Original Article

A randomized controlled trial comparing the radiographic evaluation of crestal bone resorption in single implant versus two implant–retained overdentures

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Abstract

Aim: The aim of this study was to evaluate and compare radiographically the amount of crestal bone resorption during healing and loading period in single implant versus two implant–retained mandibular overdentures in totally edentulous patients. **Materials and Methods:** A total of 20 edentulous patients (12 male and 8 female) with age range of 58.6 years were included in this clinical trial which was completed in four phases (clinical and radiographic diagnosis, surgical phase, implant loading phase, and bone level measurement phase). The eligible patients were randomly allocated in two equivalent groups of 10 participants each per group. The allocation was in 1:1 ratio via randomized chit method. Group I included the case group, that is, single implant, and Group II included the control group, that is, two implants located in mandible. A total of 30 implants were placed in Group I and 20 implants in Group II. Digital intraoral peri-apical radiographs (RVG 5100) were used for measuring the bone level immediately after implant surgery, 1 month, 3 months, 4 months, and 6 months. **Result:** This study showed that there was a mean crestal bone loss of 0.7 mm between the tip of the implant and alveolar crest at the end of 6 months after implant placement in single implant Group I while 0.67 mm in case of Group II two-implant-retained mandibular overdentures. The percentage of crestal bone loss after 6 months follow-up was 6.45% in Group I which was statistically insignificant compared with Group II where 6.25% of bone loss was recorded. **Conclusion:** Single implant–retained mandibular overdentures could be used as another alternative treatment option for completely edentulous elderly patients with severely resorbed ridges and financially and systemically compromised conditions.

Keywords: Crestal bone loss, edentulous, overdenture, intraoral periapical

Introduction

Crestal bone resorption is a common biological complication associated with dental implant failure. The amount of crestal bone loss is maximum in first year during healing and loading period. Implant-retained overdentures are widely used for the rehabilitation of edentulous jaws to increase retention of prosthesis, to enhance the masticatory function and reduce the absorption of alveolar bone by regulating neuromuscular adaptation.[1] Rehabilitation of edentulous patients become even more difficult in cases of advanced ridge resorption in mandibular edentulous cases. It is very difficult to rehabilitate an edentulous patient with a compromised mandibular alveolar bone because it often results in denture soreness, poor retention, and stability along with improper speech and low chewing efficiency.

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The York consensus statement recommends at least two implants to support mandibular overdentures for edentulous patients. However, economic constraints especially among the emerging elderly population in developing countries make our treatment strategy financially challenging. To reduce the cost and time of treatment, the concept of single implant–retained overdentures provides another option for elderly populations.[1]

The longevity and success of dental implants with prosthesis is highly dependent on integration between implant components and oral tissues, including hard and soft tissues. Initial breakdown of the implant–tissue interface generally begins at the crestal region in successfully osseointegrated-endosteal implants. In particular, after the first year of function, crestal bone loss up to or beyond the first thread of titanium screw implants, characterized by "saucerization," is often observed radiographically around certain implant types.[2] Many possible etiologies of early crestal bone loss around implants (from implant placement to 1-year post-loading) including surgical trauma, occlusal overload, peri-implantitis, the presence of microgap, reformation of biologic width, implant crest module, and others have been proposed. However, the location of dental implants, whether subcrestal or supracrestal, is still becoming an increasing importance for researchers.[3]

Enough evidence is available to advocate the hypothesis that a two-implant supported mandibular overdenture is the first choice of treatment for edentulous patients.[4,5] But, the low economic status of developing countries serves the major constraint. Hence, the use of single-implant concept was introduced to stabilize the lower denture. It served as a better alternative to two implant supported mandibular overdenture.[6]

Single-implant mandibular overdentures concept may be of beneficial effect on geriatric population regarding the health and financial status. Problems encountered with two implant–retained overdentures, like both implants should be parallel to each other, should be equidistant from the midline and should be at same level to each other, and failure of one may lead to unequal stresses on the other. All these can be avoided in case of single implant–retained overdentures.[7] Nevertheless, this concept needs well-organized controlled trials to evaluate all aspects of patients' oriented and functional outcomes.

This study was thus designed to radiographically evaluate and compare the amount of crestal bone resorption in both, thus determining the long-term success of two systems.

