Original Article

Clinical Efficacy of Single One Piece Implant Retained Mandibular Overdentures

Kyaw Naing[1], Myat Nyan[2], Ko Ko[2], Than Swe[1]
[1] Department of Prosthodontics, University of Dental Medicine, Yangon
[2] Department of Prosthodontics, University of Dental Medicine, Mandalay

Abstract

The retention and stability of dental prostheses can be dramatically increased with the use of dental implants and subsequently oral functions of the edentulous patients can be greatly improved. This study was conducted to evaluate the clinical efficacy of single one-piece implant-retained mandibular overdentures compared with conventional complete dentures. Twelve edentulous subjects (mean age: 64) with moderate to severely resorbed mandibular ridges were treated with conventional complete dentures. The clinical efficacy in terms of retention, stability, tissue scores, satisfaction level and masticatory capacity was assessed after 6 weeks. After data collection, single one-piece ball type implant was placed at the mandibular midline area of each subject. After 6 weeks of implant placement conventional mandibular complete dentures were modified into implant-retained mandibular overdentures by O-ring attachment. Clinical efficacy was assessed at 1 week, 3 months and 6 months after loading period. Paired 't' test was employed to compare retention, stability and tissue scores, and non parametric Wilcoxon test for satisfaction level and masticatory capacity between conventional complete denture and implant-retained overdenture. Single one-piece implant-retained mandibular overdentures resulted in significant increase in all parameters of clinical efficacy except tissue scores at all different time points (p<0.05). Single one-piece implant-retained mandibular overdenture treatment would be an alternative cost-effective treatment option for the mandibular edentulous predicament.

Introduction

Classical treatment for edentulous patient is fabrication of complete denture to restore oral function, comfort, appearance and health of the edentulous patient (1). Unfortunately, many of the complete dentures wearing patients have difficulty in performing oral functions (2). More than 50% of complete denture wearers have problems with the retention and stability of their mandibular complete dentures (3). Complete denture retention and stability can influence the patient's ability to function and are intimately

and directly related to patient confidence and comfort (4).

Retention of a maxillary complete denture seldom presents the dentist or the patient with serious problems because the location of the seal area is fairly constant and it does not move during ordinary function of the mouth (5). Retention is chiefly affected by three factors of the denture design: (a) the closeness of adaptation to the oral mucosa, (b) the extent of the denture base, and (c) the peripheral seal. All these factors are easy to get for maxillary denture (6). It mainly depends on atmospheric pressure and is affected by the speed of displacement, the peripheral seal, and the viscosity of saliva (7). The maxilla exhibits much less mobility on the borders of the denture than the mandible, moreover having a stable palate with thick fibrous tissues available to support the prostheses and resist occlusal forces (8).

On the other hand, although retention of the mandibular complete denture depends upon a seal in the same manner as a maxillary denture, the seal area is not as readily located, and it has considerable movements during ordinary functions of the mouth (5)(9). Factors that adversely affect successful use of a complete denture on the mandible include: (a) the mobility of the floor of the mouth, (b) thin mucosa lining the alveolar ridge, (c) reduced support area and (d) the motion of the mandible (8). These factors are the reasons why patients experience difficulty with using a complete denture on the mandibular arch compared to the maxillary arch. Because of poor retention and stability of the mandibular dentures many patients remained dissatisfied and still had problems related with their oral functions (10) (11). Moreover greater rate of alveolar bone resorption in the mandible than that of the maxilla (12), (13) further intensifies the problem.

In addition to poor oral functions with unstable dentures, there is also the potential of being traumatic to the supporting tissues. Movements of the denture base in any direction on their basal seat can cause tissue damage. In long term complete denture wearers, the morphologic changes and the reduction of the residual ridge present serious problems to the clinician on how to provide adequate support, stability, and retention of new dentures (1). Therefore edentulism can be a debilitating handicap and endentulous individuals who could not function can be regarded as 'denture cripples' (8).

Mankind has improved every minute and health science is changing for the betterment (14). With development of osseointegrated dental implants, prosthodontic rehabilitation of partially and totally edentulous patients has greatly evolutionized. The retention and stability of dental prostheses can be dramatically increased with the use of dental implants and subsequently oral functions of the edentulous patients can be greatly improved.

