



Research Article

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The Employment of CBCT in Assessing Bone Loss around Dental Implants in Patients Receiving Mandibular Implant Supported over dentures

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ABSTRACT

The aim of this study is to evaluate bone loss around implants after delivery of implant supported over dentures using CBCT. This study was performed to evaluate Postoperative bone level around mandibular dental implants using cone beam computed tomography (CBCT). The study was conducted on 10 completely edentulous patients that were rehabilitated by complete overdentures. Patients retained mandibular overdentures by two implants installed in the canine region and retained locator attachments. Standard clinical and laboratory techniques were followed for implant insertion and denture construction for all patients. The implants were divided in two groups. Implants bearing locator attachment with blue nylon insert (Group I) and implants bearing locator attachment with transparent nylon insert (Group II). The twenty inserted implants were left undisturbed for three months to achieve osseointegration. The mesial, distal, buccal and lingual bone level around the dental implants was evaluated, using the CBCT i-CAT scan with Blue sky Plan® software. Bone level was obtained at six and twelve months after loading. The CBCT measurements of bone level revealed that there was bone loss around all aspects of the inserted twenty dental implants.

Key words: *Cone beam computed tomography, CBCT, dental Implant, marginal bone level, Implant supported overdenture*

INTRODUCTION

Dental Implants is an important dentistry in the recent years. Only limited universities and practitioners used to place and use dental implant treatment in the late 1980s [1, 2]. Later on, dental implants started to be used in partially edentulous patients with the developments of implant material, components and design [3].

Adequate treatment planning and successful dental treatment relies on accurate diagnosis. An important tool for accurate diagnosis and treatment planning of implants is diagnostic imaging [2, 4]. Currently implant dentistry is a well studied and documented treatment option in rehabilitation of edentulous jaws. It is known that bone resorption takes place in edentulous sites of the jaw after extraction of natural teeth [5, 6]. Bone resorption might progress to cause significant anatomical changes of the edentulous jaws that will make implant treatment as a difficult option [7]. Restoring of function and esthetics in case of bone resorption will require additional surgeries for grafting, and will make the prosthetic management more difficult and demanding. This will lead to increased morbidity and may reduce the overall success of the implant treatment. *Journal of Prosthodontics*, Steven J. Sadowski [8] were among the leading authors propose treating edentulous mandible with the placement of only 2 implants. Success rate shown at more 4 years follow up of observation was encouraging. Mandibular residual ridge reduction usually leaves a significant remaining bone quantity in the anterior area to accommodate implants.

Proper diagnostic tools and planning before implant placement are the keys of treatment success. Dental implants have to be placed and surrounded by bone or bone replacement material. Both synthetic and naturally occurring minerals can be used in dental implants [9, 10]. They should also not cause any damage to the

neighboring vital structures. The position of implants must be compatible with the intended prosthetic plan. Panoramic radiograph is an important tool for planning of implant treatment. It might be sufficient for some cases [11].

The demand of three-dimensional (3D) imaging for evaluation of bone quality and quantity in some cases had led to the use of CT in previous years. With the advance in technology and the release of Cone Beam Computed Tomography (CBCT) it's now possible to get 3D images with lower radiation [12, 13]. CBCT nowadays is an important diagnostic tool for dental implant treatment planning and offers a good spatial resolution [14].

Patients might have difficulties with their conventional dentures due to severe bone resorption remaining ridges. These difficulties include reduced denture stability and retention that lead to lower masticatory efficiency and dissatisfaction. Several different approaches have been introduced to overcome the problem. One approach is implant supported overdenture and another approach is fixed implant supported prostheses. Implant supported fixed prostheses might be more satisfactory for patients since it feels more like natural teeth with improved masticatory efficiency. Time, cost of the implant supported fixed prostheses in addition to careful maintenance might limit this treatment option. It cannot be used also in patients with poor lip support as fixed prostheses does not have flange as in complete denture and overdenture. Implant supported overdenture gives denture with excellent retention and stability. It is cost effective and time saving approach as compared to fixed prostheses. It also offers many advantages over conventional removable dentures, such as reduced bone resorption rate, less prosthesis movements, improved esthetics, maintaining occlusal vertical dimension, improved phonetics, psychological outlook and life quality [15].

MATERIAL AND METHODS

Material:

Ten adult completely edentulous patients (6 males and 4 females) were selected. The inclusion criteria were; patients with edentulous jaws and Angle class I with moderate inter-arch distance, residual ridges were of adequate dimensions that could accommodate dental implants in the area between mental foramina. While the exclusion criteria were inadequate inter-occlusal space, uncontrolled systemic diseases, heavy smokers and history of chemotherapy or radiotherapy.

