

Effect of Using Cantilever Bar on the Supporting Structures in Implant Supported Mandibular Overdentures

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Abstract: ***Statement of problem:** free overdenture rotation during function lead to bone resorption in the posterior edentulous regions. **Purpose:** The aim of this study was to compare the influence of incorporating a cantilever extension in two implant supported bar mandibular overdentures on the peri-implant tissues in two groups of completely edentulous patients receiving two implants in the mandibular canine region. **Materials and method:** Ten completely edentulous patients were randomly assigned into two equal groups, in the first group the removable complete overdenture is supported and retained to the implants with metallic bar attachment with bilateral posterior extension, in the second group the removable complete overdenture is supported and retained to the implants with metallic bar attachment with no posterior extension. Marginal bone height and bone density changes around the implants were measured radiographically using cone beam CT. The data were collected, arrayed and statistically compared. **Results:** regarding bone density radiographically there was no significant difference between the two groups while group one recorded significant higher marginal bone loss radiographically than group two. **Conclusion:** although that there was a significant difference between the two groups regarding marginal bone loss, it was within the normal rate reported in the literature.*

Keywords: mandibular overdenture, two implants, cantilever bar, overdenture rotation

1. Introduction

Restoring the edentulous mandible with two implants placed in the interforaminal region to support or retain an overdenture considered as the first treatment option for edentulism [1].

In randomized and non-randomized clinical trials implant-supported overdentures have been shown to be significantly more stable than conventional dentures, also they were more comfortable, and increase the ability to chew various type of food significantly. In addition, this kind of treatment is much cheaper for the patients comparing to the costs for an implant-supported fixed dental prosthesis[2].

Overdentures are considered a simple, cost-effective, viable, less invasive and successful treatment option for edentulous patients [3, 4]. However, controversies toward the design of attachment systems exist [5].

Bar-retained implant overdentures are an adequate treatment option for edentulous jaws as they exhibit high implant/prosthesis survival rates and a limited incidence of technical complications after a mean observational period. Nevertheless, peri-implantitis was identified as a frequent and serious biological complication for this type of reconstruction[6].

Splinting Implants together with bars may decrease the risk of overload to each implant as a result of obtaining a greater surface area, sharing the load between implants leading to improvement of biomechanical distribution [7-9] However,

due to free overdenture rotation during function, bone resorption occurred in the posterior edentulous regions [10-14].

In addition the difference in resiliency between the clips and mucosa lead to transferring of a considerable part of the forces around the implants from the denture-bearing area. [12, 15]

Several approaches have been suggested to provide effective support for implant overdentures and minimize their rotation during function. The use of long-bar overdentures supported by interforaminal implants provides increased prosthesis stability and retention, decreased overdenture rotation, improved comfort and chewing ability compared to implant mucosa-supported overdentures [16].

The connection of implants with a cantilevered bar may decrease overdenture rotation during function, enhance the denture support, improve chewing, and reduce loading of denture-bearing areas [15, 17, 18]. Such design increase prosthesis rigidity, enhances denture stability, retention, and provides a more conservative surgical and economic treatment. Moreover, the supporting area of bars with distal cantilevers was found to be greater than those without distal cantilevers [19].

2. Aim of the study

The aim of this study was to compare the influence of incorporating a cantilever extension in two implant supported bar mandibular overdentures on the peri-implant tissues in two groups of completely edentulous patients receiving two implants in the mandibular canine region

regarding bone height and bone density changes around the implants radiographically.

In the first group the removable complete overdenture is supported and retained to the implants with metallic bar attachment with bilateral posterior extension, while in the second group the removable complete overdenture is supported and retained to the implants with metallic bar attachment with no posterior extension.

3. Materials and methods

Patient selection

Ten healthy completely edentulous patients (8 males and 2 females) were selected for the present study from the outpatient clinic of the prosthodontics department, Faculty of Dentistry, Minia University, with their ages ranged from 52-67 years.

All patients were informed about their line of treatment, procedures and the necessity for their frequent attendance. A printed approval document was signed by each patient.

