated 1mm mesial and distal of each implant on both sides and

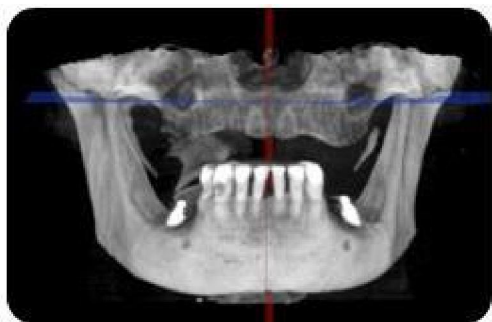


Fig.10 Horizontal plane was adjusted to pass through inferior border of zygomatic process.

Measurement of bone thickness

From sagittal view horizontal plan was adjusted 5 mm. below plane passing through inferior surface of zygomatic arch. At axial view thickness of alveolar ridge was calculated at mid line. A line was drawn perpendicular to buccal bone to lingual bone and length of this line was calculated and recorded. The procedure was repeated mesial and distal of each implant on both sides and the average of these measurements were calculated and recorded.

Statistical analysis:

All the data was collected and tabulated. Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 21 for Windows.

Kolmogorov-Smirnova and Shapiro-Wilk tests were used to assess data normality. Data were presented as means and standard deviation (SD) values. One Way-ANOVA was used to study the mean bone loss after different follow up periods. Tukey's post-hoc test was used for pair-wise comparison between the means when ANOVA test is

the average of these measurements were calculated and recorded.



Fig 11 Line drawn from crest of ridge perpendicular to line representing horizontal plan pass through inferior border of zygomatic process.

significant. An Independent t-test was used to study the difference between different groups tested.

3.Results

Bone Height loss over time

In Group I, there was anon-significant increase in the mean bone height lossafter 6 months follow up period (-0.2 ± 0.14 mm) and after 12 months follow up period (-0.26 ± 0.14 mm). While after 18 months, a non-significant increase in mean bone loss was (-0.33 ± 0.15 mm).

In Group II, anon-significant increase in mean bone height loss after 6 months follow up period (-0.21 ± 0.12 mm) and after 12 months follow up period (-0.28 ± 0.12 mm). While after 18 months, a non-significant increase in the mean bone loss was (-0.34 ± 0.13 mm).

Difference between groups:

Anon-significant difference resulted in the mean bone height loss between group I and group II during the follow up periods.

Table (1): Mean and standard deviation (SD) of bone height loss (mm) values between the two studied groups at different follow up periods.

		Bone height loss						p-value
		after 6 months		after 12 months		after 18 months		
		Mean	±SD	Mean	±SD	Mean	±SD	
Group	GP1	-0.20	0.14	-0.26	0.14	-0.33	0.15	0.331 NS
	GP2	-0.21	0.12	-0.28	0.12	-0.34	0.13	0.230 NS
Independent t-test		0.841 NS		0.795 NS		0.844 NS		

NS= non-significant

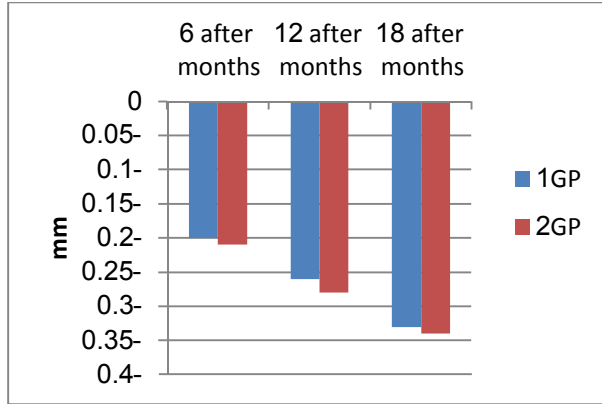


Figure (12): Histogram shows the Mean bone height loss (mm) values between the two studied groups during the follow up periods.