All subjects were complete denture wearers for at least one year and were seeking a more stable prosthesis. Patients signed detailed consents after they were comprehensively informed about the nature of this research work. CBCT scans were made to evaluate the edentulous ridges and to detect any pathological lesions, impactions or remaining roots. The location of mental foramina, bone quality and quantity available for implant placement were evaluated.

Methods:

The lower denture was duplicated in clear acrylic resin to construct radiographic and surgical stent. Every patient had two dental implants placed in the area between extracted canines in mandible. The dental implants were placed after reflection of mucoperiosteal flaps with minimal stripping of the periosteum and implant sites were prepared with external and internal irrigation with light intermittent pressure. Penetration was assisted by surgical stents.

The sterile Zimmer Screw-Vent[®] Dental Implants was inserted into its prepared bony site with recommended torque (30Ncm²) until implant became flushed with the bone crest and initial stability of the implant was achieved. The reflected mucoperiosteal flap was sutured into its original site using 000 vicryl. Follow up of all cases and suture removal was done after 10 days.

Three months later patients were scheduled to uncover submerged fixtures and healing abutments of suitable lengths were connected based on mucosal thickness to be extended above the mucosal surface. The fixtures were then tested for osseointegration by mirror handle to hear the resonant sound. Complete overdentures were fabricated for all cases. Patients were divided in two equal groups of 5 patients each. Group I of patients had blue locator nylon. While, Group II had clear locator nylon.

CBCT Scans were taken at 6 and 12 months follow up periods. CBCT images were acquired using the i-CAT next generation at standardized settings for all scans "focal spot of 0.3 mm; effective dose of 99 uSv, 10 mA, 120 kVp, 14-bits grey scale and 36s exposure time" and the field of view (FOV) was limited to the mandible. Patients were instructed not to move during radiographic exposure. After image acquisition, DICOM data was transferred to another workstation; images were viewed using third party software, Blue Sky Plan[®] software (Blue Sky, IL, USA). Sky Plan[®] is precise and can help the clinician determine the ideal position for implant

placement for the best esthetic and functional results. Images were viewed on a 17 inch HD LED computer monitor (Dell Inc., Berkshire, UK) in a dimmed light room.

Reconstructed panoramic images were created by drawing the panoramic curve on the axial image (Figure 1A), and then cross sectional images were created parallel to the implant long axis in order to measure bone level on the implant buccal and lingual aspects (Figure 1B). On the axial image, the coronal section was adjusted to pass through the implant investigated (Figure 2A) and then bone levels were measured mesial and distally on the corrected coronal image (Figure 2B).

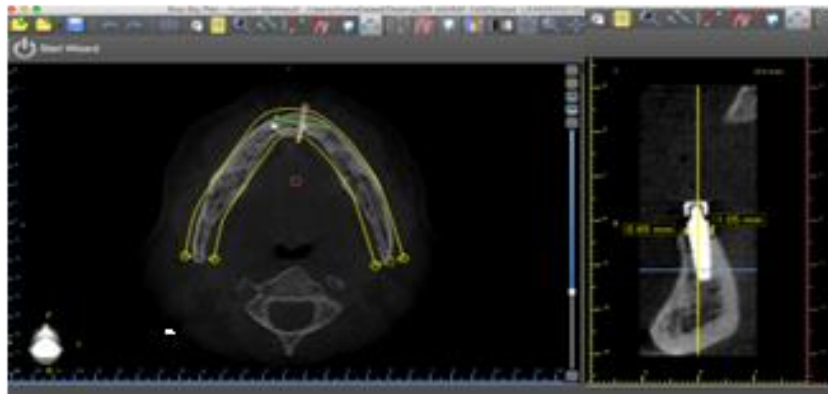


Figure 1: A. Axial CBCT image showing the drawing of panoramic reconstructed curve, B Cross sectional reconstructed image showing measurement of bone level buccal and lingual to the implant

