

EVALUATION OF MARGINAL BONE LOSS AND PATIENT SATISFACTION IN SINGLE IMPLANT RETAINED MANDIBULAR OVERDENTURE USING TWO DIFFERENT ATTACHMENT DESIGNS

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ABSTRACT

The aim of this study: is to evaluate the marginal bone level changes radiographically and patient satisfaction in immediately loaded single implant retaining mandibular overdenture using two different attachment designs (ball and socket versus telescopic).

Materials and Methods: Twenty completely edentulous patients were selected for inclusion in this study. All patients received new maxillary and mandibular dentures. One single para-symphiseal implant was inserted for each patient, immediate loading protocol was done. The patients were divided randomly to have either ball and socket attachment or telescopic attachment. In both groups, radiographic evaluation was done using the standardized long cone peri-apical technique to detect the peri-implant marginal bone level mesial and distal to the implants at two intervals (0-6 months and 0-12 months). Patient satisfaction was evaluated by OHIP-EDENT questionnaire at loading time (baseline), 6 and 12 months after loading. The data obtained were tabulated and statistically analyzed.

Results: During the follow-up periods, the marginal bone level around each implant was recorded mesially and distally in both groups (at loading time, after 6 months and after 12 months). There was no significant difference at the follow-up intervals between the marginal bone loss mesially and distally. There was no statistically significance between the two groups at the 1st and 2nd intervals. Meanwhile, there was a significant difference between the mean bone level change at the 1st interval and the 2nd interval in each group. As the P-Value is 0.000. This means that there is a direct correlation between time and the marginal bone loss. According to the patient satisfaction by OHIP-EDENT questionnaire, there was no significant difference between the two groups.

Conclusion: Within the limitations of the present study, the patient satisfaction remained high after treatment with immediately loaded mandibular overdentures supported by one titanium dental implants at the para-symphiseal region in both attachment designs. The telescopic attachment with immediately loaded single implant mandibular overdenture can be a viable and promising treatment option for edentulous patients. It can be as efficient as the ball and socket attachment. Long-term observations and outcomes are needed before recommending it as a treatment modality.

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INTRODUCTION

For decades, removable complete dentures have been the standard of care for completely edentulous patients.¹ Rehabilitation of edentulous patients with complete dentures on a severely resorbed alveolar bone, often results in poor retention, chewing efficiency, stability, and phonetics.² As a result, their quality of life declines severely.³

Furthermore, decreased area of coverage, the activity of tongue and flooding action of saliva complicated mandibular arches rehabilitation.⁴ Consequently, the introduction of implant overdentures has dramatically improved treatment outcomes of completely edentulous patients, especially in the mandible.⁵ Implants overdentures provide better stability, retention, functionality and patient satisfaction.⁶

There is controversy about the number of implants needed, when rehabilitating edentulous mandible, to provide satisfactory retention, stability, and chewing efficiency.^{7,8} Studies have concluded that there is no difference in terms of patient satisfaction and function when comparing two versus four implants mandibular overdentures.⁹⁻¹¹

Accordingly, this led to an emerging consensus that the first choice of treatment for edentulous mandible is an overdenture retained by two implants.¹² Hence, a minimum number of implants to support a mandibular complete denture can be a solution, which is minimally invasive and keeps the treatment cost reasonable. The latter parameters may significantly increase elderly edentulous patient acceptance.¹³ Edentulism is commonly related to low-income individuals, therefore many patients cannot afford two implants therapy.¹⁴

A single implant supported the mandibular overdenture concept in an edentulous mandible was introduced by in 1993.¹⁵ In 1997, the first 5-year results were published with 100% implant success rates.¹⁶ A recently published study has

confirmed that the single implant supported mandibular overdenture positively improve the oral health-related quality of life in completely edentulous patients in comparison to conventional complete denture therapy.¹⁷ Several studies concluded that there were no significant differences in implants survival or patient satisfaction in mandibular overdentures retained by 1 implant or 2 implants.¹⁸⁻²⁰

Immediate loading of implants has several advantages. It reduces treatment and may increase patient satisfaction.²¹ Although several studies have concluded that the concept of immediate loading of single implant overdenture can be a clinically reasonable treatment option for completely edentulous patients,²¹⁻²³ still the outcomes of immediately loaded single implants overdenture are debatable.

