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Research Article

Assessment of Dental Implants with two Different Crown Materials and Using Two Different Loading Protocols-Clinical and Radiographic Study

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Abstract

Objective: This study was conducted to investigate the effect of immediate and delayed loading technique with two types of crown materials (in-ceram and porcelain fused to metal crowns) on the peri-implant soft and hard tissue.

Materials and Methods: Twenty implants were inserted in missing maxillary premolar area; half of them was restored with delayed loading and the other with immediate loading techniques. Each group was further subdivided into two subgroups according to the prosthesis material (porcelain fused to metal or zirconia). Assessment of Bone Density around the implants: Image Bioquant software was used to evaluate radiographic bone density mesial, distal, and apical to each implant. Measurements were taken. Clinical evaluation was done using periodontal probing depth. In addition, radiographic evaluation was done to detect bone loss.

Results: With both types of crowns and with both techniques of loading there were no statistically significant difference in periodontal pocket depth. In addition, there were no statistically significant difference between the 2-crown materials regarding bone loss but delayed loading showed less bone loss than immediate.

Conclusion: The crown material has no effect on the periodontal pocket depth and bone loss around implants but the loading technique has.

Keywords: *Crown Materials; Clinical; Dental Implants; Loading Protocols; Radiographic Study*

Introduction

Natural sound tooth structures are superior from every aspect than any other restoration what so ever to be done for this tooth. Therefore, preservation of sound teeth is an objective of utmost importance, whenever possible, in the planning for dental treatment. Hence, restoring missing teeth independent on the neighboring teeth by a fixed replacement using a successful implant will always be hoped for to save these natural teeth [1].

Nowadays, implants received wide attention in the dental field especially with the progress achieved in the development of titanium implants [2].

Since the advent of dental implants, trials were done to ensure success and decrease susceptibility of failure, success of implants denotes their proper osseointegration [3].

Predictable results for implants with gingival care procedures made one-crown implant restoration being a successful, moderately trouble-free procedure with the for preserving the healthy adjacent teeth [4].

Unfortunately, osseointegrated implant reacts differently to the physiologic loads than does the natural tooth. This is due to the difference in their manner of anchorage to bone. Therefore, it is important to control any factor that may affect the loads transferred to dental implants [5].

Originally conventional procedure of implant procedure stated that it should be left after insertion for a certain period before loading [6]. Traditionally, fixtures inserted then left three months for the mandibular and six months for the maxillary sites, then another step, where superstructure is placed then loaded. There was a concept stating that implant should heal for a while to osseointegrate. The conventional procedure by Brånemark is facing a challenge nowadays. Researchers found that immediately loaded implants could be a predictable solution [7].

The material from which implant-supported crowns is fabricated affects loaded fixtures state with subsequent bony reactions. These reactions are mainly in the form of stressed bone and may cause inadvertently resorptive response and failure of fixture. It has been suggested to incorporate stress absorbing or load-dampening systems into the superstructures supported by osseointegrated implants, to reduce loads on the implant that occur because of the lack of viscoelasticity at the bone-implant interface [8].

Materials and Methods

This study was conducted on 15 patients for the placement of 20 implants. Patients were selected from outpatient clinic of the' Faculty of Dental Medicine, Alfarabi college. Eight patients were males while seven were females. All implants were placed in the upper premolar region. The patients were divided into two main groups according to the time of implants loading:

- **Group I:** Patients received delayed loading of implants, where implants were left submerged for 6 months (ten implants).
- **Group II:** Patients received immediate loading of implants, where temporary crowns were fabricated out of occlusion, then three weeks later, permanent restorations were placed in occlusion (ten implants).

Each group was further subdivided into two subgroups (five implants for each subgroup) according to crown materials used in the study:

- **Subgroup A:** Implants were restored with metallic crowns veneered with low fusing porcelain.
- **Subgroup B:** Implants were restored with all ceramic [zirconia] crowns.

After clinical and radiographic examination, all patients were carefully selected according to the following inclusion criteria:

1. **Patient general health:** Only systemic diseases free and patients in good general health were included in this study.
2. **Oral hygiene:** Good oral hygiene were considered necessary for patient selection, thus patients with periodontal diseases were excluded.
3. **Psychological condition of the patient:** Co-operative patient were only selected.

Implants were surgically inserted, for delayed loaded group, after installation of implant the titanium healing screw was unthreaded from its stand and inserted into the occlusal opening of the implant then tightened using the 1.25 mm hex instrument for the appropriate healing time (Figure 1).