Materials and Method

The present randomized controlled trial was carried out in the Department of Prosthodontics and Crown and Bridge in collaboration with Department of Oral Medicine, Diagnosis and Radiology and Department of Oral and Maxillofacial Surgery, to evaluate the crestal bone loss in a single implant versus two implant–retained mandibular overdentures opposing a maxillary complete denture over a period of 6 months follow-up after implant placement.

Study design

Study was designed to be a randomized clinical trial (RCT): two parallel groups with 1:1 random allocation via chit method included 20 subjects (12 males and 8 females) with mean age of 58.6 years.

Case Group I: Each subject received single implant–retained mandibular overdentures.

Control Group II: Each subject received two implant–retained mandibular overdentures.

Patient consent

The proposed treatment modalities and alternatives were discussed with patients in this study. Explanatory consultation, treatment duration, prosthodontic restoration, and possible complications as well as risks were all written in a consent form. The patients were fully informed about the possible consequences of the proposed clinical trial and signed a special written consent form designed for this purpose in accordance with the Declaration of Helsinki (2008). The consent forms were both in Hindi and English for better understanding by the patients.

Inclusion and exclusion criteria

Completely edentulous patients, co-operative patients, healthy patients without any systemic disease, patients with minimum 10 mm residual bone height available without augmentation, unsatisfied patients with old conventional complete dentures, and patients without any bone disorders were included into the study. Exclusion criteria include patients with maxillofacial defects, patients suffering from systemic diseases, patients with any type of tumor, neurologic, or cerebrovascular diseases or hemorrhagic or severe cardiopulmonary disorders, and patients suffering from any neuromuscular disorders.

Blinding

Apparently, neither participants nor care providers could be blinded as to the number of implants placed, but care providers were instructed not to comment about possible treatment outcomes to subjects. The denture retention was assessed by an independent assessor who was not aware of the type of intervention. The statistician was blinded.

This study was conducted in 4 phases:

In Phase 1, clinical and radiographic diagnosis was done. In this phase, a single dental implant in the mid-symphysis region was planned following all the surgical protocols after denture fabrication. Primary impressions were made from alginate. Impressions were poured with dental plaster and diagnostic cast were made. Border molding was performed with low fusing

compound, and final impressions were made with light body elastomeric impression material. Jaw relation and try-in was carried out. Dentures were fabricated with high impact heat cured acrylic resin, and occlusion corrections were performed – storage of maxillary and mandibular complete denture in 0.2% diluted solution of chlorhexidine and changing solution every alternate day.

In Phase 2, surgical procedures were carried out for all the subjects. After thorough clinical evaluation of the proposed implant site, midline in the case group, and canineregion bilaterally in the control group, a regular platform soft tissue level implant (Myriad, Netherland) with a diameter of 3.8 or 4.3 mm and 9.5 or 11 mm in length were selected according to patient requirement after evaluation prior to surgery. A retentive anchor with a titanium matrix (2 mm height) was selected for the prosthetic anchorage. After administration of anesthesia, a crestal incision was made with two vertical releasing incisions in the bilateral canine area for patients of Group II. For patients of Group I, the crestal incision was made in the anterior midline area. A full thickness mucoperiosteal flap was reflected using a sharp mucoperiosteal elevator. Any crestal bone irregularity was adjusted with a bone file. For Group II, a parallel pin was placed to ensure proper alignment of the osteotomy site. The osteotomy site was prepared according to the manufacture's direction using a standard bone drilling protocol, with extreme care to avoid penetration of the lingual or inferior cortex after raising mucoperiosteal flap. Initial implant stability was achieved with torques >35 Ncm and was tested manually by hand. Healing abutment of appropriate length was connected, and mucosa was approximated and sutured with (4-0) silk. Antibiotics (Augmentin 625 mg) and non-steroidal anti-inflammatory (Ibrufen 400 mg) medications were given to the patients every 8 hours for 5 days postoperatively. Immediately after surgery, all patients were allowed to take soft diet for 3 days and were also advised to maintain excellent oral hygiene. Digital radiographic evaluations of bone were carried out immediately after implant placement and subsequently at 4 and 12 weeks of healing period.

In Phase 3, loading of the implant was carried out. Subsequent digital radiographs were taken at intervals of 4 weeks and 12 weeks after loading.