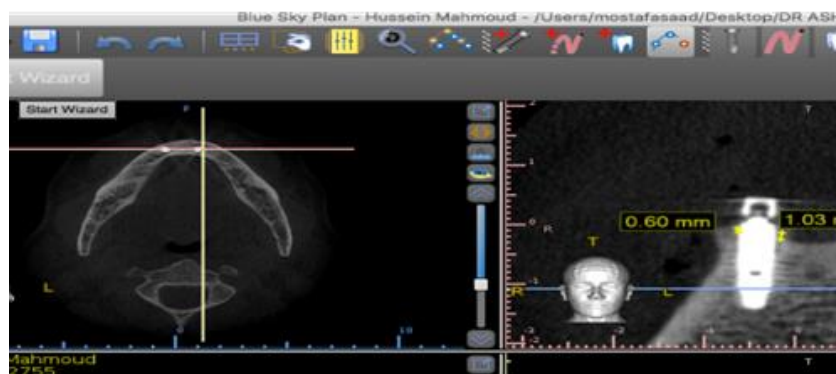


Figure 2: A. Axial CBCT image showing the alignment of the coronal section to pass through the implant, B. Coronal image showing measurement of bone level mesial and distal to the implant.

RESULTS

The study results are represented in tables (1). Mean and standard deviation (SD) values are calculated. T-test was used to compare between the two groups. Changes by time within each group were measured by Paired t-test. The significance level was set at $P \leq 0.05$.

Group I (patients rehabilitated with implants retained lower overdentures by locator attachment with blue nylon insert) mean values of the peri-implant bone height changes around implants both right and left sides during the one year follow up period are presented in table (1). Regarding the mesial aspect, the calculated means of peri-implant bone loss mesial to implant was 0.06 and 0.13 mm after six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference ($P < 0.05$) during the recall appointments.

The calculated means bone loss distal to implant was 0.12 and 0.22mm at the six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference ($P < 0.05$) during the recall appointments.

Regarding the buccal aspect, the calculated means of peri-implant bone loss buccal to implant was 0.08 and 0.17 mm after six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference $P < 0.05$ during the recall appointments. The calculated means of peri-implant bone loss lingual to implant was 0.14 and 0.27 mm after six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference ($P < 0.05$) during the recall appointments.

A total change of 0.09 mm and 0.19 mm was evident six and twelve months after denture insertion respectively as shown in table (1). This calculated amount of bone loss was statistically significant at $P < 0.001$.

Table 1: Mean values, SD values and Paired t-test for peri-implant bone loss for Group I at follow up period

Surface	Period (Number of months after overdenture delivery)	Mean difference (Mean bone loss)	SD	P-value
Mesial	6 months	0.06	0.01	0.001*
	12 months	0.13	0.03	0.003*
Distal	6 months	0.12	0.03	0.005*
	12 months	0.22	0.02	<0.001*
Buccal	6 months	0.08	0.04	0.032*
	12 months	0.17	0.06	0.013*
Lingual	6 months	0.14	0.03	0.002*
	12 months	0.27	0.03	<0.001*
Mean of all surfaces	6 months	0.09	0.01	0.001*
	12 months	0.19	0.01	<0.001*

*: Significant at $P \leq 0.05$

The mean values of the peri-implant bone height changes for group II patients (patients rehabilitated with implants retained lower overdentures by locator attachment with clear nylon insert) around implants for the right and left sides during the follow up period are presented in table (2).

Reduction in the calculated means of peri-implant bone height mesial to the abutment teeth was evident at follow up periods. Six months after denture insertion, the mean value of the measured bone loss was 0.09 mm. A total change of 0.17 mm was evident at the end of the study period as shown in table (4). This calculated amount of bone loss was statistically significant at $P < 0.05$.

The calculated means of peri-implant bone loss distal to implant was 0.37 and 0.62 mm after six and twelve months respectively. Statistical analysis of the data revealed significant difference $P < 0.05$ during the recall appointments.

Regarding the buccal aspect, the calculated means of peri-implant bone loss buccal to implant was 0.14 and 0.25 mm after six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference ($P < 0.05$) during the recall appointments. The calculated means of peri-implant bone loss lingual to implant was 0.25 and 0.38 mm after six and twelve months follow up periods respectively. Statistical analysis of the data revealed significant difference ($P < 0.001$) during the recall appointments.

A total change of 0.21 mm and 0.36 mm was evident six and twelve months after denture insertion respectively. This calculated amount of bone loss was statistically significant at $P < 0.001$.