Figure 1: *Delayed loading case with healing screw.*

For immediately loaded technique, cover screw was not inserted into the occlusal opening of the implant; straight Titanium abutment was adjusted then connected to the implant by abutment screw. Provisional crown was adjusted to be out of occlusion and cemented by provisional cement.

For the delayed loading group, after 6 months healing screws were removed, abutments were screwed in its position and adjusted. Impression was taken using elastomeric impression material.

Figure 2: *Implant supported zirconia crown.*

Figure 3: *Implant supported metal ceramic crown.*

All patients were followed-up clinically and radiographically immediately, 3 month, 6 months and 9 months after implant placement for all groups.

Peri-implant probing depth was measured using periodontal probe.

Standardized periapical X-ray films sensor Durr vistascan were taken immediately after implant insertion and on intervals of 3, 6 and 9 months post-operatively to detect marginal bone level and Bone density.

Bioquant is image analysis software that is used for different analysis applications (histomorphometric as well as densitometry analysis). In this software, the area to be measured, which called Regions of Interest (ROI) was selected (color density selection). A single pixel that represents a specific color (white pixels in radiographs) is selected or threshold allowing for automatic selection of all other pixels in the ROI that threshold areas are traced and counted as a number of pixels that can be calculated as a ratio of the whole ROI. Bioquant was used for calculation of the average density of the marginal and crystal bone. Average density is determined based on a scale of 0 - 256 and the number 256 (8 bits) stands for the whitest pixel on the screen while number 0 represents the areas of the darkest pixels on the screen, the ROI of these radiographs was a circle of a fixed size to contain the critical size defect precisely. The program calculates every pixel in the image and then performs the calculations necessary to get one number representing the average density of all the pixels and this number must be between the 0 and 256 values. The linear bone level measurements were done by measuring to points mesial and distal to the implants from the end of the implant shoulder to the first contact of the alveolar bone crest and the implant first, by opening analyze menu then setting scale to determine the length in mm. The same procedure was performed with all the follow up radiographs. Mesial and distal bone height changes around the implant were evaluated using the linear measurement system supplied by the specially designed Image J software (Image J 1.31 software: Downloadable through the Internet from National Institute of Health, USA).

The distance from the shoulder of the implant to the first visible bone-to-implant contact was determined by linear measurements. In addition, the length of the implant was measured in order to determine the magnification factor in the radiograph. The measurements of the bone levels were then adjusted according to the magnification.

A line was drawn from a reference point at the implant shoulder and the first point of bone implant contact, the measurements in mm were noted both mesially and distally and the mean was calculated. Image J software was used to evaluate radiographic bone density mesial, distal, and apical to each implant. Measurements were taken as follows.

From the area selection tools on the tool bar, the rectangular selection tool was used to specify the area, two controlled and standardized dimension square areas were made just mesial and distal to the implant including the bone implant interface, From the "analyze" command in the title bar select "measure" to give mean gray value (mean density which is expressed in numbers from 0 to 255) then the result was saved, From "analyze" command select "tools" then "ROI manger" region of interest and add your selection in the saved ROI to be used in the follow-up image for the same patient.

Results and Discussion

Results

All patients in this study attended all the follow up recall visits, showed varied degree of osseointegration. Significance was stated to be $P \leq 0.05$. Statistics was done using SPSS 16.0® (Package for Scientific researches) for Windows.

Statistical analysis was performed between group I (delayed loading) and group II (immediate loading) for both crown materials (porcelain fused to metal- zirconia crown) to evaluate the effect of loading time on pocket depth, peri-implant bone loss and bone density using paired t-test. In addition, paired t-test was performed within each group (between its subgroups) to detect the effect of the superstructure material on the same tested parameters.

Crown	Group	Delayed loading		Immediate loading		*P*-value
	Period	Mean	SD	Mean	SD	
CM	Base line	0.45	0.27	0.55	0.37	0.641
	3 months	0.65	0.14	0.75	0.25	0.455
	6 months	0.95	0.11	0.95	0.11	1.000
	9 months	1.20	0.27	1.10	0.22	0.545
All ceramic	Base line	0.35	0.33	0.40	0.22	0.789
	3 months	0.65	0.22	0.75	0.18	0.455
	6 months	0.95	0.11	1.05	0.27	0.471
	9 months	1.30	0.27	1.30	0.27	1.000

Table 1: *Means, standard deviations (SD) with results for Student's t-test to compare between mean PD within 2 groups.*

With CM (ceramo metallic) crown, the difference in values of mean PD was not statistically significant in the 2 groups along all periods.

With All ceramic crown, the difference in values of mean PD was not statistically significant in the 2 groups along all periods.

