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Comparison of marginal bone loss in implant supported over dentures in early loading: An original research

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Abstract---Aim: The purpose of the present research was to evaluate the marginal bone loss in implant supported over-dentures in case of early loading on denture. Methodology: 36 edentulous participants (mean age 68 years, SD 9.2) were randomly assigned into three treatment groups (n¼12). A single implant was placed in the mandibular midline of participants to support an overdenture using a 6-week loading protocol. The control group received Southern regular implants and standard ball attachments. One group received Southern 8-mm-wide implants and large ball attachments. Another group received Neoss regular implants and Locator attachments. SPSS was used to determine between groups differences in marginal bone loss, implant stability, implant, and prosthodontic success (P<0.05). Results: Implant success after 1 year was 75% for Southern regular implant (control) group; and 100% for the Southern wide and Neoss regular implant groups (P¼0.038). Prosthodontic success was comparable between the groups but the maintenance (41 events overall, mean 1.2) was greater for the Locator and the standard ball attachments. Conclusion: Mandibular single-implant overdentures are a successful treatment option for older edentulous adults with early loading protocol using implants of different diameters and with different attachment systems.

Keywords---attachment systems, mandibular single-implant overdentures, wide diameter implants.

Introduction

In order to overcome instability of conventional complete mandibular dentures, implant overdentures (IODs) are prescribed for patients with edentulous mandibles on many occasions.¹⁻⁴ Many studies have proven the efficiency of IODs regarding a whole series of clinical parameters such as denture stability, chewing efficiency, patients' satisfaction, and oral health-related quality of life.⁵⁻⁷ Initially, dental implants were to be free from loading forces for 3–6-months after implant placement in order to successfully achieve osseointegration.⁸ Nowadays, immediate loading (IL) protocols, which allow the patient's occlusal forces to be loaded on implants within 1 week after surgery, have been widely applied to implant supported fixed prosthesis.

This is because these protocols allow immediate restoration of oral function and esthetics and shorter total treatment timeframe without substantial deterioration of osseointegration.⁹⁻¹¹ Treatment concepts for edentulous adults using oral implants have progressed to encompass simplicity and cost-effectiveness.¹² Long-term studies have indicated that two splinted or unsplinted implants supporting mandibular overdentures (opposing complete maxillary dentures) are a globally accepted treatment option.¹³ Future directions with case reports and prospective studies point towards a more conservative approach; the use of only a single implant to support a mandibular overdenture.¹⁴ Implant outcome and patient satisfaction has shown to be comparable whether one or two implants are used for support of mandibular overdentures.¹⁵ Regardless of the number of implants used, the prosthodontic success of mandibular implant overdentures is influenced by the maintenance and repair requirements.¹⁶

This clinical burden is higher in the first year of service¹⁷, and is dominated by a recurrent need for activation and replacement of the components of the attachment systems.¹⁸ Different attachment systems are used with unsplinted prosthodontic designs of mandibular implant overdentures. Most commonly, standard 2.25mm ball attachments with the gold alloy matrices are used with positive outcomes documented.¹⁹ Recently, the widespread use of the Locator attachment system has become fashionable without adequate evidence from either prospective or randomised clinical trials.²⁰ Taking cognizance of a more minimal intervention with mandibular single-implant overdentures opposing complete maxillary dentures for older adults, it is notable that both the choice of implant diameters and attachment systems are a replication of those used with the traditional mandibular two-implant overdentures.

Consequently, a novel approach using wide diameter implants and large attachment systems has been described for mandibular single-implant overdentures.²¹ This approach is surgically adapted to conform to the anatomic state of severely resorbed mandibles using wide implants of 8mm diameter with novel large (5.9mm) ball attachment systems. The impact of this treatment approach is related to improving the support, stability, and retention of mandibular single implant overdentures.²² The health care benefits of addressing the needs of edentulous adults with a simpler, more cost-effective treatment option are clear; however, this needs to be with a diminished maintenance burden over time.

