INFLUENCE OF ARAGONITE CALCIUM CARBONATE ON BONE AROUND IMPLANTS LOADED WITH MANDIBULAR ZIRCONIA TELESCOPIC OVERDENTURE: A CBCT RADIOGRAPHIC COMPARATIVE STUDY

Mahmoud Gamal Salloum* *and* Hashem M. Hassouna**

ABSTRACT

Implant overdenture treatment is a popular line of treatment in edentulous patients where a hybrid implant-supported bridge is unsuitable. Telescopic attachment is considered one of the successful type of attachment used in overdenture patients. This study is conducted to clarify the value of using Calcium Carbonate graft material to enhance osseointegration and peri-implant bone. Zirconia was used as telescope material prepared by CAD CAM technology to maximize quality of attachment used. Ten completely edentulous male patients were selected according to predetermined criteria to receive twenty root-form endosseous implants (Protem/secure implant systemDio implant Dio corporation 1464, U-dong Haeundae-gu Busan, Korea) at the mandibular canine areas. As a within subject study, implants were categorized into two groups, graft material received group and control group. Overdentures were constructed after incorporating the telescopic attachment and finally the peri-implant bone was monitored using cone-beam CT (CBCT) at loading time, after 3, 6, and 12 months to measure the amount of marginal bone height loss and quality change around each implant. The results showed improvement in both peri-implant bone height and quality. Accordingly, within the limitation of the present study, the use of Calcium Carbonate graft material is an effective measure to enhance and stabilize peri-implant bone in implant overdenture patients.

INTRODUCTION

The introduction of dental implants and subsequently the implant-supported mandibular overdenture has improved the quality of life for edentulous patient [1]. Thomason et al.,[2] confirmed according to the York Consensus Statement that a two-implant overdenture should become the standard of care for edentulous mandible. The concept of immediate loading has been shown to be a predictable treatment option when sufficient primary stability of the implants can be achieved; especially in cases of moderate to advanced bone

* Assistant Professor Prosthetic Dental Science Dept., College of Dentistry, Jouf University, KSA.
** Lecturer Oral & Maxillofacial Dept., Faculty of dentistry , Pharos University Alexandria, ARE.

loss. In addition, overdenture may provide stress relief between the supra-structure and prosthesis, and the soft tissue may share a portion of occlusal load [3,4].

Implant-supported overdentures are one of the few areas within restorative dentistry where there is strong evidence regarding their efficacy in terms of patient satisfaction and quality of life outcomes. Mandibular implant overdenture showed an accumulating body of evidence that patients are more satisfied with Implant overdentures than conventional dentures and subsequently improved oral health-related quality of life [5,6]. Many different available attachment systems may be used to retain an implant overdenture. Most of these are compatible with the majority of implant systems currently available. The commonly used abutment types for connection between denture and implants are studs, bars, magnets, and telescopic crowns [7]. In a comparative 5-year study by Gotfredsen & Holm [8], peri-implant conditions and maintenance requirements for implant supported overdentures were evaluated. The authors found no differences in marginal bone loss or health of the peri-implant mucosa, but the frequency of technical complications and repairs per patient was higher for bar attachments than ball attachments.

The bone volume available as well as bone quality were used to be measured using CBCT (cone beam computerized tomography). This measurement facilitates implant treatment planning and estimating the primary stability and prognosis of further prosthetic treatment. In addition, it was considered as an effective tool to track changes in peri-implant tissues after implant loading. Consequently, computer-assisted image analysis has been shown to improve the diagnostic accuracy (i.e., increased sensitivity) of detecting minimal peri-implant tissue changes [9]. The use of digital image analysis has extended to implant dentistry to monitor peri-implant bone healing and gain or loss of alveolar bone density [10].

Long-term preservation of crestal bone height around osseointegrated implants is often used as a primary success criterion for different implant systems. Originally, a mean crestal bone loss ≥ 1.5 mm during the first year after loading and ≥ 0.2 mm/year thereafter had been proposed as one of the major success criteria [11]. Specifically, for conventional two-stage and one-stage two-implant overdentures loading protocols, the first year of marginal bone loss ranged from 0.2 to 0.7 mm and 0.0 to 2.0 mm, respectively. For early loading protocols, the range was 0.0 to 0.2 mm but immediate loading protocol showed a marginal bone loss 0.7 mm within 12 months [12].

In a comparison between screw retained and telescopic restorations for completely edentulous patients, Helal et al.,[13] reported that a statistically non-significant amount of bone resorption was reported for both groups after one year follow up. A similar conclusion was mentioned by keshk et al.,[14] when the telescopic and ball attachment were compared. However, kalid et al.,[7] believed that Mandibular bone volume had a close correlation with improvement in oral health-related quality of life compared to type of attachment used. Moreover, Kronstrom et al.,[15] showed no significant difference in clinical outcomes and patients' satisfaction between overdentures retained by one or two implant. In addition, Li et al.,[16] results' demonstrated a risk of bone resorption around the distal-most implants which increased by increasing number of implants. This finding confirmed the role of attachment and their role of force distribution between implants and residual ridge and so, they urged clinicians to properly distribute occlusal force in the distal areas of the mandible. Another study showed also the active role of type of prostheses on resorption of the posterior part of the arch while they relied the cause of bone resorption in the anterior part to the relative occlusal force distribution [17].

