Mandibular Implant-Retained Overdentures with two Different Implant Designs

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Abstract: The prosthetic management of the edentulous patient has long been a major challenge for dentistry. Complete maxillary and mandibular dentures have been the traditional standard of care, however most patients report significantly more problems adapting to their mandibular denture due to a lack of comfort, retention, stability, and to the inability to chew and eat. Recent scientific studies have determined that the benefits of a mandibular-implant overdenture are sufficient to propose this treatment modality rather than the conventional denture as the first treatment option. The aim of this study was to compare the micromotion between two types of dental implants supporting mandibular overdentures and analyze the bone mineral density (BMD) in the implant site of the mandible. Material and methods; twenty male patients were selected for this research with their ages ranged from 55-65 years. The patients were divided into two equal groups. Group A: the patients received mandibular complete overdenture supported by two Osteocare midi dental implants. Group B: the patients received mandibular complete overdenture supported by two Microdent dental implants. Stability and radiographic evaluation was carried out for every patient at the time of implant insertion, after 1, 3, 6 and 9 months. The results; Clinical implant stability measurements showed that no statistically significant differences between the two groups ($P < 0.05$). Radiographic evaluation showed that bone density of alveolar ridge proved no marked difference between the two groups. Regarding the bone density around dental implants at mesial and distal sides; there was significant difference between the two groups ($P > 0.05$). The bone density at mesial and distal sides of dental implants in group A was higher than in group B. It could be concluded that the surface characteristics of dental implants can affect the bone density around them.

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Key Words: overdenture; conventional denture; dental implants, micromotion.

1. Introduction

Complete maxillary and mandibular dentures have been the traditional standard of care for edentulous patients for more than a century. Complete denture wearers are usually able to wear an upper denture without problems, but many struggle to eat with the complete lower denture because it is too mobile. [(1)] An overdenture may be the treatment of choice for patients with moderate-to-severe resorption, especially as a means to provide function and esthetic in a reduced amount of time and with less morbidity relative to the restoration of implants with conventional crowns or fixed partial dentures.[(2-5)]

Scientific studies have been carried out over the past decade to determine if the benefit of a mandibular 2-implant overdenture is large enough to propose it, rather than the conventional denture, as the first treatment option.[(1)] Mandibular overdenture retained by two implants has been demonstrated to be a simplified and a successful treatment option for the completely edentulous patients.[(6)] Patients find the implant overdentures significantly more stable, and they rate their ability to chew various foods as significantly easier. In addition, they are more comfortable and speak more easily with implant overdentures. [(7)]

The standard of care in the treatment of the edentulous lower jaw by two implants retained over-denture provides the patient with significant treatment flexibility. This minimally invasive approach improves the patient's physiological bone mass, quality of life and, possibly nutritional status. Studies have shown that mandibular implant overdentures significantly increase satisfaction and quality of life of edentulous elders.[(8)] Two implants spaced between 12 and 16 mm apart (edge to edge) in the mandibular canine region can be restored with freestanding attachments in the mandibular implant overdentures.[(9, 10)]

Implant designs continue to evolve, with new thread designs and implant surface modifications (such as roughing via grit blasting and various forms of etching procedures) developed to enhance the predictability of implant survival in soft or poor bone situations.[(11,12)] These implant surface modifications promote new bone growth, a process called (osteoconduction). [(13)] As an example of these surface modifications, the titanium fluoroxide surface results from an electrochemical etching process that modifies the oxide surface with a resulting low level of fluoride in the oxide surface. [14] This fluoridated oxide surface, which acts as a site for calcium and phosphate precipitation, increases bone contact and implant stability [15, 16]

The continuous increase of man's life span and the growing confidence in using artificial materials inside the human body necessitate introducing more effective prosthesis and implant materials. However, no artificial implant has biomechanical properties equivalent to the original tissue. In order to obtain good dental implantation of the biomaterial; full integration of the implant with living bone should be satisfied. Minimum stresses in the implant and the bone must be achieved to increase the life of the implant and prevent bone resorption. [17]

Some recent innovations in dental implant technology are elaborated. Recently, two designs of implants are extensively used as fabrication materials for dental implants due to their high compatibility with hard tissue and living bone.

Although previous studies have demonstrated that implant-supported prostheses are more satisfactory and efficient for edentulous patients than conventional prostheses; until now no investigation has directly compared different types of implant-supported prostheses.