Their consent was documented after explaining all the possible complications as well as the nature of the study

The patients were enrolled in this study provided that they had the following inclusion criteria: Sufficient residual alveolar bone quantity (height and width) and quality (normal trabecular pattern) anterior to the mental foramen to receive self-taping titanium implants, U-shaped lower ridge to avoid the lingual placement of the bar that occurs with v-shaped ridges, Interarch distance was suitable to have overdentures and attachments, Angle's class I maxilla-mandibular relation with sufficient interarch space,

Patients were excluded if they had one of the following TMJ or neuromuscular disorders, Abnormal habits, (e.g. bruxism, clenching, smoking and alcoholism). Bone metabolic disorders (e.g. Diabetes), History of radiation therapy in the head and neck region.

Surgical and prosthetic procedure

Each patient had received a new set of upper and lower complete dentures ,constructed with the conventional methods.

For each patient, a customized surgical guide was fabricated using CAD/CAM technology through the data obtained from the cone-beam CT (CBCT).

Patients were scanned by the CBCT machine (SOREDEX 3DX. Nahkelantie 160, Tuusula. P.O. Box 148, FI-04301 Tuusula. Finland).The denture of each patient was marked by guttapurcha and scanned by the CBCT machine.

Captured images by CBCT were imported into viewing software then sent for fabrication of the guide as follows

The patients' scans were opened in blue sky bio software. Blue Sky Bio opens DICOM data directly from the CBCT machine, Implant sites were examined to ensure acceptable

alveolar bone quality and quantity according to the selected implants' length and width, the surgical guides were designed and planned with sites for placement of metal housings and the lateral cylinders for placement of the implants and anchorage pins.

Fabricated surgical guides were made from clear acrylic and contained 2 metal housings, over the planned implants' sites that accurately fit the provided removable sleeves by the manufacturer. Three lateral cylinders were provided in each guide to allow the placement of anchor pins for fixation of the guide.

Two root-form endosseous implants were placed at the mandibular canine areas in each patient as follows

Infiltration anesthesia was injected to the buccal and lingual mucoperiosteum of the planned implant sites; three holes were drilled in the mandible, through the provided lateral cylinders of the guides to receive the anchor pins for fixation of the guide. (Fig 1)



Figure 1: Surgical guide fixed in place with anchor pins

Osteotomy preparations were performed at the planned implants' sites bilaterally using serial drills to the proper depth of the drills. Drills were operated via specific removable sleeves designed to match the drills sizes (OXY implant. Via Nazionale Nord, 21A, 23823 Colico LC, Italy).

Only intermittent drilling with low speed, high torque and internally irrigated hand piece was used to prepare the holes for anchor pins and the osteotomy. Additional external irrigation using sterile disposable syringe was performed as well. Sterile saline was used for irrigation while preparing the osteotomy.

After finalizing the osteotomy preparations and removal of the guide ,implants were inserted as decided. All implants were of the same length (13 mm) and the same diameter (3.5mm). (oxy implant. Via Nazionale Nord, 21A, 23823 Colico LC, Italy)

The implants mounted on the vial caps were inserted in place by using the vial caps until resistance was felt, then wrench system was applied to complete seating of the implants in place, Cover screw was used for each implant to cover implants using screw driver.

The fitting surface of the denture was prepared opposite to the implant sites to accommodate the implant heads, a tissue conditioning material (Alpha dental products Co., subsidiary of Wallace A. Erickson & Co. 1920N. Clybourn Ave.,

Chicago, IL 60614, USA) was used to relined the mandibular denture to avoid tissue irritation or implant overloading.

Post-Operative measures were performed as follow, Cold packs were applied locally immediately after surgery, they should be placed for 10–15 minutes every hour, for the following 4–6 hours and Soft diet for the following week .

Drug prescription: Antibiotic: 1 gm amoxicillin for 5 days started one day before the surgery, 2 times daily every 12 hours, Analgesic and anti-inflammatory: 50 mg diclofenac potassium for 5 days 3 times daily, Mouthwash: Chlorhexidine Hydrochloride 125 mg/5 ml. 19.