Heckmann et al.,[18] conducted a 10-year study to follow-up non-rigid telescopic connectors with two inter-foraminal implants for overdenture stabilization. The results exhibited promising values and confirmed that this treatment is an efficient and effective long-term treatment modality in severely resorbed edentulous mandibles. Particularly in geriatric patient treatment this concept may provide advantages in terms of handling, cleaning and long-term satisfaction. Furthermore, Nik & Nejatian [19] examined, in two years study, the clinical efficiency of one-piece telescopic implant-retained mandibular overdentures. They concluded that that treatment outcomes for prefabricated telescopic retained overdentures on one-piece implants was favorable and are similar to that obtained in cases of delayed loading. In addition, Krennmair et al.,[20] reported that implant success and peri-implant conditions of ball attachments matched telescopic crowns used for implant overdentures. However, a frequent of maintenance was required for ball attachments than telescopic crowns.

Several researches were conducted in order to enhance available bone essential for optimal prosthetic location. Many surgical techniques and graft materials were studied intensively in the last years and a lot of values were added to implant dentistry. The advance in dental materials and tissue engineering techniques increased rapidly the implant success, reduced healing time and improved prognosis of complex cases [21, 22]. Bone graft materials could be autograft, allograft, alloplast or xenograft. From all these types, the ideal graft material should be biocompatible, biomechanically stable, resorb at a suitable time frame, shows osteoconductive, osteogenic and osteoinductive properties and a good media for capillary invasion and bone cell proliferation and differentiation. Accordingly, it is hard to found a single graft material that own all these capabilities and thus it is wise to use a material that suites certain clinical situations [23].

Xenograft material is a bone graft material of non-human source like bovine, porcine or even natural corals. Specifically, natural coral is rich in calcium carbonate (98%) in the form of aragonite ($CaCO_3$). Natural coral is an osteoconductive materials that aid bone formation in cases of low tissue metabolism. It is absorbed slowly and directly integrated into newly formed bone, allowing optimal cell adhesion by its hydrophilicity. Finally, it allows prolonged dimensional stability and massive integration, without exhibiting any inflammation [24, 25]. For bone ingrowth into porous ceramics a minimum pore size 45-100 μm is required. Coralline hydroxyapatite (HA) characterized by the genetically organized clearly regular and permeable structure of marine coral which closely resembles that of trabecular bone [26]. Furthermore, mechanically coralline HA is only slightly greater in compressive strength than cancellous bone. Accordingly, Coralline HA does not cause significant stress shielding and allows remodeling according to Wolff's Law [27, 28].

Giuliani et al.,[24] studied in-vivo the regenerative properties of coralline-drived scaffold graft in human by synchrotron radiation x-ray microtomography. Coralline-drived scaffold graft exhibited a unique structure. The specimen showed large, irregular, and interconnected cavities in the 100- to 200-μm range, separated by solid walls 10 to 50 μm thick. They reported that implant success rate seems not strictly dependent on the biomaterial that is used, but on the scaffold morphology. Mangano et al.,[29] tested the clinical, histologic, and histomorphometric characteristics of calcium carbonate in sinus elevation case series. Sinus augmentation was performed in the atrophic maxillae of 24 patients using calcium carbonate. After six months 68 implants were placed and clinically followed for 1 to 5 years. The implants showed a survival rate 98.5%. Accordingly, calcium carbonate is clinically suitable for sinus elevation procedures after 1 to 5 years of follow-up including histologic and histomorphometric analysis. Based on the

characteristics of the Aragonite Ca Carbonate graft material, this study aimed to evaluate radiographic parameters of implants positioned in osteotomy enhanced with calcium carbonate graft material.

MATERIALS AND METHOD

Ten completely edentulous male patients were selected from the outpatient clinic of the prosthodontic department, Faculty of Dentistry, Pharos University.

Patients Selection

The selection criteria were based on the validity of these patients to receive implant-tissue supported overdenture [30]. Patients with age ranged from 55-68 years. They should be free from any medical conditions that might interfere with implant placement and/or osseointegration. They all should be non-smokers and did not receive any radio or chemotherapy treatment at any time. In addition, patients should have enough bone volume and a wide band of keratinized mucosa (≥2 mm) without the need to use any hard or soft tissue grafts.

After explaining the clinical procedures of the treatment of choice and their follow up procedures informed consents were recorded from all patients.

For all patients, the following investigations and records were performed:

- Screening tests for homeostasis (Prothrombin Time (PT), Partial Thromboplastin Time (PTT), Bleeding Time, and Clotting Time).

- Screening tests for bone metabolism (Parathyroid Hormone Level (PTH), Alkaline Phosphatase Level (ALKP), and Serum Calcium Level).

- Fasting blood sugar level.

- Measuring the blood pressure.

- Mounted diagnostic casts.