For edentulous mandible, the implant-retained overdenture is an attractive treatment option because of its relative simplicity, minimal invasiveness, and economy (15). Existing complete dentures can be converted into implant-retained overdentures for many patients when moderate to extreme alveolar ridge resorption is present. The implant overdenture is supported mainly by mucosa and thus fewer implants are necessary than for the fixed prosthesis supported solely by implants.

Evidence of oral health quality improvement was more obvious, particularly since the arrival of osseointegration. However, its reliance on the high technology limits it to relatively few people. To provide treatment for the many, cost-effective conventional treatment is required but with adequate quality control. To provide cost-effective treatment without sacrificing bio-functional and prosthodontic principles, it would necessary to formulate a minimum acceptable protocol that would conform to the generally accepted prosthodontic principles, and would assist patients in regaining chewing function and esthetic rehabilitation, thereby significantly improving their quality of life. Single-implant-retained overdenture treatment mode would be the most feasible and reliable strategy to treat mandibular edentulous patients with denture adaptation problems. However, more studies would be necessary to assess the clinical efficacy of single-implant-retained mandibular overdentures compared with conventional mandibular complete dentures.

In this study, the effects on retention, stability, tissue response, satisfaction level and masticatory capacity of single one-piece implant-retained mandibular overdentures with ball and O-ring attachment by early loading protocol in patients with mandibular complete denture problems were assessed.

Materials & methods

Twelve maxillary and mandibular complete denture wearing patients, 9 males and 3 females (mean age-64) who complain of existing maladaptive mandibular denture, attending the Department of Prosthodontics, University of Dental Medicine, Yangon were selected. Each patient was received detail explanations about the research procedure and signed the informed consent form. This study was approved by Ethical and Research Committee of University of Dental Medicine, Yangon. Inclusion criteria dictated that patients have residual ridges demonstrated moderate to severe resorption with the presence of sufficient bone at the mandibular midline to allow for placement of one implant of 10x3.5mm size, have any complaint of maladaptive mandibular dentures, andalso have ability to perform proper home care of implant parts and denture hygiene. Exclusion criteria included any chronic debilitating diseases, difficulties for follow-up, psychiatric problems, drug or alcohol abuse, history of radiation therapy at head and neck,

abnormal motor functions, chronic renal or liver disease, taking corticosteroids and heavy smoking habit.

New dentures were fabricated and occlusion was harmonized according to the standardized method. After six weeks of delivery, baseline data concerning retention, stability, tissue response, satisfaction level and masticatory capacity were collected.

Before implant placement surgery, surgical guide was constructed by duplicating existing mandibular denture. Alveolar bone mapping was done for each patient to determine underlying alveolar bone contour. Implant position and alignment were determined according to alveolar bone contour and a guide hole was drilled at the midline of surgical guide. The hole was filled with radio opaque marker (guttapercha) of known length. A lateral cephalometric radiograph was taken with the patient wearing the surgical guide as a radiographic template to confirm the implant diameter, length, position and alignment (Fig. 2, 3, 4). Modifications were done as necessary.

Implant placement surgery was performed as follows. Single one-piece titanium implant (SlimLine, Onebody, ball type (EBS352010), SLA surface, Dentium, Korea) (Fig. 1) 3.5mm in diameter and 10mm in length was surgically placed under local anaesthesia at the mandibular midline with standard aseptic protocol under supervision of Implant Development Committee, University of Dental Medicine, Yangon. Implant surgery was performed with minimal mid-crestal incision and use of standard drilling protocol to avoid thermal and mechanical trauma to alveolar bone. The surgical flap was sutured with ball attachment end of the implant (4mm in length) exposed to oral cavity. The patient was instructed to stay on liquid or semi-solid non-chewing diet. Antiseptic mouth rinse was prescribed for one week. After one week post-operatively, sutures were removed and patients were instructed to use soft tooth brush for plaque control around the exposed ball abutment. All patients were instructed not to wear their mandibular dentures for initial 2 weeks. After 2 weeks postoperatively, the tissue surface of the mandibular denture around the ball attachment was relieved so that denture base does not touch the ball and then relined with soft liner (GC soft liner, GC corporation, Tokyo, Japan) as described by Liddelow (2007) (16) (Fig. 8). All patients were instructed to stay on a soft diet and to limit the denture wearing to minimum for next four weeks during initial osseointegration period.