The patients were randomly assigned to 2 groups: **group 1** received Co-Cr metallic bar joint with bilateral posterior extensions 7mm **group 2** received Co-Cr metallic bar joint with no posterior extensions

After 3 months of implant insertion, healing abutments were placed for two weeks, then two plastic bar abutments were attached to the implant heads with fixation screws, A plastic bar (bar joint design) was placed between the two copings and its required length was marked and cut, leaving 2-mm clearance space beneath the bar for oral hygiene purposes.

A prefabricated plastic pattern of the bar was luted to the plastic extensions of the bar abutments using a self-cured acrylic resin (Duralay, Reliance Dental Manufacturing Co., Chicago, USA.). For **group 1**, two plastic cantilevered bars (7 mm in length)[18] were luted to distal surfaces of bar abutments and oriented along the crest of the ridge. In **group 2**, no cantilevers were used (fig 2)

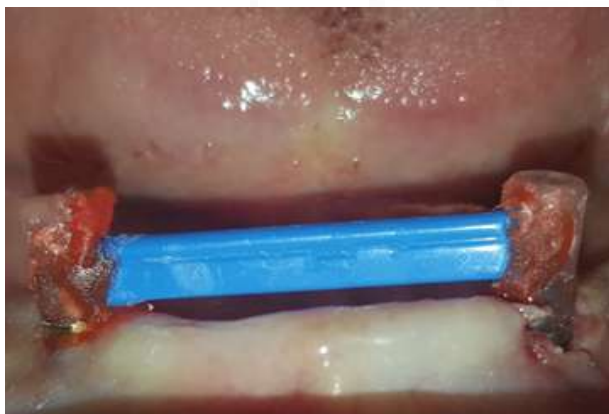


Figure 2: Adjustment of plastic bar with plastic abutment

The two copings and bar assembly were cast as one piece into cobalt chromium alloy (Niadure, DFS Diamon, Germany) according to the commonly used casting technique. The construction was then finished, tried in the patient mouth and then polished (fig 3a,b).



Figure 3(a, b): Cobalt chromium bars

Passive fitness of the bar copings complex over the implants was checked by the tactile sense when seating the tightening screws in place without any resistance.

The clinical pick-up procedure was the same for both groups, nylon clip was fixed in place on top of the bar, no clips were placed over the cantilever, The undercuts beneath the bar and copings was blocked out using smooth casting wax(GlattesGusswaches, Smooth casting wax 0.3mm.,Ref.no.40092,BEGO,Germany).

The denture's fitting surface opposite the bar coping complex and nylon clip was prepared to allow for complete seating without interference. A small window was created at the lingual flange opposite to the bar and sleeve attachment to allow for escape of excess pick-up material.

The denture was seated in the patient mouth and the patient was asked to close in centric relation and maintain maximum biting for the period of setting of the rebase material (Tokuyama Rebase II fast, Tokuyama Dental Corporation, Japan).

Radiographic evaluation of marginal bone loss and bone density

For both groups, marginal bone level around the implants was examined using cone-beam CT (CBCT) at loading time, after 3, 6, 9 and 12 months to measure the amount of marginal bone loss around each implant. Marginal bone level was measured using OnDemand3D Application software (Sordex-Scanora® 3D).

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 OnDemand3D software. The mean value of readings were taken, tabulated and statistically analyzed [20].(fig 4)

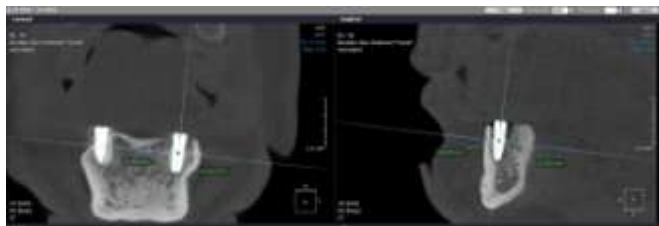


Figure 4: Measuring of marginal bone loss around implant from sagittal (buccal and lingual) and coronal (mesial and distal).

Bone density around the implants was measured using cone beam CT (CBCT) at loading time, after 3, 6, 9 and 12 months. Bone density was measured using OnDemand3D Application software (Sordex-Scanora® 3D).