- Pre-operative cone-beam computed tomography (CBCT) to exclude the presence of any pathological condition and to check the quality and quantity of the available alveolar bone at the planned implant site.

For each patient, two root-form endosseous implants (Protem/secure implant systemDio implant Dio corporation 1464, U-dong Haeundae-gu Busan, Korea) were planned to be placed at the mandibular canine areas. The split-mouth design was considered as research design. According to split-mouth research design, each patient was a member of the two study groups simultaneously [31]. The mandibular right canine osteotomies of all patients were planned to receive the implants and calcium carbonate graft substitutes (group A), while the left mandibular canine osteotomies of all patients received only implants in a conventional method (group B). All implants were planned to have the same length [10 mm] and the same diameter [3 mm].

Study Stages

The study was conducted on 4 subsequent stages as follows:

Stage 1: Construction of conventional upper and lower complete dentures:

For all patients, new sets of complete maxillary and mandibular dentures were fabricated following the conventional technique. The patients were instructed to use the new dentures minimum 3 weeks after delivery prior to surgical procedure. Any denture complains were checked and treated spontaneously.

Stage 2: Pre-surgical radiographic imaging:

A replica of the prefabricated mandibular complete denture was fabricated in a clear heat cured acrylic resin. The replica was marked with indelible pencil at the cingulae of the canines then drilled with cylindrical carbide bur (2 mm diameter), thus providing channels at the center of each tooth. Subsequently, these channels were filled with a radio-opaque material to be used as radiographic guide.

All patients were radiographed using CBCT machine (Scanora 3D, Soredex, Helsinki, Finland) with the replica occluding against the maxillary denture. The machine parameters included field of view (FOV) (7.5 cm x 10 cm), to suit the entire dental complex need to be examined, 90 kV, 4 -12.5 m A, Scan time 10 second, isotropic voxel size 0.133 mm. The machine produced image data in DICOM format (Digital Images and Communications in Medicine).

Stage 3: Implants placement and prosthesis construction:

A. Placement of the implants:

By removing the radio-opaque materials from the drilled channels, the replica of the prefabricated mandibular complete denture was modified to be used as a surgical guide. After local anesthesia a bleeding point was produced at the planned implant site by piercing the mucosa, using sterilized straight probe, through the holes of the surgical guide.

An intermittent drilling with low speed, high torque and externally irrigated hand piece was used to prepare the holes for the osteotomy. Sterile saline was used for external irrigation while preparing the osteotomy. Osteotomy was prepared using 1.2, 1.5, 2.0, 2.5 mm drills successively to the full length of the planned implant (10 mm).

The implant was removed from the sterilized package by engaging the finger wrench into the fixture internal hex firmly together. The left implant osteotomy, the implant was secured into the prepared osteotomy manually until resistance was felt followed by final seating using the ratchet wrench, (fig 1 a & b). In the right implant osteotomy site calcium carbonate graft was inserted at the osteotomy walls and a light layer was attached to the surface of the implant before insertion, (fig 1 a).

After surgery, the patients were asked to perform certain measures. Immediately cold packs should be applied locally after surgery. The packs should be placed for 10-15 minutes every half hour, for the following 4-6 hours. The patients also advised for soft diet for the following week. An antibiotic was prescribed (500 mg amoxicillin and 125 clavulonic acid) for 5 days, started one day before the surgery, 3 times daily. An analgesic and anti-inflammatory (50 mg diclofenac potassium for 5 days 3 times daily). In addition, mouthwash (Chlorhexidine Hydrochloride 125 mg/5 ml10) was prescribed. Patients were checked the day after the operation for postoperative problems, as edema or hematoma.
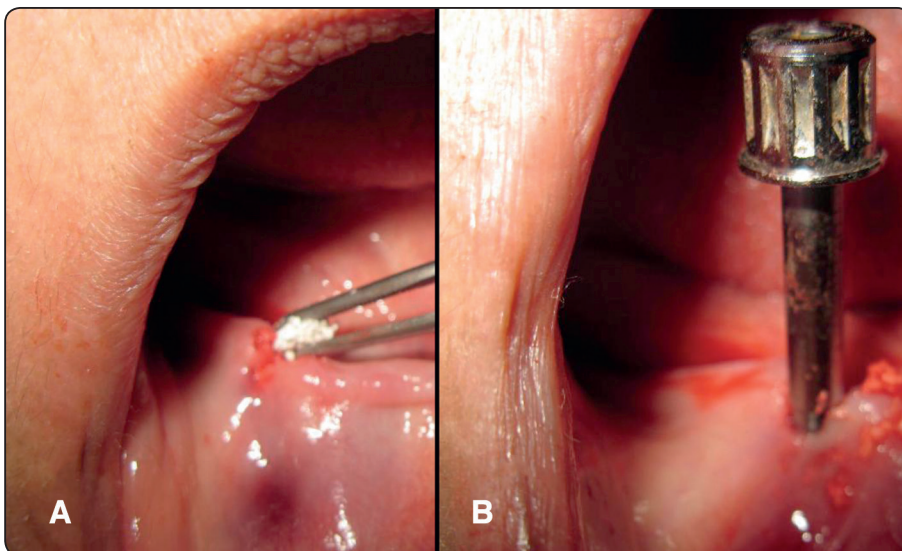

Fig. (1) calcium carbonate bone graft was added to the osteotomy site and implant surface (right osteotomy) of the patient, (A). The implant was inserted to reach its final position at the osteotomy site, (B).