A two-year follow-up study, to evaluate complete mandibular overdentures retained by symphyseal single implant using ball and magnet attachments, showed insignificant difference regarding the clinical condition and marginal bone height changes in both groups.²⁴ Another study was conducted to evaluate masticatory performance and patient satisfaction in single implant overdentures with ball and locator attachments. It was concluded that there is greater improvement in patient satisfaction with the use of ball over locator attachment.²⁵

Telescopic attachments have been used to connect implants to overdentures for years. They provide rigid attachment suitable for immediate loading.²⁶ Patients with resorbed ridges are candidates for telescopic copings as they offer good stability, excellent retention, better force distribution, the less rotational torque on the abutment, ease of removability and insertion.²⁷⁻²⁹

It was not found in literature attempts to retain single implant mandibular overdenture using a telescopic attachment.

The aim of this study is to evaluate radiographically the marginal bone level changes and patient satisfaction in immediately loaded single implant retaining mandibular overdenture using two different attachment designs (ball and socket versus telescopic).

MATERIALS AND METHODS

Twenty completely edentulous patients (age range 40-65 years old) were selected from the Out-patient Clinic of the Prosthodontic Department; Faculty of Dentistry, Minia University. Patients fulfilled the criteria and were accepted for inclusion in the study. All subjects were selected free from any local or systemic diseases that contraindicate dental implant therapy or may affect the prognosis of implants. Patients with adequate bone height and width for implantation in the interforaminal area of the mandible, without the need for augmentation procedures. There should be sufficient bone at the anterior segment of the mandible to allow for placement of one implant of more than 7 mm in labio-lingual width. A periapical and panoramic (1: 1) radiographs were taken to give better information about the bone quality and quantity and detect areas of recent extractions. The bone height at the prospective implant site was measured. Bone width was evaluated using ridge mapping. All patients were informed about their line of treatment and the necessity for their frequent attendance and a written consent was signed by the patient. Complete dentures have been constructed to the cases that met the selection criteria. All patients received new maxillary and mandibular dentures. They were encouraged to wear them for at least one month before implant surgery to enhance neuromuscular adaptation to the new dentures. Each patient received a hydroxyapatite (HA) grit-blasted implant inserted (Spectra system, Implant Direct LLC, US) with 16mm long, 3.7 mm diameter. The implant was inserted in the parasymphseal region. The healing abutment was screwed to the implant and interrupted sutures were

done. The fitting surface of the mandibular denture opposing the implant site was relieved and lined by a resilient liner (Coe Comfort; GC Corporation, Tokyo, Japan) until implant loading within two weeks. Patients were divided into two groups.

Group I (ball attachments):

At the time of loading, Patients were recalled, the fitting surface of the denture directly above the implants was relieved. A small hole was done at the lingual flange to allow for escape of excess cold curing polymerizing monomer-free resin during direct picking up. Ball abutment was screwed to implant then the metal housing was placed directly over the ball abutment. Blocking the undercut area beneath the metal housing using relief wax. Methyl methacrylate free self-curing hard relining (Rebase II Fast, Tokuyama Dental Corporation, Japan) was placed in the relieved area of the denture and the denture was seated in the patient mouth. The resin was left to polymerize while the patient was closing in centric occluding relation with minimal pressure. The denture was removed, trimmed and polished with the metal housings picked up in its fitting surface. Proper seating of denture with no rocking and proper occlusion was ensured.

Group II (telescopic attachments)

Patients were recalled after three days, an impression was taken and a cast was constructed with the implant analogue in the implant site. A plastic burn out abutment was fastened to the implant analogue on the cast. Waxed-up to have 20 tapered axial walls, dome shaped occlusal surface with a height of 5 mm. above gingival margin. Then the waxed-up abutment sprued, invested and cast in a cr-co alloy. The secondary coping was constructed in wax having two meshwork wings mesially and distally relieved to create a space by 1.5 mm. The secondary coping and meshwork wax pattern were invested and cast using a cr-co alloy. Patients have recalled again for loading. The casted abutment was

fastened to the implant and the casted secondary coping was inserted over it. The fitting surface of denture opposing the attachment was relieved and the coping was picked up using the same monomer free cold cure hard lining material used with a ball attachment. Proper seating of denture with no rocking and proper occlusion was ensured.

