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Clinical evaluation of two titanium-zirconium versus titanium implant fixture using locator attachment retained reinforced mandibular overdenture with early loading protocol

AUTHOR

Abstract
Purpose: *To evaluate the effect of two different dental implant materials (Titanium _Zirconium implant, Titanium implant) retaining reinforced mandibular overdenture with early loading protocol on surrounding bone and soft tissue.*
Materials and methods: *Six completely edentulous male patients aged 45-65 years were selected for this study. CBCT was used to evaluate bone quantity and quality, accordingly; all patient received complete dentures and the lower dentures were duplicated with clear acrylic resin to construct radiographic template which was used as a guide in construction of stereolithographic stent by CAD/CAM.*
The patients were randomly divided into two equal groups according to implant material. Group (I): received two titanium _zirconium implants (Roxolid) and group (II) received two titanium implants. At four weeks, after implant placement the lower reinforced complete denture was attached by locators to the implants (Early progressive loading protocol). Vertical bone changes were evaluated by parallel periapical long cone X-ray technique at T1 after 6 months of insertion, and at T2 after 1year of insertion; and the soft tissue changes were evaluated by modified gingival index (MGI), modified bleeding index (MBI), periimplant pocket depth (PD) measurements immediately at the insertion time of lower overdenture (T0), and (T1) at six months after insertion, (T2) at one year after insertion.
Results:
The result of this study showed that, there was a significant difference in MGI between the two groups at T1 (p =.007). No significant difference in MGI between the two groups at T0 and T2. There was significant difference in MBI between the two groups at T2 (p<.001), no significant difference at T0, T1 observation times. There was no significant difference in probing pocket depth between the two groups at T0, T1, and T2. There was significant difference in vertical bone changes between the two groups at T2 (p=.048) only, at T1 no significant difference.
Conclusion:
Both (Titanium-Zirconium implants, Titanium implants) showed improved clinical results regarding, probing depth, vertical bone height changes after one year follow up. Both types could be used successfully to support implant overdenture, with Titanium-Zirconium implants more favorable results were reported in all clinical parameters except MGI.
Early progressive loading protocol could provide satisfactory clinical results similar to conventional loading protocol.
Keywords: *Titanium-Zirconium implants, titanium implants, reinforced denture, early progressive loading protocol, locator attachments.*

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I. Introduction

For totally edentulous individuals, implant-retained and implant -supported overdentures were offered as an alternate and more successful treatment approach to the conventional complete denture. Also it have been shown to have high long-term success rates and enhanced patient quality of life; with elderly patients reporting increased confidence, phonetic, and speech capabilities; as well as dietary habits involving intake of fibrous foods, masticatory function, and, eventually, decrease risk of cardiovascular diseases and gastrointestinal disorders. [(1)] There is a certain consensus in admitting two implants placed in an appropriate position, they are enough to get an overdenture with good retention and stability for masticatory function. [(2)]

In the present era, due to the extensive research work and advancements in the field of biomaterials available for dental implants, newer materials came into being such as zirconia, roxolid, surface modified

titanium implants. These materials not only fulfill the functional requirements but are also esthetically pleasing. [3, 4]

The titanium (Ti) has many advantages, such as high corrosion resistance and biocompatibility, Ti alloys was chosen primarily to improve various qualities.[5] The most common ternary Ti alloy used in dentistry is Ti6Al4V. Ti forms spontaneously on its surface oxide particles (TixOy), resulting in a material that is extremely stable and corrosion resistant. The formation of apatite is caused by the adsorption of Ca and P ions by the Ti oxide layer. It can also adsorb certain proteins, depending on surface features like micro- and nano roughness, promoting osseointegration. [6]

Ti - Zr alloys have higher mechanical properties than cp- Ti (commercially pure titanium) alloys and exhibit outstanding in vitro and in vivo behavior. [7]Furthermore, the greater mechanical stability Roxolid (Ti 13% – 17% Zr) as a small dimensional implant (3.3 mm in diameter) could be employed in molar and premolar restorations, reducing the requirement for extra bone structure. Roxolid is a metallic biomaterial representative for implants, especially where there's limited space between the teeth.[8]