Early loading protocol was applied, (17)(18). After six weeks post-operative period, mandibular denture was relined if necessary, and O-ring housing (BPF3) was attached to the mandibular denture as described by Burns et al. (1995) (15). Space, large enough to accommodate the O-ring housing was created at the denture base opposing the ball attachment until small

perforation appears in the lingual surface of denture. Then the O-ring housing was fixed within the mandibular denture with auto polymerizing acrylic resin applied through the perforation of denture base (Fig. 6). The patient was instructed how to handle the denture and how to clean the attachment components at home.

The experimental data concerned with retention, stability, tissue response, satisfaction level and masticatory capacity were collected at each maintenance period (one week, three months and six months after placement of housing attachment). Retention and stability of mandibular denture were measured quantitatively by using force gauge (Handy Analog Push-Pull Gauge, NK-20, ALGOL Instrument Co., Ltd., Taiwan) (Fig. 7).

A small wire hook was attached at the mid-labial flange of denture with self-cured acrylic resin. The pull-end of the force gauge was connected to 0.8 mm gauge 5cm long orthodontic wire with a small distal hook to engage with the hook attached to the denture. The force gauge connected to the mandibular denture was pulled vertically until the denture dislodgement occurs. This force was measured three times with five minutes interval and the mean measurement was calculated and recorded. The push-end of the force gauge was then positioned in the gingival embrasure area around the first molar denture tooth on each side of the denture. The force gauge was pushed horizontally, parallel to the occlusal plane against the denture from a lateral position. The force needed to move the denture horizontally was measured three times on both sides and the mean measurement was calculated and recorded.

The conditions of the denture bearing tissue in both arches were evaluated with criteria-based scoring system described by Rayson et al. (1971) (19)(Fig. 9). The satisfaction level and masticatory capacity were evaluated by means of questionnaire as described Pocztaruk et al. (2006) (20) (Fig. 10, 11). In the Questionnaire I, there are nine questions with a scale ranging from 0 (zero) to 4 (four), where 0 represents the total satisfaction and 4 represents the total dissatisfaction. In the Questionnaire II, there are twelve questions, consisting of a scale from 0 (zero) to 4 (four), where 0 represents never (no problems) and 4 represents always (with problems). The mean score was calculated. The higher scores were represented a poor perception of the oral conditions, therefore worse satisfaction levels and masticatory capacity.

Before statistical analysis, satisfaction and masticatory capacity scores were calculated to express as the percentages. Consequently, the largest percentages presented in the results mean better satisfaction level and masticatory capacity.

Fig. 1.Onebody Ball type implantSLA surface with O ring housing

Fig. 2.Surgical guide with guttapercha as a known length radio opaque marker

Fig. 3.Lateral cephalometric view for radiographic assessment and surgicalguide used as a radiographic template

Fig. 4.Lateral cephalometric view after O-ring housing attachment

Fig. 5.Intraoral view of ball abutment

Fig. 6.Denture with O-ring housing attachment

Fig. 7.Handy Analog Push-Pull Guage

Fig. 8.Soft liner GC

Tissue condition

Tissue Score: Maxilla ☐   Mandible ☐

Criteria

1 Large general region of redness involving half of more of the denture bearing surface or a considerable amount of movable tissue not present before or both

2 Some movable tissue on the crest of ridge of not previously present or irritated regions covering one-third of the denture bearing area.