The patients in both groups were allowed to use their dentures immediately after attachment pick up. Patients were strictly instructed to follow a soft diet protocol for the first month.

Radiographic evaluation

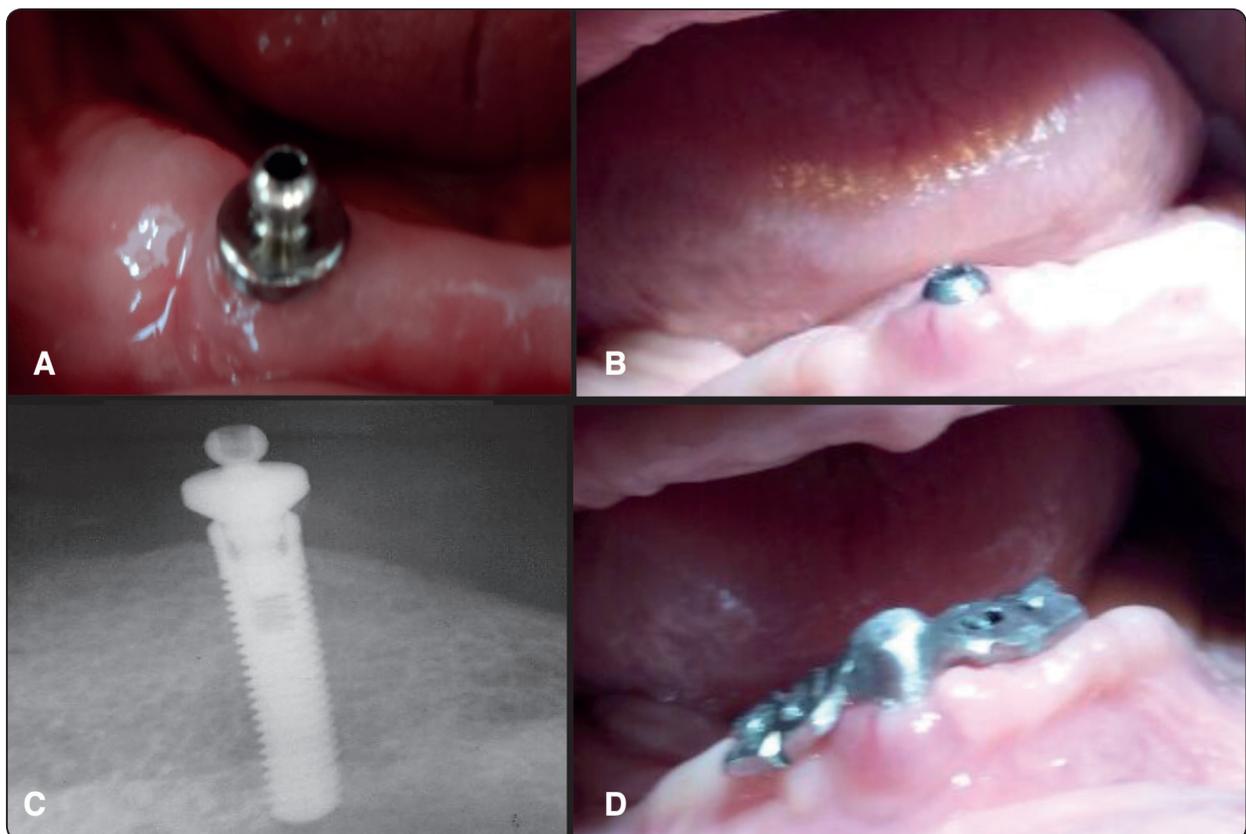
In both groups, radiographic evaluation was done using the standardized long cone peri-apical technique to detect the peri-implant marginal bone level

mesial and distal to the implants. This was done at the time of loading, six months and twelve months after implant loading. Images were analyzed by special linear measurement Digora software (version 1.51 for windows).

The marginal bone loss was calculated by subtracting the bone level at 6 months from that at loading time which denotes the marginal bone loss at the 1st interval (0-6 m).