Aim of the present study

The purpose of the present research was to evaluate the marginal bone loss in implant supported over-dentures in case of early loading on denture.

Methodology

From August to December 2007, participants with complete mandibular denture retention and stability complaints were recruited from a pool of patients seeking prosthodontic treatment. Exclusion criteria included any medical condition contraindicating implant surgery, irradiated or bone-grafted jaws. Thirty-six participants were selected for the study and this sample size was determined following established randomised clinical trial designs with mandibular implant overdentures. Each participant received a new set of complete maxillary and mandibular dentures made according to a standardized prosthodontic protocol. The participants were allowed to use their complete dentures for approximately 8 weeks to ensure proper adaptation. Subsequently, the randomisation and allocation of the 36 participants into three different interventions of 12 participants each was commenced.

- Southern regular implant group (control): Each participant received a single regular diameter (3.75mm) implant and the standard 2.25mm ball attachment system with a Dalla Bona type gold alloy matrix.
- Southern wide implant group: Each participant received a single wide diameter (8mm) implant and a novel large (5.9mm) ball attachment system (Southern Implants).
- Neoss regular implant group: Each participant received a single regular diameter (4mm) implant and the Locator attachment system.

One-stage surgical approach under local anaesthesia was followed in implant surgeries. Implants had insertion torques of 45Ncm, healing abutments of appropriate length were connected and the mucosa was adjusted and sutured. Immediately after surgery, the mandibular denture of each participant was modified and relined with a soft tissue conditioner. Six weeks postoperatively, loading procedures were commenced with the connection of the final abutments according to the group allocations. The primary outcome measures were specifically the marginal bone loss and the prosthodontic maintenance incurred during the first year. Standardized intra-oral radiographs were used to measure the change in marginal bone levels at baseline and 1 year. Measurements were made from a predefined reference point to the first implant-to-bone contact at either side of the implants and a mean value per implant was calculated. Two calibrated examiners performed the measurements separately and a mean marginal bone loss of <1.5mm in the first year determined implant success. SPSS version 25.0 was used in the analysis of the data. Analysis of variance (ANOVA) with the Tukey HSD post hoc test determined the statistical significance of differences between the groups in implant stability ($P < 0.05$). χ^2 -tests were used to analyse categorical dependent variables in baseline characteristics and to compare the implant and prosthodontic success between the groups ($P < 0.05$).

Results

No statistically significant differences in patient baseline characteristics were observed between the groups. The mean age of participants was 68 years (range 53–85) and two-thirds were females (n=24). Participants had been edentulous for a mean of 39 years (SD 12) and had worn, on average, three sets of dentures before the study commencement. Of the 36 implants used, 10 were of 7 and 9mm length, while the remaining were 11 and 11.5mm. One participant developed persistent soft tissue inflammation around the abutment after loading. Surgical excision, and subsequent healing, did not allow continuous loading for the entire 1 year. (Table 1) The outcome of this implant was relegated to the survival category. Among the remaining 33 implants at the end of the 1-year observation, each had a mean marginal bone loss of <1.5mm (mean 0.19mm, SD 0.39). Less mean marginal bone loss was observed around the Southern wide implants (0.13mm, SD 0.35) than the Southern (0.2mm, SD 0.4) and Neoss (0.23mm, SD 0.44) regular ones, but the difference was not significant (Kruskal–Wallis test, $P<0.05$).

