

RADIOGRAPHIC EVALUATION OF CRYSTAL BONE LEVEL OF IMMEDIATE LOADED IMPLANT RESTORED WITH TWO DIFFERENT CAD-CAM MATERIALS

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ABSTRACT

Purpose: This study was conducted to radiographically evaluate the effect of two different superstructure CAD/CAM fabricated materials, on crestal bone loss around immediately loaded implant.

Materials and Methods: A total of twelve healthy patients having mandibular bilateral missing first molars with acceptable bone volume were selected based on specific inclusion and exclusion criteria, each patient received a CAD/CAM monolithic zirconia, in one site, while the other site received a CAD/CAM Enamic superstructure, in 48 hours after implant insertion. Implants and abutments were examined for stability, gingival and periodontal health prior to crown cementation. Radiographic evaluation was done immediately at the time of crown cementation then at 6 and 12 months.

Results: Marginal bone loss was measured at two points, the most buccal crestal bone, and the most lingual crestal bone. Radiographic results showed no significant difference regarding mean MBL between Zirconia and Enamic on 6 and 12 months.

Conclusion: Immediate loading of a single mandibular molar implant with the final restoration seem to be a reliable technique when certain parameters are respected. Type of implant superstructure material has no significant influence on the bone supporting the implant within the time period of this study.

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INTRODUCTION

Replacement of missing teeth has become one of the most important needs for patients attending clinics seeking esthetics and/or function. Many treatment modalities are available for replacing a single missing tooth; removable partial denture, fixed partial denture or dental implant. Each modality is a possible treatment option and has its own benefits and drawbacks¹.

Alveolar bone is better preserved when restoring extracted teeth by dental implant, as dental implants integrate with jawbone, helping to keep the bone healthy and intact².

However, dental implants differ from the natural teeth in the biomechanical behavior and its relation to bone. In natural teeth, the periodontal membrane acts as a cushion dissipating forces, protecting bone from the harmful effect of biting forces. While in case of implants, all forces are transmitted directly to bone specifically around the coronal portion of the implant that may lead to crestal bone loss³.

The longevity of dental implants depend on a number of complex interlocking factors, on top of them is the biomechanical factors and due to intimate contact at the bone-implant interface, implant durability is directly linked to the selection of appropriate implant position, prosthesis design, biocompatibility as well as mechanical and physical properties of the materials of the implant superstructure⁴.

Immediate implants are placed with adequate primary stability; its corresponding restoration with full centric occlusion in maximum intercuspation must be placed within 48 hours post-surgery. Success of this process is based on design and material of the restoration to prevent micro motion of the implant⁵.

Milled ceramics are most relevant to restorative dentists and where the greatest changes in clinical practice have been realized. A majority of crown-and-bridge restorations are now produced through

CAD/CAM, often with new ceramic materials. CAD/CAM ceramic materials evolved from traditional feldspathic porcelain, an esthetic but low-strength, brittle material, to a range of materials with different strength, resilience, and esthetic properties. They are clinically successful and are replacing porcelain-fused-to-metal (PFM) restorations⁶.

MATERIALS AND METHODS

A total of 14 patients in the age range 20–50 years having bilateral first molar missing site with the presence of adjacent and opposing teeth intact with a good periodontal and general systemic health were selected from the outpatient clinic at the Faculty of Dentistry, Beirut Arab University. Each patient was given a detailed verbal and written description of the risks and benefits of the proposed treatment. They were required to sign a consent form prior to the procedure and presented to the IRB committee of Beirut Arab University for approval.

An aseptic surgical technique was followed. Antimicrobial prophylaxis included amoxicillin 500 mg three times daily for 5 days, starting 1 h before surgery and post-surgery analgesic treatment was ibuprofen 400 mg twice daily for 3 days. Implants were placed by one operator using a 3D-printed acrylic resin surgical guide template processed through a 3D printing (Formlabs 3-Shape USA) of the digital impression of each implant site. Patients were treated under local anesthesia, surgical site was examined to fit in required bone volume and similar implant length and diameter (4.1×10 mm) was selected for all cases. After punch on a healed site, an initial pilot drill was passed through the surgical guide to the depth corresponding to the length of the implant chosen. Next intermediate drills of the diameter and length of the implant were used to expand the osteotomy. The implant with its attached delivery post was placed into the prepared site with gentle digital pressure until resistance is met and seated into final position using torque ratchet to

30N. Reading of the implant stability was recorded with the help of a resonance frequency analyzer - osstell - ISQ.