Table 2: Mean values, SD values and Paired t-test for peri-implant bone loss for Group II at follow up periods

Surface	Period (Number of months after overdenture delivery)	Mean difference (Mean bone loss)	SD	P-value
Mesial	6 months	0.09	0.03	0.016*
	12 months	0.17	0.05	0.006*
Distal	6 months	0.37	0.07	0.002*
	12 months	0.62	0.05	<0.001*
Buccal	6 months	0.14	0.04	0.007*
	12 months	0.25	0.06	0.004*
Lingual	6 months	0.25	0.05	0.002*
	12 months	0.38	0.02	<0.001*
Mean of all surfaces	6 months	0.21	0.03	0.001*
	12 months	0.36	0.02	<0.001*

*: Significant at $P \leq 0.05$

To compare between the two studied groups as regards the amount of peri-implant bone height changes during the recall visits between the two studied groups, Student T test was applied and the results are shown in table (3). Six months after denture insertion, the mean value of the calculated peri-implant bone loss measured at the mesial aspect of the implant was 0.06 ± 0.01 mm and 0.09 ± 0.03 mm for group I and Group II respectively. At the end of the one year follow up period, the mean value of the calculated peri-implant bone loss was 0.13 ± 0.03

mm and 0.17 ± 0.05 mm for group I and Group II respectively. Although the amount of peri-implant bone loss was greater for group II patients the difference was statistically insignificant at $P > 0.05$.

Six months after denture insertion, the mean value of the calculated peri-implant bone loss measured at the distal aspect of the implant was 0.12 ± 0.03 mm and 0.37 ± 0.07 mm for group I and Group II respectively. At the end of the one year follow up period, the mean value of the calculated peri-implant bone loss was 0.22 ± 0.02 mm and 0.62 ± 0.05 mm for group I and Group II respectively. Marked significant amount of peri-implant bone loss was detected for group II patients, patients rehabilitated with implants retained lower overdentures retained locator attachment with transparent nylon insert ($P < 0.05$).

Six months after denture insertion, the mean value of the calculated peri-implant bone loss measured at the buccal aspect of the implant was 0.08 ± 0.04 mm and 0.14 ± 0.04 mm for group I and Group II respectively. At the end of the one year follow up period, the mean value of the calculated peri-implant bone loss was 0.17 ± 0.06 mm and 0.25 ± 0.06 mm for group I and Group II respectively. Although the amount of peri-implant bone loss was greater for group II patients the difference was statistically insignificant at $P > 0.05$.

Six months after denture insertion, the mean value of the calculated peri-implant bone loss measured at the lingual aspect of the implant was 0.14 ± 0.03 mm and 0.25 ± 0.05 mm for group I and Group II respectively. At the end of the one year follow up period, the mean value of the calculated peri-implant bone loss was 0.27 ± 0.03 mm and 0.38 ± 0.02 mm for group I and Group II respectively. Marked significant amount of peri-implant bone loss was detected for group II patients at $P < 0.05$.

Marked significant increase in the calculated mean value of all the surfaces for group two patients during the recall appointments was detected. A total change of 0.09 mm and 0.21 mm was detected for group I and group II respectively, six months after denture insertion respectively as shown in table (3). The difference in the calculated amount of bone loss was statistically significant at $P < 0.001$. At the end of the follow up period, a total change of 0.19 mm and 0.36 mm was detected for group I and group II respectively. The difference in the amount of bone loss was statistically significant at $P < 0.001$. group I showed statistically significantly lower mean bone loss than Group II.

Table 3: Mean, SD values and Student's t-test for the amount of peri-implant bone loss in the two studied groups.

Surface	Group Period	Group I		Group II		P-value
		Mean	SD	Mean	SD	
Mesial	6 months	0.06	0.01	0.09	0.03	0.101
	12 months	0.13	0.03	0.17	0.05	0.238
Distal	6 months	0.12	0.03	0.37	0.07	<0.001*
	12 months	0.22	0.02	0.62	0.05	<0.001*
Buccal	6 months	0.08	0.04	0.14	0.04	0.096
	12 months	0.17	0.06	0.25	0.06	0.111
Lingual	6 months	0.14	0.03	0.25	0.05	0.009*
	12 months	0.27	0.03	0.38	0.02	0.001*
Mean of all surfaces	6 months	0.09	0.01	0.21	0.03	0.001*
	12 months	0.19	0.01	0.36	0.02	<0.001*

*: Significant at $P \leq 0.05$

DISCUSSION

Tissue supported overdenture stabilized by two implants is often the restoration of choice due to patient preference, limitation in finance, insufficient available bone to accommodate a greater number of implants or needed improvements in stability, retention, aesthetics and phonetics.

