

Effect of neutral zone technique on marginal bone loss around implant-supported overdentures

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Abstract

Aim: The aim of this study was to compare changes in marginal bone height around immediately loaded implants supporting a mandibular overdenture constructed according to the neutral zone technique with changes around overdentures constructed according to the conventional methods. **Materials and Methods:** Twelve completely edentulous male patients were randomly allocated to two equal groups of patients. Patients in the first group received conventionally constructed complete dentures and patients in the second group received complete dentures constructed using the neutral zone record. All the patients received two single-piece titanium implants placed bilaterally in the mandibular canine regions using flapless surgery, which were then immediately loaded by the dentures. Marginal bone height was radiographically evaluated at baseline and 6, 12, and 18 months after implant loading. **Results:** There was a significant loss in marginal bone height around the supporting implants in each study group. However, no significant differences in marginal bone height were recorded between the study groups over the observation period ($P > 0.05$). **Conclusion:** Marginal bone height changes induced by overdentures constructed with neutral zone technique on immediately loaded implants are not different from those changes induced by overdentures constructed with a conventional method.

Key words: Immediate loading, implant, neutral zone, overdenture

INTRODUCTION

When a decision is made to restore the edentulous mouth, various treatment options are available. These include: Conventional complete dentures, implant-supported overdentures (ISOs) and implant-supported fixed prostheses.

While restoration of the edentulous mouth with conventional complete dentures was associated with a number of problems related mainly to denture stability and overall satisfaction,^[1,2] rehabilitation of

the edentulous mouth with implant-supported fixed prostheses is associated with higher costs coupled with surgical and technical complexities. This may be considered a barrier for the wide clinical application of full-arch implant-supported fixed prostheses, despite their superior outcome in terms of oral function, patient satisfaction, and oral health-related quality of life.^[3]

The provision of conventional maxillary complete denture and ISO in the mandible was found to be a predictable treatment option that can satisfy the

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functional and esthetic needs of a large proportion of completely edentulous subjects.^[4-6] Improved denture retention, enhanced denture stability, better chewing function, greater biting force, and increased patient satisfaction are some of the advantages that can be gained from treatment with ISOs compared to conventional dentures.^[7,8] This is coupled with realistic costs and relatively limited surgical and restorative procedures. The introduction of immediate loading concept of dental implants has added another value to the option of ISOs, where speedy restorative procedures can enhance the positive response of edentulous patients to treatment with ISOs.

Though the clinical success of ISOs is dependent on a number of factors, it can be argued that successful treatment outcome with ISOs is highly related to the existence of harmonious relationship between the prosthetic superstructure and its supporting implants. Faulty prosthetic construction may generate unfavorable torque forces upon the supporting implants and could disrupt their osseointegration.^[9] Theoretically, minimizing the amount of unfavorable torque forces affecting the denture can be achieved by carefully shaping the polished surfaces and appropriate arrangement of the artificial teeth, so that the surrounding musculature tends to stabilize the denture during function. This refers to the neutral zone concept that can be utilized during the construction of complete dentures.^[10,11] It was first described by Wilfred Fish in 1931.^[12] The neutral zone philosophy is based upon the concept that within the denture space, there is a specific area for each individual patient where the function of the musculature will not unseat the denture and the forces generated by the tongue are neutralized by the forces generated by the lips and cheeks.^[13] Positioning artificial teeth in the neutral zone achieves two objectives. First, the teeth will not interfere with the normal muscular function and second, the forces exerted by the musculature against the dentures are more favorable for stability and retention.^[13] Various techniques were proposed to record the neutral zone in the edentulous mouth.^[10,11] However, regardless of the technique used, the literature lacks any information about the effect of neutral zone record on bone response around dental implants supporting an overdenture. This is despite both the neutral zone concept and the ISO treatment modality being relatively old.

The aim of this study was to observe the changes in marginal bone height around immediately loaded implants supporting a mandibular overdenture constructed according to the neutral zone technique

and to compare these changes with those around ISOs constructed according to the conventional methods.

The examined hypothesis was: There is no difference in marginal bone loss around immediately loaded implants supporting mandibular overdentures constructed according to the neutral zone concept and around immediately loaded implants supporting conventionally constructed mandibular overdentures.

MATERIALS AND METHODS

This study was approved by the Scientific Committee of the Faculty of Dentistry, Suez Canal University, Ismailia, Egypt.

Twelve completely edentulous patients were selected from the Prosthodontic Department, Faculty of Dentistry, Suez Canal University. Before enrollment, all patients were explained the objectives, implications, and possible complications of this clinical trial and invited to participate by signing an informed consent.