3 The tissues are generally firm and appear healthy except for small isolated regions.

4 Tissues are firm and appear healthy with no signs of abrasion of other injury caused by the dentures.

All abnormal areas are to be scribed on the drawing and the following coding used:

R – Redness (isolated)

H – Hyperplastic tissue

I - Inflammation (general)

U – Ulceration

Rayson et al (1971)(19)

Fig. 9. Criteria-based scoring system for denture bearing tissue conditions

Satisfaction level

1. How do you feel about the pleasure you get from food, compare with the time when you had natural teeth? ☐

2. With respect to chewing, how satisfied are you with your dentures? ☐

3. With respect to appearance, how satisfied are you with your dentures? ☐

4. With respect to comfort, how satisfied are you with your dentures? ☐

5. With respect to being self-assured and self-conscious, how satisfied with your dentures? ☐

6. With respect to your social and affective relationships, how satisfied are you with your oral conditions? ☐

7. With respect to your professional performance, how satisfied are you with your oral conditions? ☐

8. With respect to eating, how satisfied are you with your dentures? ☐

9. Are you satisfied with your smile (esthetics)? ☐

Scale 0-completely satisfied, 1-moderately satisfied, 2-slightly satisfied, 3-scarcely satisfied, 4-completely dissatisfied

Total score: ☐

Pocztaruk et al (2006) (20)

Fig. 10. Questionnaires for satisfaction level

Masticatory capacity

1. Have you ever had to interrupt meals because of problems with your dentures? ☐

2. Have you found it difficult to chew any foods because of problems with your dentures? ☐

3. Do you need any special food preparation to enable chewing (such as cooking, cutting into small parts, humidification)? ☐

4. How stable are your dentures when eating foods of a certain consistency? ☐

5. Do you need force to swallow foods after chewing? ☐

6. Do you think that you are swallowing large pieces of food due to the lack of proper fragmentation? ☐

7. Have you found it uncomfortable to chew any foods with your dentures? ☐

8. In comparison with other people, do you perceive that you take longer to chew the foods during meals? ☐

9. Do you feel uneasy during meals due to the lack of denture security and instability? ☐

10. Have you been embarassed when eating with other people during meals? ☐

11. Have you been been irritable when having meals with other people? ☐

12. Have you been totally unable to function because of problems with your dentures? ☐

Scale 0-never (no problems), 1-rarely, 2-occasionally, 3-frequently, 4-always (with problems)

Total score: ☐

Pocztaruk et al (2006) (20)

Fig. 11. Questionnaires for masticatory capacity

Results

Table 1 denotes the mean retention values, mean stability values in gram force, mean tissue score, mean satisfaction level and mean

masticatory capacity of conventional complete dentures and single one piece implant retained mandibular overdentures after one week, three months and 6 months of loading period. There were statistically significant of differences between retention and stability of conventional mandibular denture and that of single one-piece implant retained mandibular overdenture (p <0.05).

Mean mandibular tissue score of conventional dentures was 3.25 and that of one piece single implant retained mandibular overdentures was 3.5. There was no statistical significant difference between conventional mandibular dentures and implant retained mandibular overdentures at different time points (p >0.05). According to the results, mean satisfaction level and mean masticatory capacity with conventional mandibular dentures were also significantly lower than that of implant retained mandibular overdentures at different time points (p <0.05).

The General Linear Model (GLM) Repeated Measures procedure was used to provide analysis of variance of values of parameters measured at follow up on each subject. This general linear model procedure can test null hypotheses about the effects of the within-subjects factors. Statistical significance which is determined by p value less than 0.05 showed the observed changes of measured parameters along the repeated measurements would be conclusive for larger number of similar subjects.

Variable	CD	IOD 1week	IOD 3months	IOD 6 months	p- values
Retention value (gf)	186.2	602.9	657.1	663.33	P<0.05
Stability value (gf)	313.8	1004.2	1141.7	1079.16	P<0.05
Tissue score	3.25	3.5	3.9	3.9	P>0.05
Satisfaction level (%)	57.6	89.68	93.86	95.1	P<0.05
Masticatory capacity (%)	27.6	94.98	98.33	94.94	P<0.05

Paired 't' test, Wilcoxan Sign Rank TestCD - complete denture, IOD – Implant retained overdenture