Aim of the work:

This study investigated the micromotion between two types of dental implants (Osteocare midi and Microdent implants) supporting mandibular overdentures and to analyze the bone mineral density (BMD) in the implant site and anterior alveolar ridge area of the mandible.

2. Material and methods:

Twenty completely edentulous healthy male patients were selected for this study from the outpatient clinic, Prosthetic Department, Faculty of Dentistry, Tanta University.

Patient's criteria;

The inclusion criteria for entry into the trial were that: (a) the individuals were medically fit enough to undergo minor oral surgery; (b) all patients were free from any systemic diseases that might affect the bone;(c) the dental implants could be placed into the lower jaw without the need for bone augmentation procedures; (d) the patients had been edentulous for more than five years; and (e) that patients' ages ranged from 55 to 65 years. Patients were classified into two groups.

Group A: the patients received conventional maxillary complete denture and mandibular complete overdenture supported by two Osteocare dental implants (Osteocare midi implants system, United Kingdom) made up of titanium alloy. (Fig. 1)

Group B: the patients received conventional maxillary complete denture and mandibular complete overdenture supported by two Microdents dental implants (Microdents system, Santa Eulalia de Roncana, Spain) made up of titanium alloy. Fig. (2).

Fig. (1) Osteocare midi implant

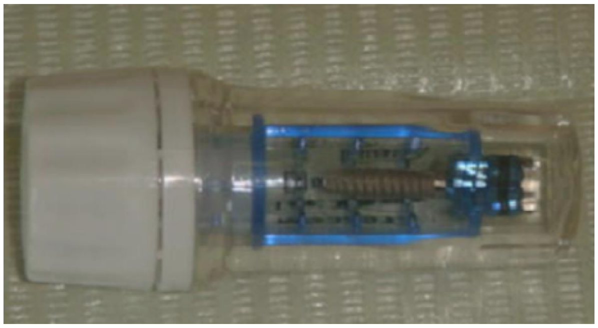

Fig. (2) Microdent implant

The two osseointegrated implant fixtures were inserted in the canine regions of each patient in accordance to available bone following the essentials of surgical protocol. The patient was recalled for regular follow-up to assess the status of implants and the peri-implant tissues. Once the evidence of osseointegration was established, the overdenture was connected 3 months after surgery and the loading of the implants was initiated with the prosthetic rehabilitation.

Procedure:

1. A preliminary impression for mandibular and maxillary arches was made using irreversible hydrocolloid impression material (Hydrogum, Zhermack, Badia Polesine, Italy) in a suitable stock tray to produce working models upon which auto-polymerizing resin custom trays were fabricated. Final impression was made using silicone impression material (Speedex, coltene A.G., Alsatten, Switzerland) capturing the details of implant abutments and the supporting soft and hard tissues for both arches.
2. The spatial relationship between the maxilla and mandible was recorded and was followed by trial insertion, and the dentures were cured in heat polymerizing resin (Superacrylic / Resin for dentures, Sofa; Dental. PRAHA).

3. O-ring attachment with the resilient Teflon housing attachment was used in this study for both groups.
4. The retentive elements for the implant abutment were housed directly at chair side into the fitting surface of the denture. The final prosthesis was checked for an excellent blend of retention, stability, and support. The patients were asked for regular recall and maintenance.

Stability assessment:

The micromotion of implants resulting from any small horizontal forces was measured by mechanical micrometer (Design and Production Engineering Department, Faculty of Engineering, Tanta University). (Fig. 3) This mechanical micrometer consists of horizontal arm with small head to hold the head of the dental implant, and measure its micromotion. (Fig. 4)

Fig. (3) Mechanical micrometer

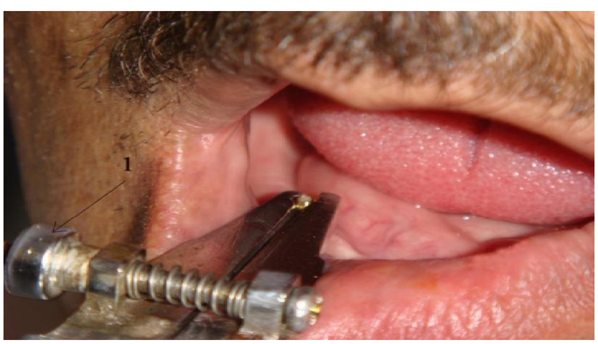

Figure (4) Show clamped implant abutment

Horizontal force was applied to measure the micromotion of dental implant. The horizontal arm was conducted with spring to dial indicator for calculating the amount of micromotion of dental implant when the force was applied. The applied force was generated by 12 volt electric current to generate horizontal force about 1.53N. This measuring process was repeated three times for each implant, and the mean value will be used to represent the mobility for the implant. The implant mobility for each patient was calculated by summing up the mobility of each implant and divided by two. The means of stability data for each group were calculated, tabulated and statistically analyzed. Implant stability was measured at insertion and after 1, 3, 6 and 9 months.