Inclusion criteria

Patients fulfilling the following criteria were eligible for inclusion in the study:

- Men aged between 50 and 65 years
- Patient being able to understand and cooperate with the requirements of the study
- Angel's class I jaw relation
- Patient with normal tongue size and behavior
- Patient with adequate interarch space (about 12 mm between the soft tissues and the occlusal plane)
- Patient with enough bone for an implant length of 13 mm and a diameter of 3.4 mm, which was assessed clinically and radiographically.

Exclusion criteria

Smokers, drug or alcohol addicts, those with any health condition precluding surgery, physical reasons that could affect follow-up, or psychiatric problems, and those who had undergone radiotherapy to the head and neck that may affect the implant area were excluded.

Grouping of patients

Patients were randomly allocated to two equal treatment groups, with six patients in each group as follows:

Group A: The patients received a maxillary complete denture and a mandibular overdenture constructed in a conventional method on immediately loaded implants

Group B: The patients received a maxillary complete denture and a mandibular overdenture constructed according to the neutral zone technique on immediately loaded implants.

Construction of the dentures

Dentures for patients in group A were constructed following the conventional clinical methods according to the guidelines of the British Society for the Study of Prosthetic Dentistry.^[14] Arrangement of cross-linked acrylic resin anatomic teeth (Acrostone Plus, Cairo, Egypt) was made on the center of ridge crest, on an average value articulator, and balanced occlusion was achieved. The polished surface contour was developed using conventional waxing method and its principles.

For patients in group B, the dentures were constructed according to the neutral zone record, by which the position of the posterior teeth and the polished surface contour were determined as follows:

- After jaw relation record was made, the casts were mounted on the articulator. The occlusion blocks were then removed and kept aside
- Trial denture bases made of self-curing acrylic resin were constructed on the mounted upper and lower casts
- Three wire loops were made of 0.9 mm gauge stainless steel wire and fixed in each denture base over the crest of the ridge before setting of the acrylic resin. The first loop was placed in the anterior region and the other two were positioned in the first molar region in each side
- Low fusing modeling impression compound (Hiflix, Prevest Denpro Limited, Delhi, India) was softened and attached to the wire loops in the mandibular trial denture base. The trial denture base was then carefully seated in the patient's mouth, who was instructed to swallow and then purse the lips as in sucking, till a satisfactory record of the neutral zone was obtained
- The same steps were repeated to record the neutral zone for the maxillary arch
- Then the denture bases with the neutral zone record were resealed on the articulator, and two v-shaped notches were cut on the occlusal surface of the maxillary compound rim to fit two pyramidal projections built up on the mandibular rim to preserve the centric occluding relation previously recorded. The compound of the neutral zone record was then reduced both buccally and lingually, leaving only its middle third
- Sufficient amount of zinc oxide and eugenol impression material (Cavex Outline, BV Holland,

Haarlem, Netherlands) was thoroughly mixed and applied to the mandibular compound rim and the external surfaces of the denture base. The denture base was then placed in the patient's, mouth who was asked to do the same functional movements as previously described to record the neutral zone

- The same procedure was repeated with the maxillary record base
- Afterward, the patient was instructed to close in centric relation guided by the pyramidal projections and the v-shaped notches. Then the patient was asked to do the previously mentioned functional movements, and not to open his mouth till the zinc oxide and eugenol impression material sets
- After setting of the impression material, the maxillary and mandibular record bases were removed from the patient's mouth as one unit and replaced on the articulator
- Plaster matrices were formed around the record bases, and the teeth were arranged within the space created. Teeth type, occlusal scheme, and occlusal concept were the same used in group A patients. After try-in, waxing up was done to fit the inner surfaces of the plaster matrices; then the denture was processed and delivered to the patient.

Implant placement

For every patient, the lower denture was duplicated into a transparent acrylic template, in which two metal balls were inserted, to be used as a radiographic stent to determine the implant site and the bone height in the canine area after taking a panoramic radiograph. Also, a graduated periodontal probe under local anesthesia was used to map the bone width in the selected area.

Each patient received two root form titanium implants [TUT Dental implants; Egyptian Co. for Dental Implants (ECDI), Cairo, Egypt]. The used implants had the following features: Single piece with ball and socket, having O-ring attachment system, threaded, sandblasted, 3.4 mm in diameter, and 13 mm in length.

Flapless surgery was performed to insert the implants in the canine region in both sides. Then, the lower denture was delivered after modification and application of soft lining material (Acrostone, Relining material; Acrostone Dental Factory, Cairo, Egypt). Patients were instructed to chew soft food and follow oral hygiene measures. After 10 days, the soft liner was removed and the O-ring attachments with their keepers were attached to their ball abutment, and picked up directly to the fitting surface of the lower denture using self-cure acrylic resin, while the patient was closing in centric position.

The denture was checked in the patient's mouth for occlusion and pressure areas. Before discharge, patients were motivated to maintain hygiene of their implants and dentures, and were asked to attend successive follow-up visits for evaluation.