The bone density measurements were recorded in relative Hounsfield units (HU).The regions of interest (ROI) were square area (6X6) plotted 1 mm from the center of implant surface to reduce the effect of the scattered radiation on the density values [25].

The bone densities at the labial and lingual bone surfaces were measured on the sagittal view screen. While the bone densities at the mesial and distal surfaces were measured on the coronal view screen.(fig 5)



Figure 5: Measuring of bone density around implant from sagittal (buccal and lingual) and coronal (mesial and distal)

The mean value of readings were taken, tabulated and statistically analyzed.

4. Results

This study was conducted, on ten completely edentulous patients to compare the influence of incorporating a cantilever extension in two implant supported bar mandibular overdentures on the peri-implant tissues in two groups of completely edentulous patients receiving two implants in the mandibular canine region regarding marginal bone height and bone density changes around the implants radiographically.

4.1 Results of Radiographic Assessment of marginal bone loss

For both groups, marginal bone loss around each implant was measured radiographically using Cone Beam Computed tomography (CBCT), in millimeters, at time of implant loading, and after 3, 6, 9 and 12 months (table 1 and figure 6).

Table 1: Comparison between the two studied groups regarding marginal bone loss at different period of follow up

Bone level implant	Insertion	3 months	6 months	9 months	12 months
Group I Mean	0.46	0.48	0.52	0.59	0.69
S.D.	0.016	0.028	0.041	0.125	0.107
Group II Mean	0.42	0.44	0.46	0.50	0.58
S.D.	0.016	0.034	0.027	0.036	0.023
p	0.465	0.048*	0.042*	0.039*	0.021*

P comparison between group I and II at the same time

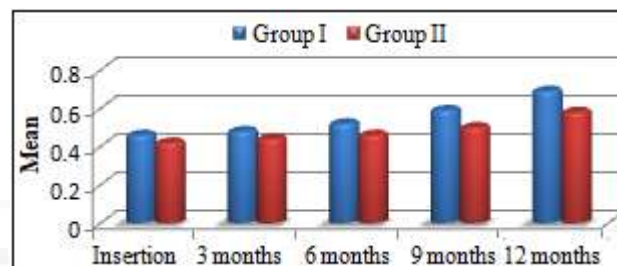


Figure 6: Comparison between the two studied groups regarding marginal bone loss around implants.

Results reflected clinical and statistical significance difference regarding marginal bone loss around the implants between the two groups through the study at 3, 6,9,12 months. Moreover there was increase in the mean marginal bone loss in both groups through the study.

4.2 Results of Radiographic Assessment of Bone Density Changes

For both groups, bone density around each implant was measured radiographically using Cone Beam Computed tomography (CBCT), in relative Hounsfield Unit (HU), at time of implant loading, and after 3, 6, 9 and 12 months (table 2, figure 7).

Table 2: Represents mean and standard deviation of bone density changes for Group I (bar with distal extension) and Group II (bar with no distal extension) at different follow-up intervals

Bone density	Insertion	3 months	6 months	9 months	12 months
Group I Mean	892.11	907.15	910.21	918.1	919.03
S.D.	13.19	10.3	10.5	11.32	10.17
Group II Mean	890.11	906.1	910.25	912.7	918.36
S.D.	14.13	10.77	10.62	11.9	11.91
p	0.471	0.582	0.474	0.625	0.514

P comparison between group I and II at the same time

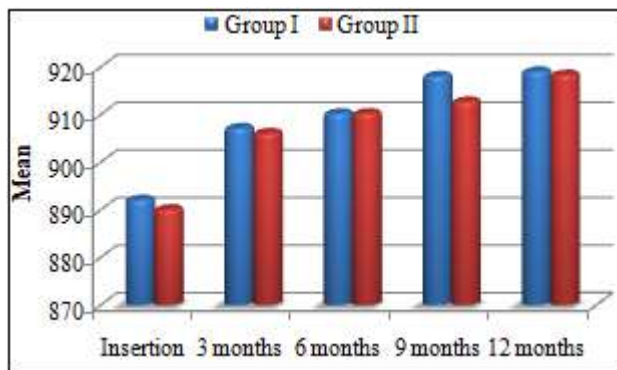


Figure 7: Comparison between the two studied groups regarding Bone density changes

Results reflected neither clinical nor statistical significance difference regarding bone density changes around the implants between the two groups at different periods of follow up; although statistical analysis showed increase in the mean bone density around the implants of both groups at different periods of follow up.