Also the same was done for the 2nd interval by subtracting the bone level at 12 months from that at loading time (0-12 m).

The marginal bone level changes of the follow-up intervals were calculated, tabulated and statistically analyzed.



(Fig. 1A) ball abutment fastened to the implant. (Fig. 1B) telescopic abutment fastened to the implant (Fig. 1C) peri-apical radiograph for measuring the mesial and distal marginal bone level. (Fig. 1D) the secondary coping with meshwork wings seated in place over the 1ry coping.

Patient satisfaction

In both groups, patient satisfaction was evaluated by the Recording patient satisfaction by OHIP-EDENT questionnaire. The questionnaire was developed to evaluate oral health related quality of life of edentulous patients receiving new prostheses. It was read to the patients and their responses were recorded in sheets. It consists of 19 questions (items) regarding chewing ability, oral function, and problems with dentures related to fit, pain or discomfort. There were also questions related to the quality of life topics asking if subjects were being upset, embarrassed, and finding life less satisfying because of denture problems. Each question had five response substitutes. The responses were scaled using a 5-point scale (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, and 4 = very often). Sum of scores was calculated by adding the item scores and were between 0 (absence of problems) and 76 (very problematic). All cases were evaluated immediately at the loading time (baseline), 6 months, and after 12 months of overdenture insertion. Results were calculated, tabulated and statistically analyzed.

RESULTS

Radiographic evaluation

During the follow-up periods, the marginal bone level around each implant was recorded mesially and distally in both groups (at loading time, after 6 months and after 12 months). Statistical analysis was performed using SPSS version 16.0 (SPSS Inc.,

Chicago, IL, USA). For statistical evaluations, the groups were evaluated using the paired sample t-test p values <0.05 were considered statistically significant

During comparing the mean values of marginal bone loss mesially and distally in both groups, it was noticed that there was no significant difference at the follow-up intervals between the marginal bone loss mesially and distally as shown in the table (1).

Therefore the mean values of marginal bone loss at the mesial and distal surface of implants at each follow-up interval were added to get the mean of marginal bone loss for each implant.

The mean values and standard deviation of the measurements of marginal bone level change were 0.5720 ± 0.04099 for group I at the 1st interval and 0.5655 ± 0.03993 for group II at the 1st interval. As the P-Value is 0.135, so there was no statistically significance between the two groups at the 1st interval.

Also, the mean values and standard deviation of the measurements of marginal bone level change were 0.7790 ± 0.03291 for group I at the 1st interval and 0.7840 ± 0.02722 for group II at the 2nd interval. As the P-Value is 0.613, so there was no statistically significance between the two groups at the 2nd interval.

Meanwhile, there was a significant difference between the mean bone level change at the 1st interval and the 2nd interval in each group. As the P-Value is 0.000. This means that there is a direct correlation between time and the marginal bone loss.

TABLE (1) The mean marginal bone level change between mesial and distal surfaces of the two groups

Group	Group I (1 st interval)		Group II (1 st interval)		Group I (2 nd interval)		Group II (2 nd interval)	
	Mesial	Distal	Mesial	Distal	Mesial	Distal	Mesial	Distal
Mean	0.5630	0.5810	0.5680	0.5630	0.7800	0.7780	0.7890	0.7790
St. dev.	± 0.0427	± 0.039	± 0.0464	± 0.0347	± 0.0389	± 0.0278	± 0.0289	± 0.026
P. value	0.121		0.610		0.794		0.299	

*P. value < 0.05 (considered significant)

Patient Satisfaction evaluation

The OHIP-EDENT test results were analyzed using Friedman’s test to compare the scores of follow-ups (baseline, 6 and 12 months) in each group separately, table (3)and(4). The p- value < 0.001. There was a significant difference between baseline, 6 and 12 months follow-ups and baseline in each group separately. The scores decreased from 74.4 to 38.9 to 0.4 (mean) in Group I ball attachments. The scores decreased from 74.5 to 40.7 to 0.5 (mean) in Group II telescope attachments. This indicates a significant increase in patient satisfaction.