Group	Supra-structure	CM		All-ceramic		*P*-value
	Period	Mean	SD	Mean	SD	
Delayed loading	Base line	0.45	0.27	0.35	0.33	0.620
	3 months	0.65	0.14	0.65	0.22	1.000
	6 months	0.95	0.11	0.95	0.11	1.000
	9 months	1.20	0.27	1.30	0.27	0.580
Immediate loading	Base line	0.55	0.37	0.40	0.22	0.461
	3 months	0.75	0.25	0.75	0.18	1.000
	6 months	0.95	0.11	1.05	0.27	0.471
	9 months	1.10	0.22	1.30	0.27	0.242

Table 2: *Means, standard deviations (SD) with results for Student's t-test to compare between PD with 2-crown materials.*

With delayed loading implants, the difference in values of mean PD was statistically significant in the 2 groups along all periods.

With immediate loading implants, the difference in values of mean PD was statistically significant with the 2 groups along all periods.

Side	Group	Delayed loading		Immediate loading		*P*-value
	Period	Mean	SD	Mean	SD	
Mesial	Base line - 3m	0.02	0.04	0.08	0.08	0.756
	3 months - 6m	0.08	0.04	0.14	0.09	0.645
	6 months - 9m	0.12	0.08	0.28	0.08	0.184
	Base line - 6m	0.10	0.07	0.22	0.16	0.200
	Base line - 9m	0.22	0.08	0.50	0.12	0.005*
Distal	Base line - 3m	0.04	0.05	0.08	0.08	0.684
	3 months - 6m	0.08	0.04	0.14	0.05	0.656
	6 months - 9m	0.10	0.01	0.24	0.09	0.196
	Base line - 6m	0.12	0.08	0.22	0.04	0.177
	Base line - 9m	0.22	0.08	0.46	0.11	0.023*

Table 3: *Means, standard deviations (SD) with results for Mann-Whitney U test to compare between bone loss with 2 groups of CM (ceramo metallic) crown.*

**: Significant at P ≤ 0.05.*

At the mesial side, the difference of values of mean bone loss was not statistically significant in the two groups along all periods except through the period (Base line - 9 months) where immediate loading group was statistically significant with more amount of bone loss compared to delayed loading group.

At distal side, the difference between bone losses showed no statistically significance between two groups through all periods except through the period (Base line - 9 months) where immediate loading group showed statistically significantly higher mean amount of bone loss than delayed loading group.

Side	Group	Delayed loading		Immediate loading		*P*-value
	Period	Mean	SD	Mean	SD	
Mesial	Base line - 3m	0.02	0.04	0.12	0.04	0.547
	3 months - 6m	0.12	0.08	0.10	0.08	0.887
	6 months - 9m	0.06	0.05	0.18	0.08	0.487
	Base line - 6m	0.14	0.09	0.22	0.04	0.575
	Base line - 9m	0.20	0.07	0.40	0.07	0.044*
Distal	Base line - 3m	0.06	0.05	0.10	0.07	0.798
	3 months - 6m	0.10	0.12	0.08	0.04	0.854
	6 months - 9m	0.06	0.09	0.24	0.11	0.090
	Base line - 6m	0.16	0.15	0.18	0.08	0.978
	Base line - 9m	0.22	0.16	0.42	0.11	0.048*

Table 4: *Means, standard deviation (SD) with results of Mann-Whitney U test to compare mean amounts for bone loss regarding two groups with All-ceramic crown.*

**: Significant at P ≤ 0.05.*

At the mesial side, difference between mean bone losses showed no statistically significance through 2 groups through all periods except through the period (Base line - 9 months) where immediate loading group was with statistically significant more mean amount of bone loss in comparison to delayed loading one.

At distal side, the bone loss difference did not show statistically significance regarding both groups through all periods except through the period (Base line - 9 months) where immediate loading group was with statistically significance with more mean amount of bone loss compared to delayed loading one.

Side	Supra-structure	CM		All-ceramic		*P*-value
	Period	Mean	SD	Mean	SD	
Mesial	Base line - 3m	0.02	0.04	0.02	0.04	1.000
	3 months - 6m	0.08	0.04	0.12	0.08	0.773
	6 months - 9m	0.12	0.08	0.06	0.05	0.575
	Base line - 6m	0.10	0.07	0.14	0.09	0.883
	Base line - 9m	0.22	0.08	0.20	0.07	0.976
Distal	Base line - 3m	0.04	0.05	0.06	0.05	0.972
	3 months - 6m	0.08	0.04	0.10	0.12	0.944
	6 months - 9m	0.10	0.01	0.06	0.09	0.898
	Base line - 6m	0.12	0.08	0.16	0.15	0.857
	Base line - 9m	0.22	0.08	0.22	0.16	1.000

Table 5: *Means, standard deviations (SD) with results of Mann-Whitney U test comparing mean amount of bone loss with the two supra-structures in delayed loading group.*

At the mesial side, the mean bone loss did not show statistically significance regarding both crown materials.