5. Discussion

The present study compare the influence of incorporating a cantilever extension in two implant supported bar mandibular over dentures on the peri-implant tissues in two groups of completely edentulous patients receiving two implants in the mandibular canine region marginal bone height and bone density changes around the implants radiographically.

Pre-operative cone-beam computed tomography (CBCT) was performed for all patients in order to obtain information about the width, height, and inclination of the alveolar process; anatomic and topographic structures; and, to some extent, the trabecular architecture [21].

Cone-beam computed tomography was also performed for the patients' and their dentures. CAD-CAM technology was used to fabricate clear acrylic resin stereolithographic surgical guides for all patients using all data collected from CBCT.

Also CBCT were used for radiographic evaluation of marginal bone loss and bone density changes through this study.

This was in agreement of [22] Hashimoto et al (2003) who reported that CBCT shown superiority in the display of hard tissues associated with the dental region with a substantially decreased radiation dose to the patient when comparing with multi-detector CT, also CBCT provides clear images of highly contrasted structures & is extremely useful for evaluating bone.

The marginal bone area is considered a significant indicator of implant health. Marginal bone is the area that bears the maximum stress around an implant. Blood supply to the marginal bone area is reduced around an implant compared with that of a natural tooth, because the blood vessels from the periodontal ligament are absent. Its major source of blood supply is from the periosteum covering the bone[23].

Statistical analysis of the results showed significant marginal bone loss around the implants supported with distal extension (cantilever bar) to those with no distal extension. This may be due to that cantilevered bars could induce stress concentration in the supporting bone that might lead to bone resorption under occlusal loads

Results of marginal bone loss of this study were in agreement with several biomechanical studies [18, 24, 25]. In these studies, the authors found that cantilevered bars could induce stress concentration in the supporting bone that might lead to bone resorption under occlusal loads [24, 26].

Mericske-Stern et al., 2000; Naert et al., 1997,[27, 28] concluded that Implant retained overdenture associated with bar-clip anchor with two distally placed cantilevers displayed the greatest stress level, Although cantilever extensions of bar attachments have been recommended for mandibular implant-retained overdentures to increase denture stability against non-axial loading

Barao et al. 2013[29], found that Cantilevered bar-clip overdenture with or without distal extension display the highest von Mises stress, maximum and minimum principal stresses values within implant/prosthetic components whereas the fixed full-arch implant-supported prosthesis presented the lowest ones.

Elsyad et al. (2013)[18], found that the two implants with cantilevered bars subjected to higher strains compared to bar without cantilevers. The direct contact of the acrylic resin to the cantilevered bars counteracts the overdenture rotation and forms a lever which transmits moment loads to the implants.

Mean annual marginal bone loss after 1 year of implant service with Group I implants was 0.69 mm (\pm 0.107) and with Group II implants, it was 0.58 mm (\pm 0.023). Both these figures are below 1.5 mm of annual bone loss in first year of implant service and fulfill the success criteria described by [30] Misch et al; 2003

Results of bone density changes of this study was in agreement with previous histological and histomorphometrical studies in monkeys with immediately loaded and delayed loaded implants which confirm that there is no significant difference in the soft periimplant tissues, and the periimplant bone presents no differences at the osseointegration level, meaning that the bone-to-implant contact percentage is similar between the 2 loaded groups [31]

Statistical analysis showed increase in the mean bone density around the implants of both groups. This was in agreement with Gottfredsen et al; 2001[32], who reported that static continuous loads on implants resulted in increased bone density.

Periodontal parameters have commonly been used for clinical monitoring of the soft tissues around dental implants[33].

6. Conclusion

Within the limitation of this study, it could be concluded that cantilever extension in two implant supported bar mandibular overdentures induce significant effect regarding marginal bone loss on peri implant tissues, although these changes were within the normal range reported in literatures.

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