The locator is a newer clinical alternative to the established attachments used for implant retained overdenture. A characteristic feature of locator attachment is the unique dual retention with combined internal and external retentive features. This provides a greater retention surface area than other types of attachments [16, 17]. Three colour coded nylons (blue, pink and clear) are supplied for Zimmer implant locators. Their retentive forces are 680, 1361 and 2268 grams respectively [18, 19]. Dual retention is obtained from the internal and external features of the abutment. The locator male part (nylon) pivots in its metal housing for a resilient connection of the prosthesis. The retentive male part keeps contact with the socket and stays static even though its metal housing undergoes rotational movement [20-23].

All criteria for patient's selection were directed to control the adverse effect of systemic and local factors that contraindicate proper osseointegration of implants and avoid excessive load or undue forces on the residual ridge and implants [24, 25]. Standard clinical and laboratory techniques were followed for denture construction for all patients to decrease variables that could affect the results of this study. Cross-linked acrylic resin teeth were balanced following the lingualized concept of occlusion to ensure axial loading of the implants.

Implants success criteria included implant stability, no pain and absence of any pathologic process or radiolucency [26]. The results revealed that the use locator attachment fulfils the criteria of implant success as indicated by clinical examination and the measured amount of bone loss.

At the end of 12 months follow-up period, a statistically significant decrease in peri-implant bone height for the two studied groups was detected. A total change of 0.19 mm and 0.36 mm was detected for implants bearing locator attachment bearing blue nylon insert (Group I), and implants bearing locator attachment with transparent nylon insert (Group II) respectively. This amount of bone loss fully complies with success criteria mentioned by Cox and Zarb [27], and Albrektsson [26] et al. and were within the permissible range previously reported to occur within the first year of implant placement.

This bone loss could be based on the hypothesis that marginal bone loss is the result of micro-damage accumulation occurring in bone after implant placement. It was also explained as a manifestation of wound healing which occurs after implant surgical placement and as a reaction to loading [28]. Crestal bone loss could also be explained by the finding that forces applied on implants are distributed on the crestal bone rather than along the entire implant/bone interface.

Primary implant stability depends on implant design, local bone quantity, local bone quality, surgical technique and fit inside the bone [29-31]. The acceptable range of crestal bone height loss for the two groups until the end of the study period may be attributed to proper selection of cases, adequate implant length in proportion to the height of the residual alveolar ridge, proper oral hygiene measures, proper implant installations and angulations.

It was observed that significant crestal bone loss was detected distal to implants in the two studied groups six and twelve months following implant loading. This finding is in agreement with previous clinical study *Payne et al.* [31] after a one-year study found a mean marginal bone loss of 0.30 mm distally and 0.22 mm mesially with immediate overdenture supported by unsplinted conical Brånemark fixtures. Implants supporting overdentures act as a fulcrum that has two lever arms. Posterior lever arm is from the fulcrum to the posterior denture base extension. However, from the fulcrum to the edges of anterior teeth incisally is anterior lever arm. Forces on any of the two lever arm produce rotation. The used scheme of occlusion in patients included in the study provides no contact in centric and light contact in eccentric jaw positions anteriorly. Thus forces on the anterior lever arm by forces on anterior teeth minimized, reducing the tipping stress. The stress bearing areas of the overdenture resist the occlusal load placed on the posterior lever arm. This may account for the less amount of mesial bone loss detected in this study.

Naert et al [32] in a nine-year longitudinal study observed bone loss of 0.7 mm during the first year and a mean annual bone loss of 0.05 mm during the study period. In addition, Payne et al [33] recorded a 0.35 mm loss of bone height at the crest after one year of conventional loading and was reduced to 0.09 mm after two years. Nickenig et al [34] after six and twelve months of functional loading found mean marginal bone loss of 0.8 mm and 1.1 mm respectively associated with the machined neck implants, while the rough-surfaced micro threaded neck implants scored 0.4 mm and 0.5 mm mean marginal bone loss respectively.

It was observed that more bone loss was observed in (implants bearing locator attachment with transparent nylon insert) compared to those bearing blue nylon insert. This difference was during the first six months after implant loading.

Based on the clinical findings together with the results of this study, the locator attachment fulfils the criteria of implant success as indicated by clinical examination and the measured amount of bone loss. The results of this study showed that the use of locator attachment had less bone height loss aperi-implant area throughout the one year follow up period compared to other studies.

CONCLUSION

Bone loss was detected around all aspects of the placed implants at the six and twelve months follow up using CBCT. It was observed that more bone loss was observed in implants bearing locator attachment with transparent nylon insert compared to those bearing blue nylon insert. Bone loss was seen more evident on distal aspect of the placed mandibular implants supporting overdentures.

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