The OHIP-EDENT test results were analyzed using Wilcoxon signed-rank test (Two-tailed test) to compare the scores of each follow-up (baseline, 6 and 12 months) in group I with the same follow-up in Group II. The p- value >

0.001. There was no significant difference between the follow-ups in both groups. This indicates that the patient satisfaction was not significantly different between Group I and Group II.

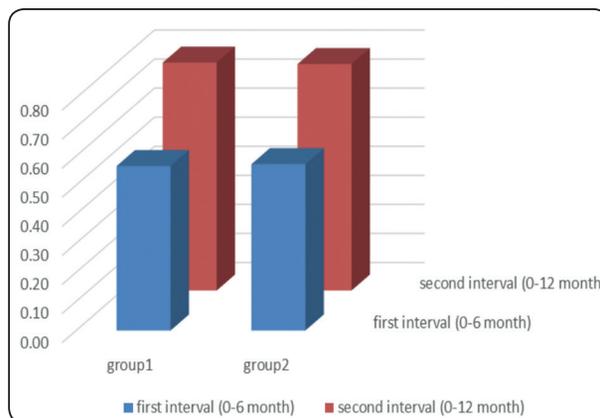


Fig. (2) bar graph revealing the marginal bone level change between both groups during the different follow-up intervals

TABLE (2) The mean marginal bone level change between the two groups at 1st and 2nd interval

Group	1 st interval (0-6m) Mean± St. dev.	2 nd interval (0-12m) Mean± St. dev.	P. value	significance
Group I	0.5720± 0.04099	0.7790± 0.03291	0.000*	S
Group II	0.5655± 0.03993	0.7840± 0.02722	0.000*	S
P. value	0.135 (NS)	0.613 (NS)		

*P. value < 0.05 (considered significant)

TABLE (3) Group I OHIP-EDENT scores sum at the follow ups (baseline, 6 and 12 months)

Group I	Observations	Minimum	Maximum	Mean	Std. deviation
Baseline	10	70.000	76.000	74.400	2.119
6 Months	10	38.000	41.000	38.900	1.101
12 Months	10	0.000	4.000	0.400	1.265

TABLE (4) Group II OHIP-EDENT scores sum at the follow ups (baseline, 6 and 12 months)

Group II	Observations	Minimum	Maximum	Mean	Std. deviation
Baseline	10	69.000	76.000	74.500	2.273
6 Months	10	36.000	61.000	40.700	7.304
12 Months	10	0.000	4.000	0.500	1.269

DISCUSSION

In the present study, 20 subjects were included for the one-year follow-up and no implant failure was observed during this study.

For standardization, the implant diameter and length was fixed in all cases (3.7mm width and 16mm length) which are suitable for the anterior mandible. As using different implant dimensions lead to different surface area contacting supporting bone that may influence the stress distribution per unit area.³⁰

The area of symphysis was avoided for implant insertion, and this is attributed to the anatomical structure and the potential risk factor of mandibular arch fracture especially in old age patients.³¹

Standardized Peri-apical long cone paralleling technique was used for evaluation, to avoid the excessive radiation exposure by cone-beam C.T.

The radiographic examination revealed that most of the marginal bone resorption took place during the first 6 months of prosthetic loading. The results of the marginal bone level change in this study showed an insignificant difference between both groups. The mean values of bone resorption in this study were accepted and comply with the success criteria.³²

Loading implants immediately following placement offers major advantages compared with the traditional delayed healing protocol including reduced number of surgical procedures, faster rehabilitation and increased patient comfort and satisfaction. Moreover, a simplified treatment protocol is beneficial especially for edentulous subjects struggling with non-retentive mandibular dentures. However, long-term follow-up studies are important to evaluate clinical outcomes.

Ball and socket allow multidirectional movements of the prosthesis so acting as shock absorber decreasing the load on the abutment.³³

The use of ball abutments or short telescope with 2 degrees tapering and rounded top, allowing more freedom of denture rotation thus decrease the torque action on the abutments.

Other factors as initial primary stability, optimal denture stability, wide supporting area coverage and maximum denture extension within the functional activity of muscular action and balanced occlusal scheme evenly distribute the load and may reduce the unfavorable lateral destructive forces. Thereby these factors can play a major role in our study enable the use of immediate loading protocol and enhancing the clinical outcomes.