Evaluation of the marginal bone height changes

Each patient in both groups was evaluated radiographically immediately after implant loading and at 6, 12, and 18 months after implant loading using direct digital panoramic machine (Curix 242 S; Agfa-Gevaert N.V., Mortsels, Belgium) [Figure 1]. This method is used by many authors to assess changes in bone height around ISOs.^[15-17]

The exposure parameters were considered fixed for all patients at 78 kV and 16 mA for 15 s to assess the radiometric marginal bony changes around the implants.

The panoramic images were analyzed radiometrically using Digora software (Soredex Medical System, Helsinki, Finland). The mesial and distal alveolar bone height around each implant (linear measurement) was recorded as follows:

- Two lines were drawn (mesial and distal) parallel to the long axis of the implant, extending from the apical end of the implant to the crest of the alveolar bone [Figure 1]
- The actual bone height mesial and distal to the implant was determined by applying a distortion coefficient:

$$\text{Actual bone height} = \frac{\text{Actual implant length} \times \text{radiographic bone height}}{\text{Radiographic implant length}}$$

- The mean of the mesial and distal bone height was measured, and the changes in bone height between different intervals were calculated by subtracting

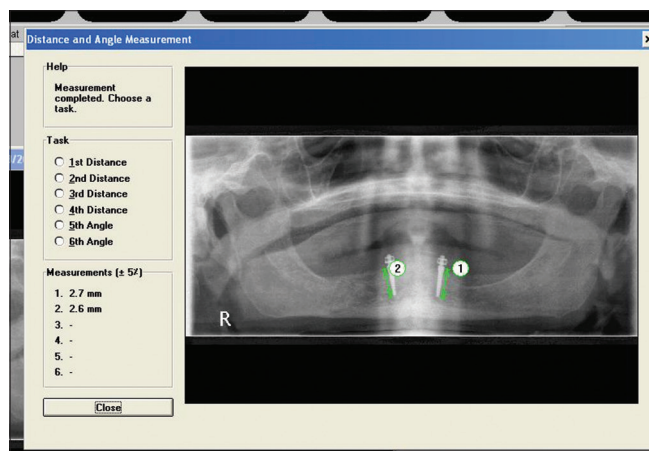


Figure 1: Digora software for measuring peri-implant bone height

the bone height that was measured at the follow-up from the preceding measurement.

Statistical analysis

The recorded measurements were tabulated and analyzed using the SPSS statistical package (version 15). Differences in bone height values within each study group over the follow-up intervals were evaluated using paired *t*-test. The *t*-test for independent samples was used to compare bone height values between both study groups during the study period. The significance level was set at 0.05.

RESULTS

The flow diagram of this clinical study is given in Figure 2.

During the observation period, no implants were lost, but there was a continuous reduction in the marginal bone height around the implants throughout the period of the study for both groups.

Table 1 shows a significant loss in marginal bone height between different intervals of the follow-up period in group A. Similarly, Table 2 illustrates significant loss in marginal bone height between different intervals of the follow-up period in group B.

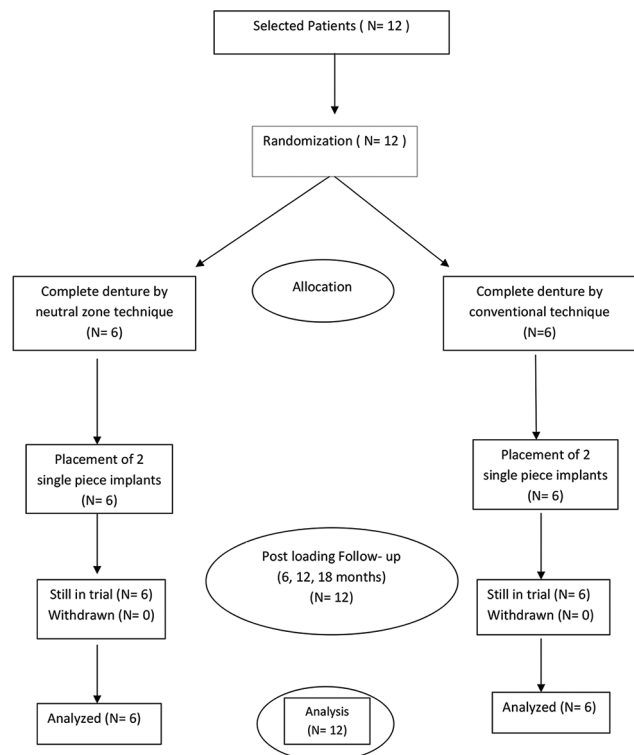


Figure 2: Flow diagram of the clinical study

Table 3 presents a comparison of the mean reduction in bone height at different study intervals between the conventional group A and the neutral zone group B. The differences between the study groups were not significant at the different intervals of the follow-up periods ($P > 0.05$).