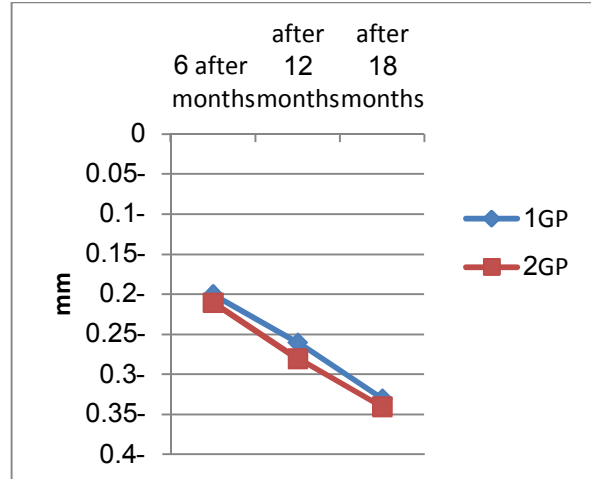


Figure (13): Double line graph showing the Mean bone height loss (mm) values the two studied groups during the follow up periods.

Effect of time:

A significant increase resulted in the mean bone thickness loss after 12 months follow up period (-1.39±0.28 mm) compared to after 6 months follow up period (-0.71±0.29 mm). While after 18 months, a significant increase in the mean bone loss was (-2.66±0.38 mm) for Group I.

A significant increase resulted in the mean bone thickness loss after 12 months follow up period (-

1.50±0.33 mm) compared to after 6 months follow up period (-0.70±0.27 mm). While after 18 months, a significant increase in the mean bone loss was (-2.45±0.44 mm) for Group II.

Difference between groups:

A non-significant difference resulted in the mean bone height loss between group I and group II at different follow up periods.

Table (2): Mean and standard deviation (±SD) of the bone thickness loss (mm) values between the two studied groups at different follow up periods

		Bone thickness loss						p-value
		after 6 months		after 12 months		after 18 months		
		Mean	±SD	Mean	±SD	Mean	±SD	
Group	GP I	-0.71 ^a	0.29	-1.39 ^b	0.28	-2.66 ^c	0.38	≤0.001*
	GP II	-0.70 ^a	0.27	-1.50 ^b	0.33	-2.45 ^c	0.44	≤0.001*
Independent t-test		0.952 NS		0.562 NS		0.395 NS		

Different superscript, lowercase letters indicate statistically significant differences
NS= non-significant* Significant

4. Discussion

This prospective study demonstrated the possibility of achieving osseointegration with good conditions of peri-implant tissues and satisfactory marginal bone resorption values for implant retained and supported overdenture in patients having Combination syndrome with narrow maxillary ridges. The use of implant retained and supported maxillary overdenture will minimize the undesirable forces transmitted to the anterior maxillary segment. The use of implants installed in the anterior maxillary segment improves proprioception, reduces trauma to the underlying tissues, thereby reduces bone resorption and attains more patient tolerance.⁽¹⁷⁾ As

bone resorption in anterior maxilla was considered as the most consistently present sign of combination syndrome,⁽¹⁸⁾ this study was attempted to assess and compare the effect of two different treatment modalities on prevention of combination syndrome by measuring bony changes in the anterior maxilla.

Goodacre *et al.*⁽¹⁹⁾ reviewed clinical implant studies and reported that the highest failure rate (21.3%) for any type of prosthesis occurred with maxillary overdentures. The lower success rates have been attributed primarily to the quality of bone in edentulous maxilla, since a looser arrangement of trabecular bone with a thin, or even absent, cortical

plate is generally considered to be less capable of stabilizing and supporting implants.⁽²⁰⁻²²⁾

To achieve a satisfactory esthetic outcome with dental implants in a deficient anterior maxilla, augmentation is often required. Autogenous bone grafts, either onlay or particulate, with or without guided bone regeneration, are used to treat alveolar ridge defects.^(23,24)