After one week, final impressions were made by dual impression technique using addition silicone rubber base impression. After setting of the impression, implant analogs were fitted in place guided by the bevels & slots in the impression surface.(Fig.2) The impression with analogs was poured in extra-hard stone. After setting the cast was separated from the impression, (fig. 3).

Using CAD/CAM technology, the cast was scanned by 3D scanner (R700, 3Shape, Copenhagen, Denmark) and the 3D model was imported into Exocad software (Exocad GmbH, Darmstadt, Germany) to design the telescopic attachment, (fig. 4). Finally, a zirconia telescope (Cercon, DENTSPLY, USA) was milled to fit the head of the implant abutment then was cemented

Fig. (2) Implant Analogue in place in final impression

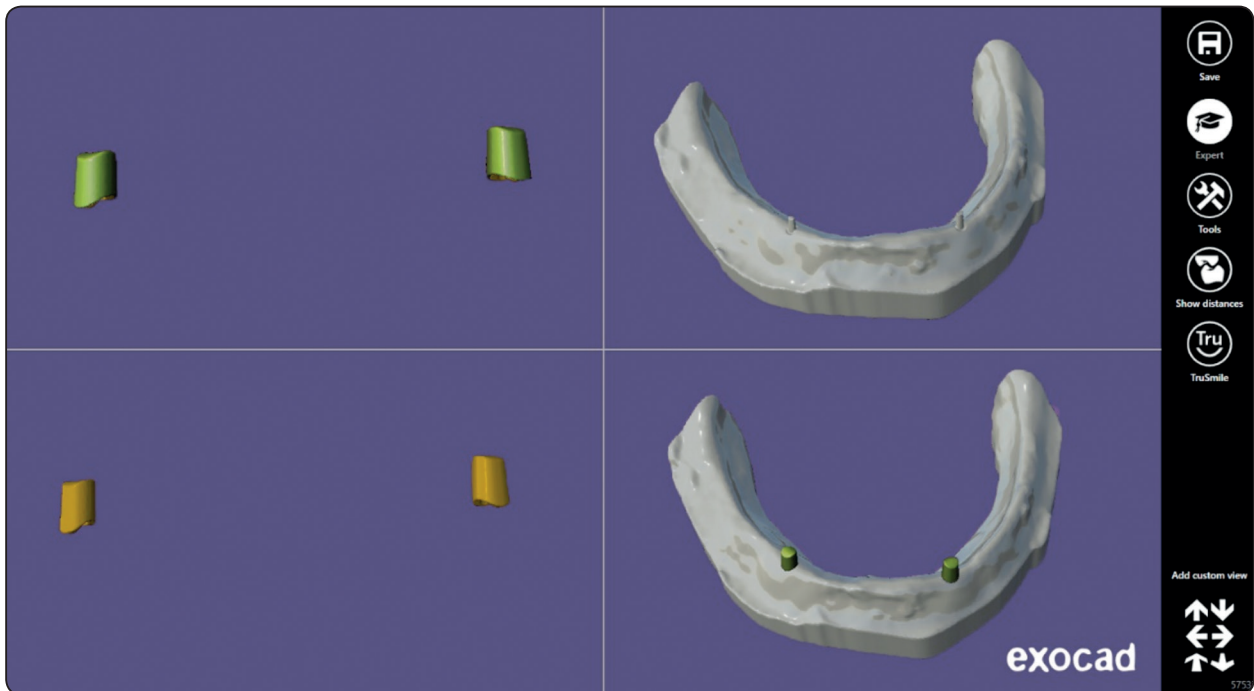Fig. (3) Cast poured from master impression carrying the implant analogue.

Fig. (4) The upper left image is the telescope secondary coping that will be attached to the overdenture. The lower left image is the primary coping that will be cemented to the abutment. The upper right image is the scanned model before designing. The lower right side is the scanned model with the designed telescopic attachment.

in place (Fig.5). Consequently, jaw relation record was performed using trial denture base followed by try-in stage. Relief holes were prepared in the final mandibular denture fitting surface opposite to the cemented zirconia telescope and then the denture was checked for passive seating. After thorough drying, a brush was used to apply adhesive of cold cure hard liner to the fitting surface of mandibular denture and left to dry for 30 seconds. On the other hand, the polishing and occlusal surfaces were painted with Vaseline as a separating medium to avoid adherence of hard liner materials.

The secondary coping of the zirconia telescope (female part) was fitted on the cemented one to be ready for pickup. The hard liner was injected into the fitting surfaces of mandibular denture and the denture was seated in the patient's mouth. Subsequently, the patient was asked to occlude lightly against the upper denture for one minute, then functional chewing and swallowing movements were carried for 2 minutes. The denture was removed after 4 minutes incorporating the zirconia socket (Fig. 6). The excess was removed immediately with scalpel and finally, the fitting surfaces of the denture were finished and smoothed at the sharp areas.