DISCUSSION

Ideally, the goal of any prosthetic dental treatment is to provide a durable and satisfactory prosthesis that maintains the health of the supporting/surrounding oral/dental structures. Thus, factors that may affect the long-term osseointegration of the dental implants supporting and retaining the overdentures are worth investigating. This study was designed to examine the impact of neutral zone technique as a denture stabilization factor on bone response around ISOs.

Table 1: Bone height changes (in mm) at different intervals of the follow-up period for group A (overdentures constructed with conventional technique)

	0-6 months	6-12 months	12-18 months	0-18 months
Mean difference	0.475	0.333	0.351	1.159
Mean % changes	3.6	2.6	2.8	9.3
SD	0.08	0.10	0.14	0.10
P value	0.001*	0.0002*	0.0004*	0.0004*

SD=Standard deviation. *Significant ($P < 0.05$)

Table 2: Bone height changes (in mm) at different intervals of the follow-up period for group B (overdentures constructed with neutral zone technique)

	0-6 months	6-12 months	12-18 months	0-18 months
Mean difference	0.4540	0.2740	0.3980	1.126
Mean % changes	3.5%	2.3%	3.4%	9.5%
SD	0.08	0.09	0.09	0.10
P value	0.001*	0.0002*	0.0002*	0.0003*

SD=Standard deviation. *Significant ($P < 0.05$)

Table 3: Comparison of the bone height changes (in mm) between the study groups (A and B), at different intervals of the follow-up period

	0-6 months	6-12 months	12-18 months	0-18 months
Unpaired <i>t</i> -test (difference between groups A and B)	1.028	0.9276	0.9126	0.9219
P value	0.3103 (ns)	0.3595 (ns)	0.3672 (ns)	0.3624 (ns)

ns=Non-significant ($P > 0.05$)

The outcome measure was changes in marginal bone height around ISOs constructed with the neutral zone technique in comparison with that around conventionally constructed ISOs. The rate of bone loss around dental implants is an important indicator of a successful osseointegration. Adell *et al.*^[18] indicated that mean bone loss for implants should not exceed 1.5 mm for the first year and 0.1 mm per year following that. In a literature review about the outcome of implant inserted in a flapless surgery, the mean radiographic bone loss for the successful implants ranged from 0.7 to 2.6 mm after 1 year of implant placement.^[19] The findings of this clinical study show that mean radiographic bone loss in both study groups was within the normal range after 18 months observation time. Also, the rate of bone loss around immediately loaded implants supporting conventionally constructed mandibular overdentures was similar to that around immediately loaded implants supporting mandibular overdentures constructed according to the neutral zone concept. It seems that the application of the conventional measures in the construction of ISOs is sufficient to produce a favorable bone response around the supporting implants.

A review of the literature shows that many factors can be implicated in the reduction of bone around dental implants. These include surgical trauma during drilling, forced tightening of implants upon installation, covering the gingival margins around the implant, excessive functional and masticatory forces upon the implants, and faulty prosthetic superstructure.^[20]

A possible explanation for our results is that a flapless surgical protocol was followed to reduce the amount of surgical trauma. Moreover, patients in both groups were subjected to periodical recall visits and instructed to follow high levels of oral hygiene. Also, patients with risk factors for developing peri-implant diseases were not selected for this trial.^[21] Furthermore, a measure to reduce the displacement forces affecting the overdentures was implemented in both study groups. The artificial teeth in the conventionally constructed overdentures were arranged on the crest of the ridge and the polished surfaces were made concave according to the traditional well-known principles of waxing-up removable dentures. On the other hand, overdentures in the second group were made according to the neutral zone concept. Moreover, the retention elements for the overdentures in both study groups were ball attachments. Such type of implant attachment provided a long-term favorable marginal bone loss around overdentures supported by two implants in the mandible.^[22,23]

Rehmann *et al.*^[24] indicated that despite the expected benefit of the neutral zone technique for the function and stability of the complete denture, it cannot be recommended for routine clinical application. This is because of the relatively complex procedures associated with its application and the need for a sufficiently skillful practitioner and a cooperative patient. Our results are in line with this view. It can be argued that there is no clear added value in terms of bone response around ISOs to prefer the use of the neutral zone technique over the conventional technique in the construction of mandibular ISOs.

A limitation of this study is that the sample size was relatively small. Also, the study comprised only male patients and the observation period was limited to 18 months following implant insertion. Further research that considers these limitations is recommended to confirm our findings.

CONCLUSION

By taking the limitations of this study into consideration, it can be concluded that marginal bone height changes induced by overdentures constructed with neutral zone technique on immediately loaded implants are not different from those changes induced by overdentures constructed with a conventional method.

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Conflicts of interest

There are no conflicts of interest.

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