The locator attachment system is a non-splinted, low-profile attachment that is resilient. The locator attachment mechanism also includes a self-aligning feature and dual retention (inner and outer). Today available in a new form which can be used with fixed complete denture as LOCATOR F-Tx which is a fixed attachment system that is clinically removable for rigid connection of partial (with cross-arch stabilization) and full-arch restorations to endosseous dental implants in the maxilla or mandible. [9]

The early progressive loading indicated to a gradual loading or stimulation will allow bone to mature and grow denser and improve in quality, and the result increase the strength of implant and thus the ability to tolerate greater forces and permit successful implant prosthetic treatment.[10]

The maintenance on dental implant is of critical importance for the longevity of successful osseointegrated implants [11], as bacterial colonization occurs within 30 minutes following implantation [12]; which lead to perimplantitis. [13] Or may be lead to periimplant mucosities [14]

Few studies compared the effectiveness of zirconium-titanium implant to the titanium implants under early loading protocol, so the aim of the study was clinical evaluation of two titanium-zirconium versus titanium implant fixture using locator attachment retained reinforced mandibular overdenture with early loading protocol.

II. Material And Method:

Six completely edentulous male patients aged 45-60 years were selected for this study at the Outpatient Clinic of the Prosthodontics' Department, Faculty of Dentistry, Mansoura University. All the procedures were explained to the patients, only motivated patients who cooperated were included in the study, and an informed consent was signed, as well as the approval of the Faculty of Dental Medicine Mansoura University's Research Ethic Committee. Patients were healthy and free of all systemic diseases that affect osseointegration around the implant, moderate size mandibular alveolar ridge covered with even compressibility mucosa verified by using periodontal probe, gingival thickness of about 2mm verified by dual scan of cone beam computed tomography (CBCT) during treatment planning. Adequate residual alveolar bone quality D2 bone type in the canine region according to the Misch bone density classification scheme (350 to 850 Housefield units); confirmed by CBCT, Angel's class I maxillomandibular relation with moderate inter- arch space (20 mm) confirmed through tentative jaw relationship, and class III restorative space of 9-11mm determined by putty index technique. [15, 16]

Cone beam computed tomography (CBCT) was used for every case to evaluate bone height at mandibular canine region. According to the type of implant material used, Patients were randomly classified into 2 equal groups: Group (I); the patients received two titanium _zirconium implants retained mandibular overdenture Group (II); the patients received two titanium implants retained mandibular overdenture. The conventional mandibular reinforced complete dentures for all patients in both study groups were constructed by following all steps of conventional complete denture construction (Fig.1).

(Fig.1) Complete denture insertion.

The mandibular dentures were duplicated with clear acrylic resin to fabricate radiographic template. Multiple holes (1 mm in diameter) were prepared in different labial, buccal and lingual polished surfaces, fitting

surface of mandibular radiographic template for mounting reference gutta-percha radio-opaque markers. Patients were subjected to CBCT while wearing the radiographic template. Then the radiographic template was subjected to CBCT exposure alone. The individual images were superimposed over each other by using dual scan technique guided by gutta-percha radiopaque markers in order to estimate mucosal thickness, and subsequent formation of tissue support stereolithographic template (Fig.2). The Stent was constructed by rapid prototyping machine.

(Fig.2) Stereolithographic surgical template.

According to the type of implant material, two implants (12 mm length and 4.1 mm diameter) were surgically inserted in the canine's area using flapless surgery for each patient in both groups. Osteotomies for fixation pins were performed by anchor drill 1.5×20mm supplied with 3DDX universal kit while the patient was closing at the maximum intercuspal position. Tissue punch (4.2 diameter) at low speed was used to cut the soft tissue to the crest of the ridge with continuous copious irrigation (Fig.3).

(Fig.3) Tissue punch for soft tissue removal.

The stent was removed from the patient's mouth and the final implant drill (12×3.5 mm) from implant system kit was used at a speed of 1000 rpm and the torque was adjusted to 30 to gradually widen the implant site until the final implant diameter was reached. The implants (Titanium-Zirconium, Titanium) for both groups (I), (II) were gripped carefully by an implant driver hand tool (Fig.4).

(Fig.4) Implant gripped by an implant driver.