Stage 4: Follow-Up and Evaluation

a) Assessment of crestal bone loss:

For both groups, crestal bone level around the implants was examined using cone-beam CT (CBCT) at loading time, after 3, 6, and 12 months to measure the amount of marginal bone loss around each implant. Crestal bone level was measured using On Demand 3D application software (Sordex-Scanora 3D ver.16 Soredex, Helsinki, Finland). The distance from the marginal bone to the apex of the implant was calculated in millimeters using straight line tool of the system. The mesial and distal bone heights were measured on the coronal view screen, while the buccal and lingual bone heights were measured on the sagittal view screen, using the linear assessment of the software. The mean value of readings were taken, tabulated and statistically analyzed [32].

b) Assessment of bone density changes:

A relative Hounsfield units (HU) changes was used to represent changes in bone density around the implants in the selected cut images. This was monitored at loading time, after 3, 6, and 12 months. The values were recorded using OnDemand3D

Fig. (5) Cemented zirconia telescopes

Fig. (6) The secondary coping of the zirconia telescope (female part)

Application software (Sordex-Scanora® 3D Soredex, Helsinki, Finland). The regions of interest (ROI) were square area (3X3) plotted 1 mm from the center of implant surface to reduce the effect of the scattered radiation on the density values (32). The bone densities at the labial and lingual bone surfaces are measured on the sagittal view screen while the bone densities at the mesial and distal surfaces are measured on the coronal view screen. The mean value of readings were taken, tabulated and statistically analyzed using (SPSS for Windows, version 14) at significance level (p<0.05).

RESULTS

All measurements of both peri-implant bone height and bone density at loading time (first visit), 3 months after loading (second visit), 6 months after loading (third visit), and 12 months after loading (fourth visit) were collected, tabulated, and statistically analyzed using Post-hoc test. The value was considered significant if the P-value was less than 0.05.

Peri-implant bone height

The Mean ± Standard Deviation (SD) of buccal peri-implant bone height in graft group (A) throughout the four intervals or visits of study periods (at the loading time, and at 3, 6, and 12 months after loading) were 10.21±1.81, 10.22±1.63, 10.17± 1.61 and 9.6± 1.63 mm respectively. However, the Mean ± Standard Deviation (SD) of buccal peri-implant bone height in control group (B) throughout the four intervals or visits of study periods were 10.1±1.77, 9.8±1.88, 9.3±1.93, 8.11±2.69 mm. The mean value of buccal peri-implant bone loss of group A were less than group B with statistically significant values (P< 0.05) at the second, third and fourth visits, (Table 1, fig4).

Table (1): Comparison between peri-implant bone height in graft group (group A) and control group (group B) from different sides (buccal, lingual, mesial, & distal) of the implant.

	First Visit	Second Visit	Third Visit	Fourth Visit
Buccal (group A)				
Mean	10.21	10.22	10.17	9.6
SD	1.81	1.63	1.61	1.63
Buccal (group B)				
Mean	10.1	9.8	9.3	8.11
SD	1.77	1.88	1.93	2.69
P value	0.086	0.041*	0.035*	0.01*
Lingual (group A)				
Mean	11.25	10.94	10.03	9.8
SD	1.35	1.64	1.50	1.44
Lingual (group B)				
Mean	11	10.4	9.51	8.7
SD	2.09	2.21	2.22	2.69
P value	0.071	0.041*	0.047*	0.034*
Mesial (group A)				
Mean	10.72	10.74	10.3	10.1
SD	1.46	1.85	2.34	2.34
Mesial (group B)				
Mean	10.9	10.41	9.5	9.1
SD	2.13	2.44	2.58	2.44
P value	0.078	0.06	0.044*	0.031*
Distal (group A)				
Mean	10.92	10.7	10.55	10
SD	1.69	1.71	2.18	2.33
Distal (group B)				
Mean	10.57	10.1	9.25	8.42
SD	2.09	2.39	2.26	3.10
P value	0.103	0.07	0.036*	0.01*

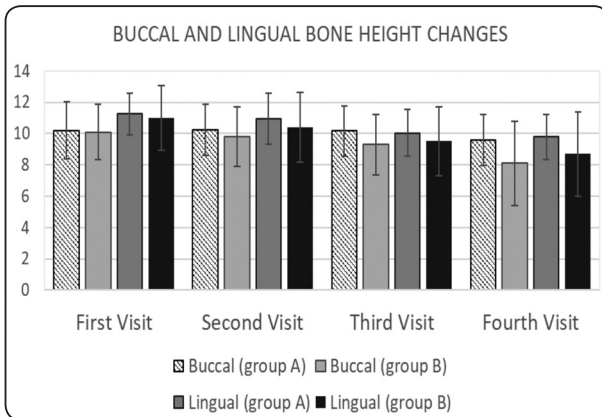** Significant at P< 0.05 SD standard deviation*