The overall mean ISQ value for the implants at baseline was 71.8 (SD 6.2). The mean ISQ value of the Southern regular diameter implants (control group) was significantly lower than that of the other two groups (ANOVA, $P<0.05$). A total of 41 maintenance events were recorded for 34 overdentures completing the 1-year observation period (one patient had early implant failure. Majority of events (n=33) were related to the maintenance of the matrix portion of the attachment systems. Four maintenance events were required for the large ball attachments (two matrix replacements; two overdenture fractures), 19 for the Locator attachments (16 matrix replacements; two relines; and one overdenture replaced), and 18 for the standard 2.25mm ball attachments (13 matrix activations; two matrix activations; two overdenture fractures; and one incident of peri-implant mucosal enlargement requiring surgical excision). Using the six-field table for reporting prosthodontic outcomes with implant overdentures. 83.3% of the overdentures in the group with the large ball attachments were considered successful compared with 66.7% in the Locator attachments and 63.6% in the standard 2.25mm ball attachment groups. The prosthodontic success, while higher in the group with the large ball attachment systems, was not statistically significant (χ^2 -test, $P<0.05$). (Table 2)

Discussion

This randomised-control trial compared the surgical and prosthodontic outcomes of mandibular implant overdentures supported by single implants of different diameters and retained with different attachment systems. The use of a wide diameter implant of 8mm in the mandibular midline with a corresponding large ball attachment system of 5.9mm is a novel approach. The overall 1-year implant success in this study was 91.7%, and others²³ reported better outcomes with mandibular single-implant overdentures. A recent 3-year prospective report still reports on implant survival, against a background of only 25 oxidised surface implants presented with machined surface failures. On the other hand, the lower success rate of 75% for the Southern regular implants in the present study is a notable finding. We followed an early loading protocol at 6 weeks in this study.

Histological and clinical findings support the use of this protocol with roughened surface implants. Our results and those of Walton et al. also confirm the success of this protocol for mandibular single-implant overdentures. Immediate loading with mandibular single-implant overdentures, on the other hand, resulted in higher risks for implant loss, or soft tissue complications. The overall mean marginal bone loss after 1 year of function in the present study was minimal (0.19mm, SD 0.39) when compared with others. This could be attributed to the specific surface characteristics of the implants used in our study, or the dominance of basal bone known to be resistant to the resorptive process. Implant outcome reporting requires stability assessment of the individual implants. One prospective study using the same RFA device we used, reported a mean ISQ value of 73.1 for 28 Bra°nemark implants supporting mandibular single- implant overdentures.

This value was comparable with the mean value reported in our randomised clinical trial (ISQ 74.6) for implants of different diameters loaded for a similar period. The overall number of prosthodontic maintenance events required in this study was relatively low (n=41, average 1.2). The tendency for food and plaque accumulation within the recess of the female abutment was another “nuisance” with the Locator attachment in this study. Keeping this “difficult” abutment design free of debris was daunting for older adults with reduced manual dexterity. The adjustable Dalla Bona-type gold alloy matrices of the standard 2.25mm ball attachments also presented specific needs for maintenance. Of the total 18 events, 13 were related to matrix activations. Payne and associates used this attachment system and reported 18 events of matrix activations for 12 mandibular two-implant overdentures in 1 year.¹⁷

Conclusion

Mandibular single-implant overdentures opposing complete maxillary dentures are a successful treatment option for older edentulous adults with early loading at 6 weeks using implants of different diameters and with different attachment systems. Larger attachment systems on wide diameter implants are associated with reduced maintenance requirements.

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Tables

Table 1
Implant outcome: four-field table analysis

	Success number (%)	Survival number (%)	Unaccounted for number (%)	Failure number (%)
Southern regular implant group (control)	9 (75)	1 (8.3)	1 (8.3)	1 (8.3)
Southern wide implant group	12 (100)	0	0	0
Neoss regular implant group	12 (100)	0	0	0

Table 2
Mean and standard deviation of marginal bone loss after 1 year

	Number of implants	Mean (mm)	SD	95% confidence interval	P-value
Southern regular implant group (control)	9	0.2	0.4	-0.01, 0.05	0.735
Southern wide implant group	12	0.13	0.35	-0.09, 0.35	
Neoss regular implant group	12	0.23	0.44	-0.04, 0.05	