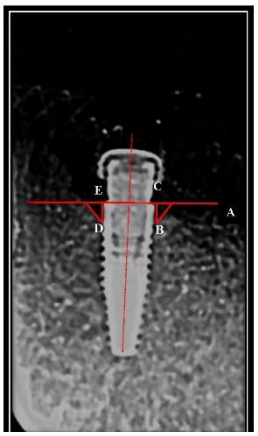
Then it was manually inserted into their prepared sites until it became at the same level of crestal bone by using hand ratchet at torque of 35- 45N. The healing abutments of 2mm collar height were screwed into the internal hex of the implant by using the hex driver.

Early progressive loading protocol was used for two study groups after four weeks, the healing abutments were manually removed using the hex driver, two mm collar height locator attachments were screwed into the fixture using locator driver in the predetermined sites. The titanium female housing caps with black nylon inserts were seated over the locator abutment, direct functional pickup technique was used. The zero retention black nylon inserts were replaced by extra light retention blue inserts (Fig.5a and b). Occlusion was then refined by selective grinding.

(Fig.5 a) The fitting surface of the denture with picked up female house.

(Fig.5b) Black nylon inserts were replaced by blue inserts.

Peri-implant soft tissue evaluated by modified gingival index (MGI), modified bleeding index(MBI), Probing pocket depth (PD), gingival index according to **Mombelli et al.**[17] A graduated plastic probe was used to measure the pocket depth in millimeters.[18] The peri-implant soft tissue evaluated at the time of insertion (T0), six month (T1) one year (T2) after overdenture insertion for group (I) and group (II).
Standard parallel periapical X-ray technique was used to evaluate vertical bone height changes around implant fixtures through made a reference index for bone evaluation at 3 times by using auto-polymerized acrylic resin for bite registration [19]
which were measured according to Rasouli Ghahroudi et al. [20] after insertion time at six month (T1), and one year after mandibular overdenture insertion (T2) (Fig.6).



(Fig.6) Tracing of the bone loss on periapical film.

III. RESULTS

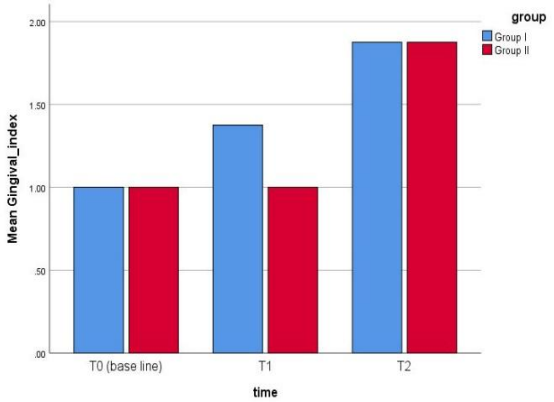
Peri-implant Soft Tissue Changes

MGI; the results showed that there was statistical significant difference in MGI between T0, T1, T2 for group I (p<.001) and group II (p<.001). There was a significant difference in MGI between the two groups at T1 (p =.007). No difference in MGI between the two groups at T0 and T2 as illustrated in table (1), (Fig.7).

Table (1): Comparison of gingival index between two groups and observation times

	Group 1			Group 2			Mann-Whitney test (p value)
	M	**Min**	**Max**	**M**	**Min**	**Max**	
T0	1.00a	1.00	1.00	1.00a	1.00	1.00	1.00
T1	1.00a	1.00	2.00	1.00a	1.00	1.00	.007*
T2	2.00b	1.00	2.00	2.00b	1.00	2.00	1.00
Freidman test (p value)	<.001*			<.001*			

M; median, min; minimum, max; maximum, * p is significant at 5% level. Different letters in the same column indicates a significant difference between medians of each observation times (Wilcoxon signed ranks test, p<.05). The same letters showed no significant difference



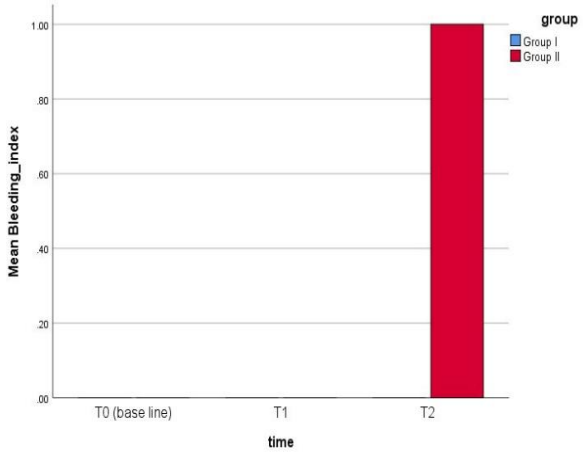
(Fig.7) Comparison of gingival index between two groups at different observation times**.**

MBI; There was no significant difference in MBI between different observation times for group I. For group II, there was no significant difference in MBI between T0-T1. However, a significant difference was found between T0-T2, between T1-T2. There was significant difference in MBI between the two groups at T2 (p<.001), no significant difference at T0, T1 observation times as showed in table (2), (Fig.8).