Fig. (7): A bar graph showing the mean value and the standard deviation (as error bars) of buccal and lingual bone loss of group A and B throughout the time intervals of the study.
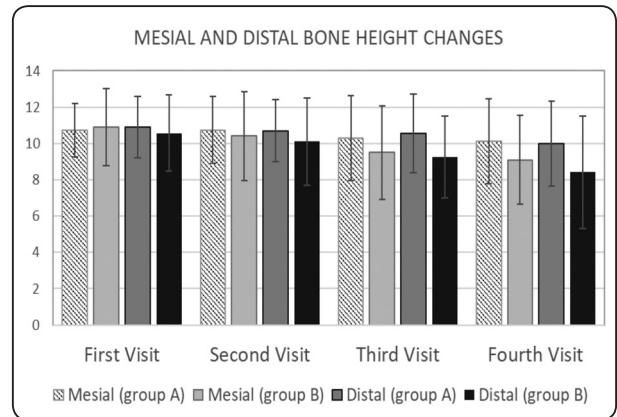

Fig. (8): A bar graph showing the mean value and the standard deviation (as error bars) of mesial and distal bone loss of group A and B throughout the time intervals of the study.

From the lingual aspect the mean values and standard deviations of the bone height of the studied intervals in group A were 11.25±1.35, 10.94±1.64, 10.03±1.50 and 9.8±1.44 mm respectively. Regarding group B, the means and standard deviations were 11±2.09, 10.4±2.21, 9.51±2.22 and 8.7±2.69 mm. A statistically significant difference (P < 0.05) was recorded between group A and B at the second, third and fourth follow up intervals, (Table 1, fig 7). A statistically significant difference was seen between Group A and B at the second, third and fourth intervals at P<0.05.

At the mesial side the calculated mean value and standard deviation of the peri-implant bone height of group A during the four studied intervals were 10.72±1.46, 10.74±1.85, 10.3±2.34 and 10.1±2.34 mm respectively. In group B, the mean value and standard deviation of the peri-implant bone height were 10.9±2.13, 10.41±2.44, 9.5±2.58 and 9.1±2.44 mm. A statistical significant difference was seen between group A and B at the third and fourth follow up intervals of the study, (Table 1, fig 8).

The peri-implant bone height at the distal aspect of group A at the studied intervals were

10.92±1.69, 10.7±1.71, 10.55±2.18 and 10±2.33 mm respectively. In group B, the mean and standard deviation of the bone height were 10.57±2.09, 10.1±2.39, 9.25±2.26 and 8.42±3.10 mm. A statistical significant difference was seen between group A and B at the third and fourth follow up intervals of the study, (Table 1, fig 8).

Peri-implant bone density

The peri-implant bone density (represented in HU) recorded from the CBCT software at the areas of interest for group A and B then the mean and standard deviation during the different visits were calculated and checked for significance at P< 0.05.

The mean and standard deviation of bone density at the buccal aspect at the four studied intervals for group A were 737.17±402.46, 723.59±423.41, 752.71±461.97 and 727.46±595.40 HU respectively. In group B the mean and standard deviation were 680.80±424.19, 658.03±405.45, 672.67±416.35 and 711.88±294.05 HU. The difference between bone density of group A and B were statistically significance (P< 0.05) at the first, second and third intervals, (table 2 and fig. 9).

TABLE (2): Comparison between peri-implant bone density in graft group (group A) and control group (group B) from different sides (buccal, lingual, mesial, & distal) of the implant.

	First Visit	Second Visit	Third Visit	Fourth Visit
Buccal (group A)				
Mean	737.17	723.59	752.71	727.46
SD	402.46	423.41	461.97	595.40
Buccal (group B)				
Mean	680.80	658.03	672.67	711.88
SD	424.19	405.45	416.35	294.05
P value	0.042*	0.045*	0.036*	0.107
Lingual (group A)				
Mean	782.08	600.65	730.92	446.48
SD	476.87	421.80	396.02	297.94
Lingual (group B)				
Mean	586.51	496.73	702.00	428.66
SD	377.90	289.55	379.19	344.19
P value	0.002*	0.0045*	0.311	0.254
Mesial (group A)				
Mean	818.83	675.57	943.09	937.56
SD	378.13	271.52	337.72	320.36
Mesial (group B)				
Mean	906.49	943.53	875.98	800.26
SD	217.26	368.42	316.23	368.26
P value	0.023*	0.001*	0.041*	0.045*
Distal (group A)				
Mean	1020.55	1081.30	1091.74	1249.20
SD	334.90	191.63	475.59	443.64
Distal (group B)				
Mean	844.66	800.12	859.07	1106.02
SD	346.56	218.35	299.41	309.95
P value	0.003*	0.021*	0.041*	0.042*
Apical S (group A)				
Mean	771.63	778.92	912.91	1056.50
SD	386.22	379.93	301.68	434.46
Apical S (group B)				
Mean	751.97	742.32	826.50	804.58
SD	392.65	347.09	345.47	472.46
P value	0.132	0.156	0.042*	0.012*
Apical C (group A)				
Mean	838.49	822.49	942.73	996.20
SD	379.60	412.41	303.44	401.99
Apical C (group B)				
Mean	711.75	773.82	863.69	871.86
SD	358.64	349.48	312.75	477.39
P value	0.045*	0.036*	0.045*	0.038*