Radiographic assessment:

Preoperative panoramic radiographs were made for all patients to evaluate the quality of bone at the edentulous ridge area, the position of mental foramen and the changes in bone density around the implants and anterior alveolar ridge area. Digital panoramic images were used with Retrograph plus (Villa systemi medical, Italy) panoramic unit which is a film-sized photostimulable storage phosphor plate (PSP) rather than film. The PSP plates were processed and adjusted automatically by the CR500 (Kodak direct view, Kodak Company, USA) software package. Fig. (5)

Radiographic Densitometry:

All digital panorama radiographs were taken for each patient before implant insertion and after 1, 3, 6, 9 months. Changes in the bone density around implants and anterior ridge area were measured using DIGORA digitized image program. All digital panorama radiographs were automatically digitalized and stored in the computer with the processed Digora software (DIGORA for windows, Soredex, Helsinki, Finland) and adjusted to this work. The measured densities were obtained automatically due to performed software package on panoramic images.

All the radiographic data were tabulated and statistically analyzed for each patient.

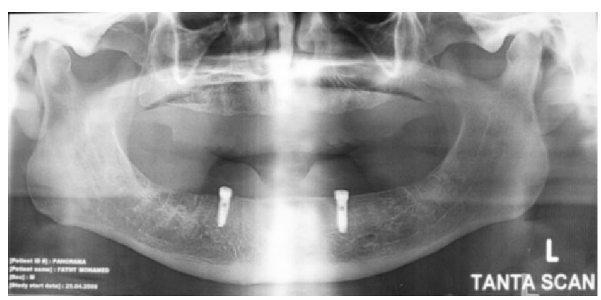

Fig. (5) Panorama after implant placement

3. Results:

Implant stability:

Table (1) shows the mean and standard deviation of implants micromotion for group A and for group B. At insertion of dental implants, there was no significant difference between the two groups (*P* = 0.4). After one month, the mean and standard deviation of implant micromotion for both groups were increased. There was no significant difference between the two groups (P = 0.18). After 3, 6 and 9 months follow up period; the mean and standard deviation of implant micromotion for the two groups were decreased. There was no significant difference between the two groups (P = 0.09, 0.41 and 0.79) respectively.

Bone density of alveolar ridge:-

Table (2) shows the mean bone density of the alveolar ridge in group A and group B. At insertion of dental implants, insignificant difference was observed between the two groups followed by a decrease of bone density of the alveolar ridge after one month with no significant difference between the two groups. An increase in bone density was revealed for both groups during the following periods of observations without statistical significant difference.

Bone density around dental implants:-

Tables (3) shows the mean bone density of dental implants between the two groups where insignificant difference was observed at insertion of dental implants, followed by insignificant increase of bone density among the two groups after 1, 3, 6 and 9 months intervals.

Table (1): Comparison of micromotion of dental implants at different periods of follow up between the two groups

Follow up Periods	Stability of dental implants		t	*p*
	Group 1	Group 2		
At insertion (Mean ± S.D)	0.09 ± 0.05	0.08 ± 0.06	0.008	0.4
After 1 month (Mean ± S.D)	0.42 ± 0.26	0.43 ± 0.19	0.01	0.18
After 3 months: (Mean ± S.D)	0.31 ± 0.06	0.32 ± 0.1	0.01	0.09
After 6 months (Mean ± S.D)	0.23 ± 0.02	0.24 ± 0.03	0.008	0.41
After 9 months (Mean ± S.D)	0.13 ± 0.03	0.13 ± 0.03	0.0027	0.79

* Significant, ($P < 0.05$)

Table (2): Comparison of bone density of the alveolar ridge at different periods of follow up between the two groups