In Phase 4, digital intraoral peri-apical radiographs (RVG 5100) were used for measuring the bone level using *measuring tool* immediately after implant surgery, 1 month, 3 months, 4 months, and 6 months and magnification error was checked. The data obtained were saved using Paint software used in Microsoft 8.1. The data so obtained for measuring the bone levels with the help of computer software (RVG 5100) were tabled. All data were statistically analyzed for result.

Method used for calculating crestal bone level at particular time will be given by

Original crestal bone level at baseline = (radiographic crestal bone level × original or physical length of the implant body)/ radiographic length of the implant body

Method used for calculating crestal bone loss:

Crestal bone change or loss (at given time) = original crestal bone level at baseline – crestal bone level at that particular time

An analytical study was conducted on eight edentulous subjects of which five were male and three were female. Measurements on implant length, magnification, and crestal bone level were recorded at different time intervals to estimate crestal bone loss [Graph 1].

Result

This study showed that there was a mean crestal bone loss of 0.71 mm between the tip of the implant and alveolar crest at the end of 6 months after implant placement in single implant Group I [Table 1] while 0.67 mm in case of Group II two-implant-retained mandibular overdentures [Table 2]. The percentage of crestal bone loss after 6 months follow-up was 6.45% which is in Group I which was statistically insignificant compared to Group II wherein 6.25% of bone loss was recorded [Table 3].

Discussion

Rehabilitation using complete dentures on edentulous patients who suffer from a compromised alveolar bone often results in denture soreness, poor retention, instability, unclear pronunciation, and low chewing efficiency. Implant-retained overdentures are widely applied for the rehabilitation of edentulous jaws as it is able to increase retention rates of prosthesis, enhance the masticatory function, and reduce the absorption of alveolar bone by regulating neuromuscular adaptation.

This study is very useful for the clinicians who face patient recession due to high cost of implants. In developing countries whereby implant affordability is a major issue, there two implant–supported overdentures can very well be replaced by single implant supported overdentures. Besides, they are less technique sensitive. Compared to the conventional complete denture, two or more implant-retained mandibular overdentures can promote function and enhance success rates. The York consensus statement recommends at least two implants to support mandibular overdentures for edentulous patients. However, economic constraints especially among the emerging elderly population in developing countries make this treatment strategy financially challenging. In order to reduce the cost and time of treatment, the concept of single implant-retained overdentures provides another option for elderly populations. Single implant–retained overdentures have advantages over two implant–retained overdentures. Two implant-retained overdentures require the implant to be parallel to each other, equidistant from

Table 1: Crestal Bone loss in Group I (single implant retained mandibular overdentures)

Factor	Parameter	Implant placed	1st month	3rd Month (implant load)	4th month	6th month
Crestal bone loss (mm)	Mean	0.00	0.34	0.52	0.57	0.70
	SD	0.00	0.16	0.12	0.07	0.06
	Min	0.00	0.07	0.37	0.46	0.62
	Max	0.00	0.50	0.70	0.70	0.78

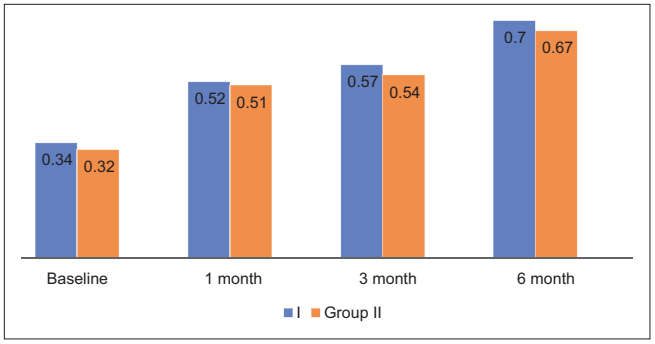
Table 2: Crestal Bone loss in Group II (two implant retained mandibular overdentures)

Factor	Parameter	Implant placed	1st month	3rd month (implant load)	4th month	6th month
Crestal bone loss (mm)	Mean	0.00	0.32	0.51	0.54	0.67
	SD	0.00	0.12	0.13	0.06	0.05
	Min	0.00	0.06	0.37	0.46	0.60
	Max	0.00	0.49	0.68	0.68	0.72