There is overwhelming evidence that implant overdentures are superior to conventional complete dentures in several aspects, especially for the edentulous mandible. It has therefore been suggested that, if possible, mandibular implant overdentures should be the first option for complete denture wearers with adaptation difficulties.³⁴

Another way to further reduce the cost of implant treatment and expand the benefits of it to more people is by using a single midline implant as support for a mandibular overdenture. This is a promising option according to short-term studies but awaiting long-term evaluation.^{18,19}

An early 5-year study demonstrated good results with such an overdenture. These and similar results³⁵ led to a suggestion to use the single midline implant overdenture as an inexpensive treatment for geriatric and other patients with low functional demands. During the last few years, several short-term randomized clinical trials have been presented indicating an increased interest in the profession to evaluate this option³⁶⁻³⁸. The results of these short-term studies have in general been assessed as promising but long-term observations are required for a firm conclusion regarding the clinical usefulness of mandibular overdentures supported by a single midline implant.

In addition, the midline denture fracture might be related to the relatively thin denture base in the

midline because of the small diameter of the lower central incisors in this area. Consequently, the denture at the area for attachment picking-up was over waxed to give enough thickness for relief and avoid the denture fracture at this area. But also the reinforcement of denture in telescopic attachment cases was made by using a metallic meshwork in the denture base.

Single implant overdenture has significantly improved the quality of life, retention, the efficiency of chewing, phonetics, and patient's social life. According to a study done by Gonda et al. in 2007, the single implant in overdenture becomes the fulcrum and the denture base area around the implant is usually thin so the overdenture is susceptible to fracture. So reinforcement can effectively reduce the strain and prevent the deformation of the overdenture.³⁹

However, a study was done by Šćepanović et al. in 2015 stated that 1-year bone resorption around immediately loaded mini dental implants is within the clinically acceptable range for standard implants.⁴⁰ According to Carl E. Misch prosthetic classification, the RP5 prosthesis is subjected to more bone loss posteriorly in comparison to the RP4 prosthesis. Therefore a single implant overdenture needs to be relined over a period of time for better prognosis in the future.

One single midline implant might be a lower cost alternative, but there still no longer term scientific evidence for the applicability of this treatment option.

Recently there is a growing interest to assess the patient satisfaction about implant overdentures to evaluate them. Several recent studies were concerned by the impact of implants on oral health-related quality (OHRQoL) especially in cases of immediate loading.^{41,42}

In another study done by Sun et al. in 2014, it was shown that a single implant retained mandibular overdenture can significantly improve the masticatory efficiency (ME) and Oral Health Related Quality of Life (OHRQoF) and improvement in OHRQoF is

mainly because of improved ME and also improved chewing efficiency and pain relief contributes to significant improvement of OHRQoF.⁴³

This study concluded that single implant retained mandibular overdenture improved the prosthesis function, retention and general oral comfort of the patients. The results are in agreement with several studies.^{44,45} Similar effects of the single immediately loaded implants on the patients' satisfaction were found by two other studies, which also used OHIP.⁴⁶

The provided retention from the attachment and improving adaptation of patients with time may be the reason for the increased satisfaction scores. Components of lower cost, shorter surgery time and lower need for maintenance could be the reason for high patient satisfaction score suggesting that a mandibular overdenture supported by single implant could be a viable alternative to the customary two-implant overdenture.

There was no significant difference between group I (ball attachment) and Group II (telescopic attachment). This indicates that the type of attachment ball or telescope have nearly the same impact on improving the OHRQoL of the patients. This differs from the results of another study which compared ball to locator attachments and their effect on OHRQoL. The study concluded that there was significant difference between ball and locator attachments in favour of ball attachment.²⁵

CONCLUSION:

Within the limitations of the present study, the patient satisfaction remained high after treatment with immediately loaded mandibular overdentures supported by one titanium dental implants at the para-symphiseal region in both attachment designs. The telescopic attachment with immediately loaded single implant mandibular overdenture can be a viable and promising treatment option for edentulous patients. It can be as efficient as the ball and socket attachment. Long-term observations and outcomes are needed before recommending it as a treatment modality.

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