Open try impression technique was used for cast fabrication using type IV extra hard stone, impression coping replaced by abutment then scanned using a CAD-CAM scanner (Sirona InEos X5). The opposing diagnostic cast and bite were also scanned; occlusal clearness was checked on virtual articulator.

With the aid of Sirona inLab SW CAD 15 software abutments margins were traced and crowns were designed to produce Stereolithography STL file which sent to the milling machine (Sirona inLab CM X5); for Zirconia, crowns were milled then cleaned in ultrasonic solution, dried and sintered according to manufacturer directions. For Enamic crowns, finishing and polishing was completed using manufacturer-supplied kit. All patients were restored one side with zirconia, and other side with enamic crowns and cemented with u-200 (3M) resin cement on its straight corresponding abutment. Cementation was done extraorally, then crown-abutment unite was screwed to the implant intraorally after 48 hours of implant placement. Bone level evaluation was done using radiographic parameters and statistical data was analyzed.

Radiographic parameters assessed

The level of alveolar bone around each implant was evaluated using cone beam computed tomography (CBCT) ⁷. For each patient, three CBCT images were captured (at time of loading, three, and six-months) on lower jaw, to evaluate the changes in crestal bone level with respect to the implant.

In curved slicing, the coronal plane represented by a line drawn in a path passing through the center of implant placed in bone, to form the dental arch, thus, making it almost drawn in the same position in each repeated CBCT.

In order to take measurements exactly in the same position in each following CBCT, a fixed reference line was marked tangent to apical tip of implant, then a line drawn from crest of bone buccal and lingual perpendicular to the horizontal tangent. This line will represent the level of the bone in the sagittal plane (Figure).

Readings at intervals 0, 6, and 12 months, reflecting the changes in crestal bone level around implant which was measured at the highest level of bone on buccal and lingual side of each crown. Marginal bone loss was measured at two points; buccal and lingual crestal bone.



Figure: CT image showing the line drawn from crest of bone buccal and lingual perpendicular to the horizontal tangent.

RESULTS

Marginal Bone Loss (MBL):

Comparison of MBL between zirconia and enamic crowns at both sites was not significant. When measuring bone loss at the most buccal and most lingual crestal bone, the study showed no significant difference regarding mean MBL between zirconia and enamic in 6 and 12 months.

Effect of time periods on MBL in each site:

In implants restored with zirconia crowns, both buccal and lingual bone loss showed a non-significant difference. In implants restored with enamic crowns, both buccal and palatal showed no significant decrease in MBL. Data presented in the Table.

TABLE: Bone height calibration in mm at different time in buccal and lingual side in the two studied groups (Zirconia and Enamic).

	Zirconia	Enamic	P value
I. Buccal			
Baseline:			
Range	8.7-10.7	8.6-10.7	
Mean±S.D.	10.0±0.62	9.9±0.71	0.321 N.S.
6 months:			
Range	8.6-10.5	8.7-10.8	
Mean±S.D.	9.8±0.76	10.0±0.70	0.411 N.S.
12 months:			
Range	8.6-10.5	8.7-10.8	
Mean±S.D.	9.8±0.73	10.0±0.74	0.354 N.S.
II. Lingual			
Baseline:			
Range	8.5-11.2	8.4-10.8	
Mean±S.D.	10.21±0.82	10.2±0.83	0.958 N.S.
6 months:			
Range	8.3-11.0	8.5-11.1	
Mean±S.D.	10.1±0.91	10.2±0.82	0.892 N.S.
12 months:			
Range	8.3-11.0	8.5-11.1	
Mean±S.D.	10.1±0.93	10.2±0.85	0.901 N.S.

(N.S.: not significant at level 0.05)

DISCUSSION

In this study, a comparative evaluation of immediate implant restored with enamic versus zirconia restoration. The treatment protocol involved fabrication of crowns within 48 hours. During surgery, a guided method used, punch and drilling through it to reach final drill and implant insertion, with less resultant discomfort and swelling because muscle attachment is uninvolved and smaller punch with less resultant bone loss⁸.

The edentulous area was bounded by neighboring teeth in a normal contact condition with no rotation since the proximity of the proximal contour of neighboring teeth is an essential factor to ensure adequate bone height, and complete fullness of the papilla in the interdental embrasure space⁹.