At the distal side, the mean bone loss did not show statistically significance regarding both crown materials.

Side	Supra-structure	CM		All-ceramic		*P*-value
	Period	Mean	SD	Mean	SD	
Mesial	Base line - 3m	0.08	0.08	0.12	0.04	0.773
	3 months - 6m	0.14	0.09	0.10	0.08	0.880
	6 months - 9m	0.28	0.08	0.18	0.08	0.552
	Base line - 6m	0.22	0.16	0.22	0.04	1.000
	Base line - 9m	0.50	0.12	0.40	0.07	0.534
Distal	Base line - 3m	0.08	0.08	0.10	0.07	0.887
	3 months - 6m	0.14	0.05	0.08	0.04	0.734
	6 months - 9m	0.24	0.09	0.24	0.11	1.000
	Base line - 6m	0.22	0.04	0.18	0.08	0.893
	Base line - 9m	0.46	0.11	0.42	0.11	0.967

Table 6: *Means, standard deviations (SD) with results of Mann-Whitney U test to compare mean amount of bone loss of the two-crown materials in immediate loading group.*

At the mesial side, the mean bone loss did not show statistically significance regarding both crown materials. At the distal side, the mean bone loss did not show statistically significance regarding both crown materials.

Discussion

This study was designed to compare bone healing around immediately and delayed loaded implants with two types of crown materials. Cases with parafunctional habits as clenching or bruxism, patients with inadequate arch space or excessive bone resorption were excluded from this study to facilitate implant insertion and avoid implant overloading [9]. All implants investigated in this study during the follow up period either immediately loaded or delayed loaded showed changes both clinically and radiographically. Those reactions was by logic attributed to biological reaction to implant supported single restoration in patients' mouth, as it is well known that prosthesis insertion alter the oral environment and plaque accumulation with its sequelae along with the stresses transmitted to the studied fixtures. Measuring of pocket depth was performed though there is a great debate existing still regarding correlating probing depth with implant failure rates [10].

Concerning the effect of crown material on the pocket depth, implant restored with zirconia crowns showed shallower pockets (1.2 mm for delayed loading and 1.867 mm for immediate loading) than those restored with porcelain fused to metal crowns (3 mm for delayed loading and 2.533 mm for immediate loading) at the end of follow up period. Measuring pocket depth denotes changes occurring in two aspects, one in the supporting bone, while the other in the gingival tissues surrounding the implant. However, no statistically significant difference between the 2 crown materials. Brandenberg., *et al.* [21] agreed with the finding that zirconia allows for stable peri-implant soft tissues in terms of probing depth. Therefore, a deep pocket might denote increased alveolar bone resorption or congestion and inflammation of the surrounding gingiva or simply both [11].

Some other 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 [12]. Variable results regarding bone levels of implants with time was stated by some researchers [13,14] and can be found in the data of several other studies [15]. In addition, effect regarding crown material with peak masticatory stresses of osseointegrated implant prosthesis was studied by Hobkirt and Psarros [16] who 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 statistically significantly higher values than delayed loading implants after 9 months. Bone loss in mesial side of immediate loading group was 0.4 mm while in the distal side it was 0.2 mm. These values were statistically significantly higher than delayed loading group, which had, means amount of bone loss of 0.2 mm and 0.22 mm in the mesial and distal sides, respectively. These values agreed with Miyata., *et al* [17]. 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 as stated by Boronat., *et al* [18]. Also Galal., *et al.* [13] found that it showed more bone loss than conventional delayed loading protocol. On the contrary, Kushaldeep., *et al*. [22] found that there is no difference between the immediate and delayed loading protocols. Comparison between bone-loss with the two supra-structures revealed non-statistically significant difference between Ceramo-metal and All-ceramic restorations through the whole study period. These results were in agreement with Sertgoz 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. According to Leinfelder [20], an all porcelain occlusal surface had a hardness which is 2.5 times more than natural teeth, composite resin hardness was 80 kg/mm^2 and that of enamel was 350 kg/mm^2, denoting that composite resin hardness was approximately four times less than enamel.

Conclusion

It was concluded that the material of the crown has no effect on the implant while delayed loading showed better results than immediate loading regarding pocket depth and bone loss around dental implant.

Conflict of Interest

No conflict of interest exist.

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