* Significant at P< 0.05   SD standard deviation

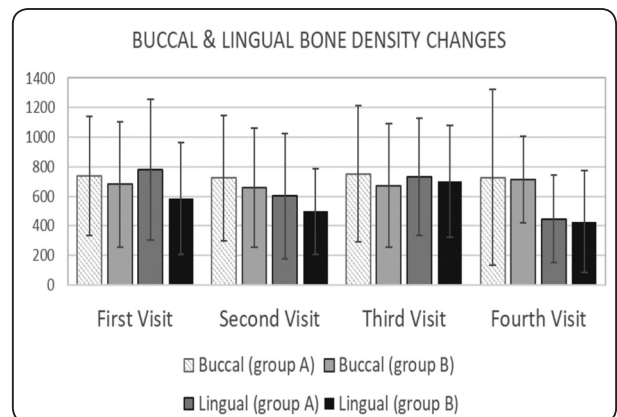**Apical S , Apical sagittal   Apical C , Apical coronal**

Fig. (9): Comparison of mean value of bone density between group A and B from the buccal and lingual side corresponding each follow-up interval.

At the lingual aspect the mean and standard deviation of bone density at the studied intervals for group A were 782.08±476.87, 600.65±421.80, 730.92±396.02 and 446.48±297.94 HU respectively. In group B the mean and standard deviation were 586.51±377.90, 496.73±289.55, 702.00±379.19 and 428.66±344.19 HU. The difference between bone density of group A and B were statistically significance (P< 0.05) at the first and second intervals, (table 2 and fig. 9).

At the mesial side, group A showed mean values and standard deviation (818.83±378.13, 675.57±271.52, 943.09±337.72 and 937.56±320.36) at their respective intervals. In group B the means and standard deviations were 906.49±217.26, 943.53±368.42, 875.98±316.23 and 800.26±368.26. A statistically significant difference was seen at all studied intervals between group A and B at (P<0.05), see (table 2 and fig. 10).
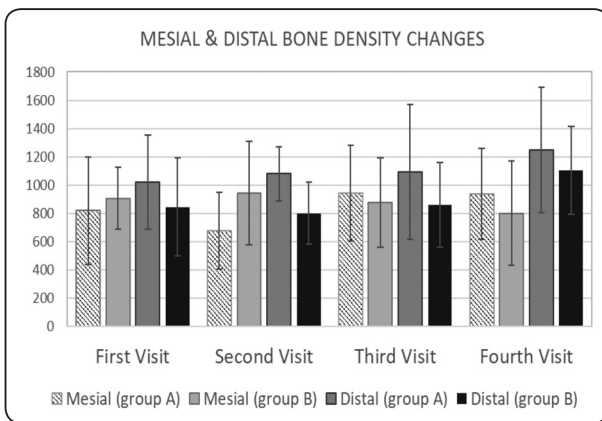

Fig. (10): Comparison of mean value of bone density between group A and B from the mesial and distal side corresponding each follow-up interval.

The mean values and standard deviations of the bone density of group A at the distal aspect were 1020.55± 334.90, 1081.30±191.63, 1091.74±475.59 and 1249.20±443.64 at the respective time intervals. In group B, the mean values and standard deviations during the studied intervals were 844.66±346.56, 800.12±218.35, 859.07±299.41 and 1106.02±309.95 respectively. The difference between group A and B was statistically significance at all studied time intervals, see (table 2, fig. 10).

In group A, the mean values and standard deviation of bone density at the apical part (as seen in the sagittal section) were 771.63±386.22, 778.92±379.93, 912.91±301.68 and 1056.50±434.46 at respective time intervals. In group B, the means and standard deviations were 751.97±392.65, 742.32±347.09, 826.50±345.47 and 804.58±472.46

respectively. The difference between group A and B was statistically significant at the third and fourth intervals, see (table 2 and fig 11).
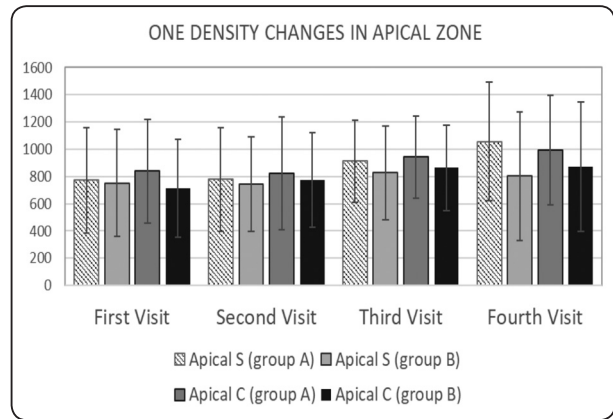

Fig. (11): Comparison of mean value of bone density between group A and B from the apical side (sagittal view).