Implants was placed entirely within bone and away from significant anatomic structures (e.g., the inferior alveolar canal). 10 mm of vertical bone dimension and 8 mm of horizontal was available for implant placement. These dimensions prevented encroachment on anatomic structures and allow a minimum of 2.0 mm of bone on both the lingual and facial aspect of the implant¹⁰.

CBCT has been regarded as a high-quality reliable image-acquisition method for the dental maxillofacial area, in comparison with other tomographic methods¹¹. Surgical guide was manufactured with the aid of CBCT and CAD-CAM to estimate the orientation and location of the implant to be inserted before implant placement¹², to insure all the implants are placed precisely in their accurate positions¹³, with less chances of error, and offers reproducibility and hence minimizes the presence of variables during implant placement¹⁴.

Drilling for implant site was done by using the manufacture drills starting with the pilot drill, to insure proper parallelism of the implant positioning. The wrench turned the screw until a recommended torque of 35 Ncm was applied. Final drilling was

done cancel to get full contact between the threads of the implant and the surrounding bone which will have the great effect on primary stability, and load transfer from the implant to the supporting tissues¹⁵.

Zirconia and enamic was selected in this study as crown materials because of their good esthetics coupled with biocompatibility, it was seen that the zirconia crowns exhibited the least marginal gingival inflammation¹⁶, taking into consideration that glazed surfaces show less plaque accumulation than non-glazed surfaces¹⁷.

Monolithic zirconia and Enamic crowns was fabricated with no fear from causing more wear to the opposing dentition, since according to Esquivel-Upshaw in 2018¹⁸, monolithic zirconia exhibited non significant wear of opposing enamel compared to metal-ceramic crowns and control enamel after one year.

Restorations were designed and milled using CAD/CAM technology to insure exact monolithic copies of final crowns, producing a perfectly contoured interim restoration, since gingival recession and inflammation is directly related to marginal adaptation, axial contours¹⁹, in addition to all advantages of such technology including rapid production, improved wear properties, decreased laboratory fees and improved cross infection control²⁰.

Cone beam computed tomography (CBCT) was chosen as it provides detailed anatomy of teeth, bone, and the changes in the alveolar area around implant in multiple planes. Data can be oriented so that patient's anatomic features are realigned which helps in standardization of images. In addition to cursor-driven images that provide the clinician with dimensional assessment that are free from distortion and magnification²¹. Therefore, measurement will be taken exactly in the same position in each x-ray cut every time.

Some studies, suggested that radiographic interpretation of the alveolar bone levels has

proved to be one of the most valuable tools for evaluation of implant success^{11, 22}. Variable results regarding bone levels of implants with time was stated by some researchers and can be found in the data of several other studies^{5, 23}. In addition, effect regarding crown material with peak masticatory stresses of osseointegrated implant prosthesis was studied by Hobkirk, J. A., & Psarros, K²⁴, and, Yuan J.C., & Sukotjo C.²⁵ whom stated that no difference was found regarding load rates with using ceramic or resin prostheses and this with accordance with our results. Results of the present study showed that the amount of bone loss with immediate loading implants showed higher values with zirconia crown than with enamic crown. Bone loss in zirconia site of immediate loading group was 0.3 mm while in the enamic site it was 0.2 mm. These values agreed with Boronat, et al²⁶. Immediate loading protocols create excessive load that exceed the loading capacity of the interfacial bone, furthermore, slight load on healing bone shortens healing rather than prolong it and the bone tissues adapt their trabeculae to the accepted magnitude and direction of the load. Also Galal, et al.²³, found that immediate loading showed more bone loss than conventional delayed loading protocol. On the contrary, Kushaldeep, et al.²⁷, found that there is no difference between the immediate and delayed loading protocols.

Comparison between bone-loss with the two superstructures crown materials revealed non-statistically significant difference between zirconia and enamic restorations through the whole study period. These results were in agreement with Sertgoz²⁸, who stated that using a prosthetic superstructure with lower elastic modulus neither led to substantial difference in stresses over cortical and spongy bone around implants. Hardness of a material was related to the stress absorption from impact loads.

SUMMARY

This study was conducted to radiographically evaluate and compare a relatively CAD/CAM hybrid material (Enamic) used as crown for immediately loaded single implant with a CAD/CAM monolithic Zirconia, using CBCT to measure crestal bone loss, it was found out that no significant difference regarding mean MBL between zirconia and enamic in 6 and 12 months.

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