Table 1. Clinical efficacy in term of mean retention value, mean stability value, tissue score, mean satisfaction level and mean masticatory capacity of conventional complete dentures and implant retained overdentures at different time points
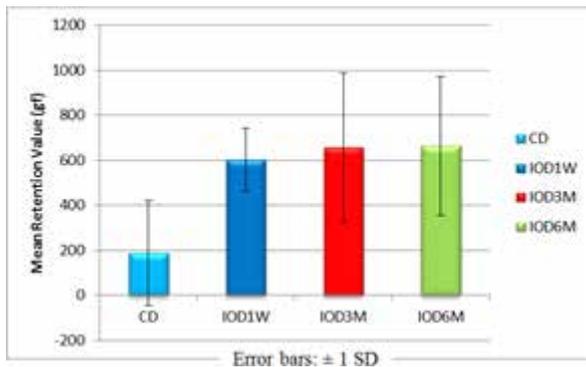
Fig. 12. Comparison of mean retention values of conventional mandibular dentures and those of implant retained mandibular overdentures at 1week, 3 months and 6 months
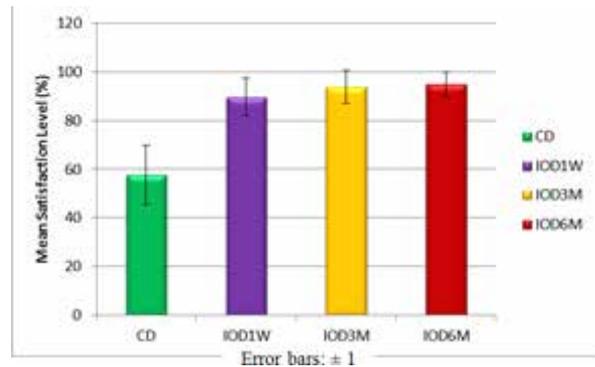

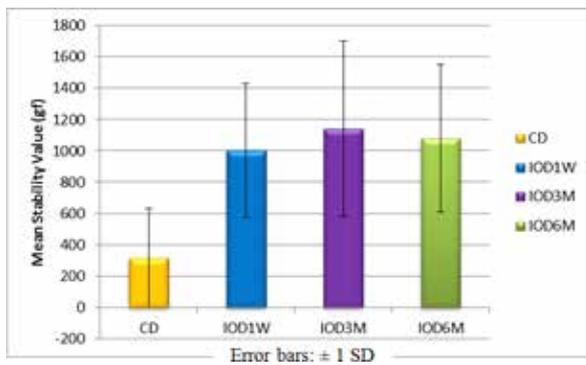Fig. 13. Comparison of mean stability values of conventional mandibular dentures and those of implant retained mandibular overdentures at 1week, 3 months and 6 months

Fig. 14. Comparison of mean tissue scores with conventional mandibular dentures and those with implant retained mandibular overdentures at 1week, 3 months and 6 months

Fig. 15. Comparison of satisfactory levels of conventional mandibular dentures and those of implant retained mandibular overdentures at 1week, 3 months and 6 months
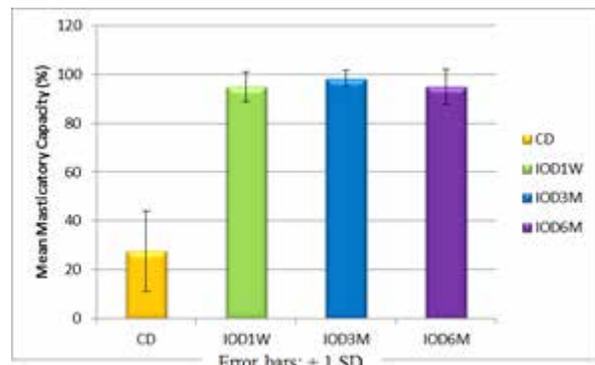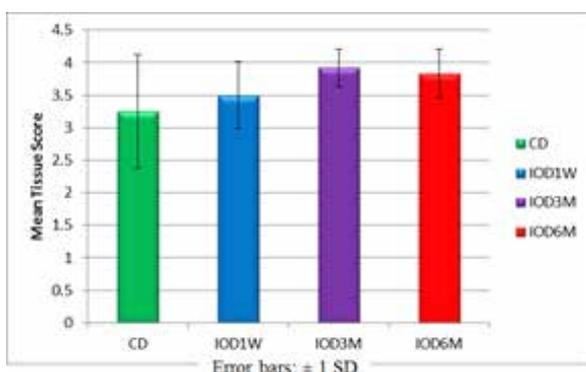