In group A, the mean values and standard deviations of the apical bone density (as seen from coronal view) were 838.49±379.60, 822.49±412.41, 942.73±303.44 and 996.20±401.99 at the respective time intervals. In group B, the mean value and standard deviations were 711.75±358.64, 773.82±349.48, 863.69±312.75 and 871.86±477.39 respectively see (table 2, fig 11). A statistically significant difference was calculated between group A and B at all-time intervals at p<0.05.

DISCUSSION

The current study was conducted to clarify the value of using Calcium Carbonate as an osteoconductive bone graft supplied at osteotomy during treating implant overdenture patients. It was hypothesized that the use of bone graft extracted from natural source like coral will enhance bony tissue in implant overdenture patients. Based on the characteristics of the bone graft used, it suits the low tissue metabolism of the selected old age group [24]. Moreover, CAD CAM telescopic components were also used as a promising attachment solution for implant overdenture patients [13, 14, 33]. In addition,

a within-subject approach was considered to limit individual variations expected among selected patients [34].

This study focused on tracking changes both in bone height and density at four different intervals (baseline, 3, 6, 12 month). Generally, the results revealed an improvement in bone height and density in the grafted side with a variable difference between measurement sides throughout the timeframe. Furthermore, after one year the bone height changes buccally and distally showed highest significant difference between grafted and non-grafted side which means more enhancement than other sides. These findings have appreciating the value of the bone graft used especially in areas where biomechanical physiologic limit is a border line [23]. Regarding bone density, the bone graft exhibited an increase in density which tends to be minimized by time in buccal and lingual side and increased apically.

It should be mentioned that this type of bone graft acts to release Calcium ions and activate bone deposition (first months). Between (6 - 12 months) the coral grains started to be absorbed and growth of interwoven-fiber bone tissue started. Finally, after one year substitution of interwoven-fiber bone and coral grains with lamellar bone [25]. This biological process clarified the changes in bone density after one year of loading. In addition, it is also superimposed by the biomechanical response of bone to overdenture in immediate loading condition.

These findings were also influenced by location of recorded data which could be claimed to biomechanical variations and manner of support of implant overdenture treatment modality. In contrast to implant supported prosthesis, two-implant supported overdenture receives hybrid support from both implants and residual ridges[3].

The values of bony changes around implants were coincident with several results mentioned in Alsabeeha et al., [4] and Ma & Payne [12] review of literatures. They reviewed the difference between immediate and early loaded implants versus delayed loaded implants in implant overdenture patients. It was also in accordance with Albrektsson et al.,[11] study which approved the acceptable bone loss within first year of implant placement. They described that a bone loss 1.5 mm during the first year and then a stabilizing of crestal bone loss to only 0.2 mm yearly is acceptable. The results of the current study also agreed with Chow et al.,[35] results and were also competitive in bone preservation in some aspects of the study. However, they focused on bone changes in implant overdenture of elderly patients suffering from reduced bone mineral density.

In addition, the finding of using Calcium carbonate bone graft agreed with Giuliani et al. [24] and Pountos et al.,[25] whose appreciated the bone augmentation effect of using coralline Calcium carbonate. They reported that the use of this graft material had a good affinity to encourage bone formation even in low metabolic rate conditions. Moreover, Liu et al.,[36] showed a favorable effect of using calcium carbonate on peri-implant bone and their results coincides with the current study. They also confirmed in their research the valuable biocompatibility and osteoconductive properties of using Calcium carbonate as an implant surface coating after a 12-week healing period. They also added that a calcium carbonate coating can improve and accelerate the early ingrowth of bone and osseointegration and this may reduce clinical healing times and thus improve implant success rates.

The current study was also a good chance to use the CAD CAM technology to fabricate the telescopic attachment for the implant overdenture especially when combined with zirconia material. Krennmair et al.,[20] studied conventional metallic telescopic attachment in two-stage loading protocol for three years. The results of the bone loss showed

1.8 mm which looks comparable to the current study considering relative bone stability (<0.2 per year after 1st year). In addition, after 10 years of follow-up Heckmann et al.,[18] and using conventional one-stage loading protocol, the mean bone loss recorded was 3.19 mm appreciating the need for a longer period of follow-up.

Accordingly, adding Calcium Carbonate to implant osteotomy of implant overdenture could be a supplementary clinical step that enhance peri-implant bone. It may also be used as a routine for patients having bone of low mineral density of low bone metabolism.

The current study had certain limitations including limited time of follow-up, unfollowed soft tissue changes and the need for using recent bone metabolism monitoring markers. Accordingly, we recommend to conduct a study with extended period of follow-up to see the performance of bone after one year of loading and complete absorption of the graft material. We also suggest using another parameter of evaluation such as monitoring bone metabolism monitoring markers to track any changes in bone resorption occurred with time of loading.

CONCLUSION

The use of aragonite Calcium Carbonate in implant osteotomy of mandibular implant overdenture, retained by Zirconia telescopic attachment, is an effective measure to enhance and stabilize peri-implant bone.

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