The successful use of autogenous bone blocks⁽²⁵⁾ allow simultaneous implant placement by enhancing initial implant stabilization. Nevertheless, autogenous bone harvesting is accompanied by considerable morbidity.⁽²⁶⁻²⁸⁾

Dasmah *et al.*⁽²⁹⁾ studied marginal bone level alterations around implants installed in grafted sites using block graft and onlay grafting techniques within a 5 years period. They found no significant difference in the extent of resorption between block and particulate autogenous bone grafts with the most of the resorption occurring during the first year. This coincide with the results of this study that might be attributed to that the autogenous chin block was mainly compact bone and in the ridge split group the split thickness flap guaranteed the blood supply through the periosteum nourishing the labial plat of bone and prevents its complete separation.

The use of ridge expansion and ridge splitting to augment deficient bone will add to the horizontal dimension with implant placement. Chisels were used by Duncan and Westwood⁽³⁰⁾ and Guirado *et al.*⁽³¹⁾. In this study, grafting of the split crest gap was evaluated. The use of grafting material (Bio-Gen®) to fill the gap which was covered by collagen membrane (Biocollagen®) to protect the graft and prevent the ingress of the epithelium. This was in accordance with other studies.⁽³⁰⁻³²⁾

Successful osseointegration was assessed throughout the study period by observing any clinical signs of inflammation or infection. Radiographic evaluation was also carried out during the follow up period to detect any sign of peri-implant radiolucency that would denote marginal bone loss.

Our study resulted in no significant difference in the amount of bone loss achieved between both groups. Results of this study showed decrease in bone height in all groups over 18 months (0.33 mm for group I and 0.34 mm for group II) and this was lower than bone loss observed by Kelly⁽²⁾ (1.35 mm over three years).

In Group I, there was a significant increase in the mean bone loss after 18 months (-2.66 ± 0.38 mm). While in group II, a significant increase in the mean bone loss was (-2.45 ± 0.44 mm) after 18 months. The decrease in bone thickness seems to be greater than decrease in bone height and this coincides with results obtained by Tan *et al.*⁽³³⁾

A cone beam scan taken before and after the bone-grafting procedure, as performed in this study, provided accurate and reliable measurements of the bone gain. It is important for the surgeon to assess the three-dimensional changes in the augmented alveolar ridge prior to implant placement. However, the high cost and risk for radiation exposure with this method limit its routine application. For this reason, we used cone-beam, low-dose CT in this study.

One and a half years follow-up examinations were performed for each implant placed into augmented bone. All fixtures showed satisfactory osseointegration, and no patient suffered from inflammation, pain, or discomfort.

All abutments were surrounded by healthy, stable peri-implant soft tissues, probably because of the rigorous periodontal monitoring and effort to maintain good oral hygiene. Because the plaque-control compliance was adequate and the loading on the implant-supported prosthesis was carefully evaluated at the follow-up visits eliminating any possible occlusal interference, we speculated that the cause for bone resorption could be attributed to parafunctional habits. Tensile or compression forces at the bone-implant surface, resulting in rapid crestal bone loss in the absence of mucosal inflammation, can be generated by these habits.⁽³⁴⁻³⁷⁾

However, with correspondence to many studies, the positive results of the present study confirmed that implants placed in bone regenerated by this augmentative technique can successfully withstand the functional demands of implant loading.⁽³⁸⁻⁴³⁾

According to a systematic review, the survival rate of implants placed into sites with regenerated/augmented bone using barrier membranes varied from 79% to 100% with the majority of studies indicating >90% after ≥ 1 year of function.⁽⁴⁴⁾ The survival rates obtained in such a systematic review are similar to those generally reported for implants placed conventionally into sites without the need for bone augmentation.

Conclusions:

The present study demonstrated that implants can be successfully placed in alveolar ridges augmented with autogenous bone or ridge splitting with Bio-Gen and Biocollagen membrane. In addition, clinical and radiographic data after one and a half years of loading showed that peri-implant tissue was healthy and marginal bone ridge values were satisfactory around implants.

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