Table (2): Comparison of bleeding index between groups and observation times

	Group 1			Group 2			Mann-Whitney test (p value)
	M	**Min**	**Max**	**M**	**Min**	**Max**	
T0	.00a	.00	.00	.00a	.00	.00	1.00
T1	.00a	.00	.00	.00a	.00	.00	1.00
T2	.00a	.00	.00	1.00b	1.00	1.00	<.001*
Freidman test (p value)	1.00			<.001*			

M; median, min; minimum, max; maximum, * p is significant at 5% level. Different letters in the same column indicates a significant difference between medians of each 2-observation times (Wilcoxon signed ranks test, p<.05). The same letters showed no significant difference.



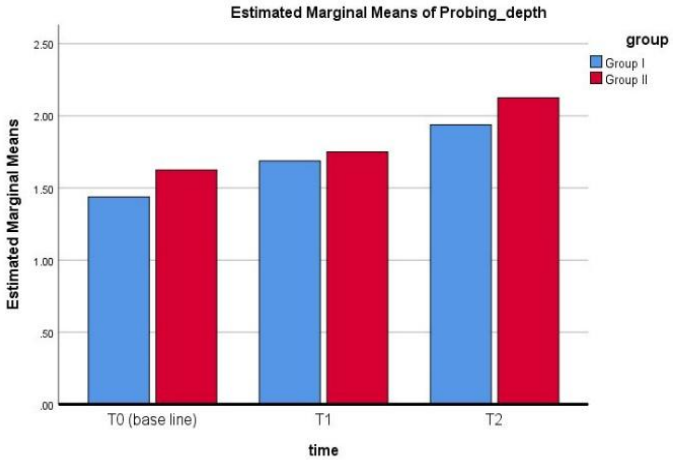
(Fig.8) Comparison of bleeding index between two groups at different observation times.

PD; Probing depth was increased significantly with advancement of time for group I (p<.049) and group II (p<.043). There was no a significant difference in pocket depth between the two groups at T0, T1, and T2 as reviled in table (3), (Fig.9).

Table (3): Comparison of pocket depth between two groups and observation times

	Group 1		Group 2		Repeated measures ANOVA
	X	**SD**	**X**	**SD**	
T0	1.44a	.51	1.62a	.72	.38
T1	1.69b	.48	1.75b	.68	.77
T2	1.94c	.57	2.13c	.62	.36
Repeated measures ANOVA	.049*		.043*		

X; mean, SD; standard deviation * p is significant at 5% level. Different letters in the same column indicates a significant difference between medians of each 2-observation times (Tukey test, p<.05). The same letters showed no significant difference



(Fig.9) Comparison of pocket depth between two groups at different observation times.

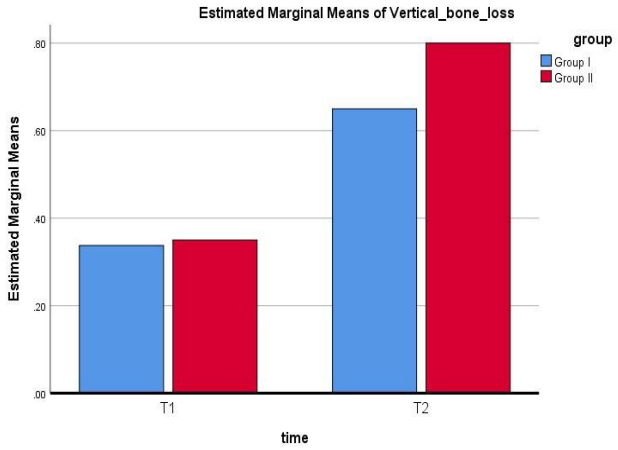
Peri-implant Hard Tissue Changes

There was statistical significant difference of vertical bone height changes between T1, T2 for both groups. There was significant difference in vertical bone changes between the two groups at T2 (p=.048) only, at T1 no significant difference, as in table (4), (Fig.10).