Table 3: Comparative evaluation of Group I versus Group II

Follow-up periods	Group I (Mean±SD)	Group II (Mean±SD)	*P* value
Baseline	(0.34±0.16)	(0.32±0.51)	>0.05
1 month	(0.52±0.12)	(0.51±0.13)	>0.05
3 month	(0.57±0.70)	(0.54±0.06)	>0.05
6 month	(0.70±0.06)	(0.67±0.05)	>0.05

P value was statistically non-significant



Graph 1: Graphical comparison of crestal bone loss Group I versus Group II

the midline, and at the same level, and failure of one may lead to unequal stresses on the other. These are avoided in case of a single implant–retained overdentures. According to Tokuhisa *et al.,* the use of ball O-ring attachment could be advantages for implant-supported overdentures about optimizing stress and minimizing denture movement in comparison to bar attachment and magnets.[8]

The longevity of dental implants is highly dependent on integration between implant components and oral tissues, including hard and soft tissues. Initial breakdown of the implant-tissue interface generally begins at the crestal region in successfully osseointegrated endosseous implants. Many possible etiologies of early crestal bone loss around implants (from implant placement to 1-year post-loading) including surgical trauma, occlusal overload, peri-implantitis, the presence of microgap, reformation of biologic width, implant crest module, and others have been proposed. However, the location of dental implants, whether subcrestal or supracrestal, is still becoming an increasing importance for researchers.

Submerged titanium implants had 0.9 to 1.6 mm marginal bone loss from the first thread by the end of the first year in function, while only 0.05 to 0.13 mm bone loss occurred after the first year. Based on the findings on submerged implants, Albrektsson *et al.* proposed criteria for implant success, including a vertical bone loss of less than 0.2 mm annually following the implant's first year of function.[9] F. Vafaee *et al.* in their study found that marginal bone loss was 0.5 mm at the end of 6 months in single implant–retained mandibular overdenture.[10] Studies reported that radiographic measurement of crestal bone loss by intraoral periapical (IOPA) radiographs are subject to change at each appointment. Previous studies like Ji-Hoon described a conventional technique to assess crestal bone changes by measuring the distance between the first screw thread of the endosseous implant to the top of the alveolar crest.[11] The main disadvantage of this technique is to precisely measure crestal bone loss as the distance is very small to calculate between those two points.

To minimize inconsistencies and measurement errors, Pravin Kumar G. Patil and Smita Nimbalkar proposed a method to measure the radiographic crestal bone level from the tip of the implant body to the top of the alveolar crest instead of the first thread of the implant to the alveolar crest, as the distance between the first thread and alveolar crest was much less and could not be measured precisely.[12]

Finding and observations of our study is in accordance with observations made by A.J. Flichy Fernandej *et al.* which shows that after 6 months, bone loss was 0.80 ± 1.04 mm on mesial side and 0.73 ± 1.08 mm on distal side, while after 12 months, bone loss was 0.92 ± 1.02 mesially and 0.87 ± 1.01 distally.[13] The observation made in the study by F. Vafaee *et al.* which was 0.5 mm at the end of 6 months is also comparable to our study. The findings in the study of Guruprasad for crestal bone loss was 0.74 mm which supports the finding of our study.[14]

Batista *et al.* conducted a systematic review and meta-analysis and found that single implant mandibular overdenture with a complete denture as the opposing arch may be considered an alternative treatment for completely edentulous patients.[15]

Conclusion

The study results showed no significant difference in crestal bone loss in the two groups suggesting two implant systems can be replaced by single implant–supported overdentures in cases of low single implant–retained mandibular overdentures could be used as another alternative treatment option for completely edentulous elderly patients with severely resorbed ridges and financially and systemically compromised conditions. The scope of single implant–retained overdentures can be a promising alternative for patients with an atrophic mandible, systemically compromised patients with financial difficulties.[16] We can conclude that the single implant–supported overdentures is a good treatment option for severely resorbed, financially and systemically compromised completely edentulous patients of developing countries like us. The limitation of this study was small sample size with short duration of 6 months follow-up period.

Future perspectives

There is a need for further studies with a greater number of sample size and longer duration follow-up, to confirm the results of this study for measuring and calculating crestal bone loss in single implant–supported overdentures.

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Conflicts of interest

There are no conflicts of interest.

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