Fig. 16. Comparison of masticatory capacities of conventional mandibular dentures and those of implant retained mandibular overdentures at 1week, 3 months and 6 months

Discussion

In this study, there was no implant loss during study period. Clinically, all single implants located at the symphysis of anterior mandibles showed no signs and symptoms of gingivitis, peri-implantitis, mobility, pain and discomfort. The mean retention force of the single one-piece implant retained mandibular overdenture was significantly greater than that of conventional complete dentures (Table 1). By attaching the

denture to the single midline implant with O-ring attachment, retention of the mandibular overdenture was dramatically increased regardless of tongue position and lip pressure during function.

Even single implant with O-ring attachment can assist to obtain higher retention of complete mandibular conventional denture. It made the patients easy to manipulate their mandibular dentures. It maintained anterior border seal of denture not easy to break during functional movements. Anterior border seal is very easy to break for conventional denture especially for patients with habit of retracted tongue position, severe anterior mandibular ridge resorption and not well adapted to their mandibular dentures. Its retention force was enough to resist all the dislodging forces generated surrounding muscles including tongue. All the subjects can easily perform their routine oral functions without any complaints.

Concerning the stability, retention is a prerequisite to stability (5). Some degree of retention must be present for mandibular dentures to have the quality of stability. Generally, the greater the ridge loss, the smaller the denture base area and the less influence the impression surface area will have on the stability and retention of the denture.

Placing single midline implant at the anterior mandible resists the mandibular denture anteroposterior dislodging forces. Additionally,

functional retromylohyoid flange extension and correct footing of two buccinator muscles on both buccal polished surfaces also limited lateral horizontal displacing forces to the denture (21).

The wearing of complete dentures may have adverse effects on the health of both oral and denture supporting tissues. In the present study, sore spots and ulcers were found mostly in the mandibles wearing conventional denture, whereas they were hardly found in implant overdentures. This would be because of more stable and more retentive implant retained overdentures.

While they were using conventional mandibular dentures, they were less satisfied with their dentures. They were not able to chew very well. They felt less comfort during function and social contact. All these problems were related with retention and stability of their mandibular dentures. It was found that implant retained overdenture had higher satisfaction level compared with that of conventional denture. Owing to the fact that there was no significant difference in retention and stability values with time, it is speculated that better adaptation and muscular control of implant-retained overdenture contributed to better patient satisfaction.

Regarding the denture rotation, the functional flange extension and the full mucosal support provided by the overdenture anchored to a single implantmay limit the problems

encountered with the standardmandibular overdenture approach (22) (23).

Denture fracture is one of the common complications with overdentures. During this study period, three patients encountered overdenture fracture. Two mandibular overdentures were fractured because of accidental drop, and another one was fractured during function. In the study of Gonda et al. (2010) (24), the incidence of denture base fractures was not significantly different between overdentures retained by one implant and those retained by two implants.

Period recalls and long term observation are necessary for evaluating long term success. The maintenance will include regular relines of the prosthesis, regular replacement of attachments, good oral hygiene and prophylaxis of the implants and to safeguard possible breakage of components.

Conclusion

 Adequate retention and stability of complete dentures are fundamental determinants for successful treatment outcome. One-piece single implant placed at symphyseal region assists patient's manipulative skill to their mandibular dentures. Its additional retention and stability on the mandibular complete denture are just enough to resist dislodging forces from the surrounding muscles, particularly those from the strongest one, the tongue. Resulting increased

retention together with the significantly stable mandibular complete denture ensures patient's confidence on wearing the denture and subsequently improves patient's satisfaction and masticatory efficiency. Single implant-retained mandibular overdenture treatment can solve financial constraints of elderly edentulous patients to a certain extent and it would be regarded as a cost-effective promising treatment modality.

Therefore, within the limits of this study, it might be concluded that one-piece single implant-retained mandibular overdenture treatment could be an alternative effective treatment option and also provide a future paradigm shift of treatment to solve the mandibular edentulous predicament. Future research should be directed to evaluate the long-term effectiveness of this treatment modality with larger sample size and also to observe changes of periimplant tissues and remaining denture supporting tissues longitudinally over time.

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