Table (4): Comparison of vertical bone loss between two groups and observation times

	Group 1		Group 2		Paired samples t test
	X	SD	X	SD	
T1	.34a	.14	.35a	.12	.87
T2	.65b	.15	.80b	.19	.048*
Paired samples t test	<.001*		<.001*		

X; mean, SD; standard deviation * p is significant at 5% level. Different letters in the same column indicates a significant difference between medians of each 2-observation times (Tukey test, p<.05). The same letters showed no significant difference.



(Fig.10) Comparison of vertical bone loss between two groups at different observation times.

IV. Discussion

This study evaluated bone and soft tissue changes that occur around two different dental implant materials retaining reinforced mandibular overdenture with early loading protocol.

The results of this study regarding MGI scores showed that with the passage of time, scores have increased significantly for both groups. The elevated MGI scores could be attributed to the early loading protocol [(22)], or to locator attachments as it have a greater tendency for food and plaque accumulation within the central access of the abutment female part. [(23)] This approved by **ELsyad et al** , in their previous studies which recorded significantly higher plaque and gingival scores for locator attachment retained mandibular overdenture[(24)].However this finding is in disagreement with **Shawky et al** ,who reported that the locator attachments are more advantageous in terms of periimplant soft tissue.[(25)] MGI scores were significantly higher in group I at T1. This may be due to the patients did not follow instructions about oral hygiene procedure in these group.[(22)]

There was a significant difference in bleeding index between observation times for group II only at T2. No significant difference bleeding index between observation times was noted for group I, this result was in disagreement with another study of **Quirynen et al**. [(26)] who didn't find significant differences between two implant types in bleeding scores. At T2 group II recorded significant higher bleeding index than group I, this may be attribute to the Ti ions that released from these implants can trigger periimplant mucosal inflammation, [(27)] or due to gingival inflammation that occur with plaque accumulation.[(24)]

There was no significant difference in probing pocket depth between two groups at difference observation times, but there was a significant difference in probing depth between each 2 observation times for both groups. Probing depth significantly increased from T0 to T1, then significantly increased from T1 to T2; this may be due to gingival changes that occur with loading denture or may be due to bone changes accompanied the functional implant with the time according to **ELsyad et al.** [(18)] This Finding regarding group I in agreement with **Barter et al** study who evaluated the success and survival rate of titanium-zirconium implants in partially edentulous patients. [(28)] Fortunately, pocket measurements in this study did not exceeding acceptable range that associated with successful implant [(29)] .

There was a significant difference in vertical bone loss between observation times for group I and II. Group II shown more bone loss than group I; similarly approved by **Brizuela et al**, study that conclude higher bone implant contact percentage for Ti-Zr implants than Ti implants.[(21)]

For both groups, vertical bone loss significantly increased from T1 to T2. At T1, no significant difference in vertical bone loss between groups was observed. At T2 observation time, group II showed significantly higher vertical bone loss than group I, may be attributed to higher mechanical properties and

biocompatibility of TiZr implant than a titanium implant [(8)], also may be due to the elasticity modulus of TiZr implant lower than titanium alloy implant, and relatively close to the bone; and as the result favourable load transference from the implant metallic surface to the implant supporting tissue, and finally better osseointegration process. Another study found that the TiZr implant has an effect on osteoblast adhesion, proliferation, and differentiation, as well as the osteogenic induction process. [(7)] Otherwise, **Oup et al,** believed that the vanadium element of titanium implant released into the blood and urine can initiate an inflammatory cascade leading to osteolysis [(30)] , and could have cytotoxic effects on periimplant tissue which may affect bone implant contact.[(21)]

V. Conclusion

Both (Titanium-Zirconium implants, Titanium implants) showed improved clinical results regarding, probing depth, vertical bone height changes after one year follow up**.** Both types can be used successfully to support implant overdenture, however with Titanium-Zirconium implants more favorable results in all clinical parameters except MGI.

Early progressive loading protocol could provide satisfactory clinical results similar to conventional loading protocol.

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