Follow up Periods	Bone density of alveolar ridge		t	*p*
	Group 1	Group 2		
At insertion (Mean ± S.D)	160 ± 20	159.7 ± 19.5	0.31	0.76
After 1 month (Mean ± S.D)	148.4 ± 30.2	149.8 ± 28.8	1.59	0.13
After 3 months (Mean ± S.D)	178.4 ± 12.2	179 ± 28	0.74	0.47
After 6 months (Mean ± S.D)	208.3 ± 22	209.5 ± 14.2	1.72	0.1
After 9 months (Mean ± S.D)	217.7 ± 35.5	218.1 ± 18.8	0.38	0.7

* Significant, ($P < 0.05$)

Table (3): Comparison of Bone density around dental implants during different periods of follow up between the two groups

Follow up periods	Bone density around dental implants		*p*
	Group 1	Group 2	
At insertion (Mean ± S.D)	141.85± 7.42	142.40±7.39	0.172 0.765
After 1 month (Mean ± S.D)	140.00±7.44	140.60±6.78	0.188 0.647
After 3 months (Mean ± S.D)	143.00±7.56	142.6±7.53	0.188 0.667
After 6 months (Mean ± S.D)	145.00±6.11	143.25±5.62	0.095 0.776
After 9 months (Mean ± S.D)	145.9±7.12	143.25±5.90	0.467 0.401
At insertion versus 9 months	**T = 0.335** ***P* = 0.745**	**T = 0.615** ***P* = 0.554**	

Significant, ($P < 0.05$)

4.Discussion:

The prosthetic rehabilitation of the edentulous patient has long been a major challenge for dentistry. Treatment options include a conventional complete denture and a dental prosthesis supported or retained by dental implants. The implants represent a significantly better solution for tooth loss replacement, as they are anchored directly into the bone and provide complete stability in contrast to the traditional tooth-replacement alternatives. (18) The new generation of Osteocare midi with polycarbonate housing was selected for the first group as this type of implants are made of pure titanium which provides special design of the thread form with blasted and etched surface that have been shown to maximize bone-to-implant contact, as well as bone expansion and compression which results in successful osseointegration. (19)

Microdent implant system was used for the second group which is biocompatible and made of pure titanium which plays an important role in successful osseointegration. (20) O-ring attachment with the resilient Teflon housing attachment was used in this study for both groups as it appears to transfer stress in a more favorable manner, being a shock-absorber, pressure and torque reducer, doesn't wear by time, and so doesn't need to be changed. Also, this type of attachment offer more patient satisfaction, less expensive, and more hygienic, thus enhances success and longevity. (21) The stability of dental implants measured by the amount of micromotion as a result of application of horizontal forces on the implant using a fabricated measuring appliance called mechanical micrometer. The idea of this appliance is that the decrease in the micromotion indicated increasing in implant stability. (22)

The long term success of using osseointegrated implants for prosthetic rehabilitation of the edentulous patient shows that high success rates can be predictably achieved with high implant stability. Implants of different designs, reach different degree of stability which seems to determine their future clinical performance, since the relationship between bone densities and implant failure has been established. (23) The measurements of implant stability at the time of insertion were high which may be due to high insertion torque of dental implants that provides high primary stability. This is confirmed by the results of Freiberg *et al.,* 1995 and O`Sullivon *et al.,* 2004. (24, 25) The stability data in both groups decreased after the 1st month of implant insertion which may be due bone resorption accompanied with implant placement. Implant stability increased after 3, 6, and 9 months which may be related to early phases of osseointegration and bone remodeling. These results are in agreement with the results of many authors (26, 27)

Bone density decreased around dental implants after the first month of implant insertion which may be due to implant placement procedure, detachment of marginal periostium and physiologic bone resorption at edentulous area. The bone density begins to increase after the third month which may be related to the use of the overdenture. These results were coincident with that of Albrektsson *et al.,* 1989 and Misch *et al.,* 2001 (28, 29) who stated that microstrain increases in the bone tissues affecting bone remodeling and accompanied by increasing in bone density. Although the bone density was higher in the first group than in the second group, there was insignificant difference between the two groups in bone density around dental implants; This is may be explained by the type of implants of group A (Osteocare midi) provided a design of greater thread engagement with blasted and etched surface which have been shown to maximize bone-to-implant contact, as well as bone expansion and compression which results in successful osseointegration.

5. Conclusion:

The results of this clinical study concluded that there is no significant difference in the implant stability in patients treated with these two types of dental implants while the surface characteristics of dental implants can affect the bone density around them.

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