

## Comparative study on the qualities of dentures fabricated by neutral zone concept and conventional method in atrophic mandibular ridges

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### Abstract

The unstable mandibular complete denture is usually associated with an atrophic ridge, where the prosthetic rehabilitation of a patient is the most challenging for a prosthodontist. One of the methods used to solve this problem is neutral zone concept. Artificial teeth and denture base should be in proper position within the neutral zone where the displacing forces of the lips, cheeks, and tongue are in balance. The aim of this study is to compare tooth positions, the qualities of dentures such as retention, stability and patient satisfaction between dentures fabricated by neutral zone concept (neutral zone denture) and conventional method (conventional denture). Fourteen completely edentulous patients with moderate to severely resorbed ridges were selected. Two dentures were constructed using different methods: one by neutral zone impression making and the other by conventional mean. Tooth positions of both dentures were determined by measuring the distance between radiographic images of two wires which were adapted along the crest of the ridges and lingual fossae of the anterior teeth

and central fossae of the posterior teeth by using a digital slide caliper. The retention and stability of each denture were measured by using a Push-Pull Gauge at the time of denture delivery. Patient satisfaction with mandibular dentures was assessed by Modified Smith's Questionnaire method after two weeks. The results showed that tooth positions of neutral zone dentures were not as far away from the crest of the ridge as that of conventional dentures in all regions (anterior, left and right premolars, and left and right molars) and there were significant in left premolar, right premolar and right molar regions ( $p < 0.05$ ). Neutral zone dentures were significantly more retentive, stable and higher scores of patient satisfaction than conventional dentures ( $p < 0.05$ ). Application of neutral zone concept and neutral zone impression making is crucial in mandibular complete denture construction for atrophic ridges.

### Introduction

For a prosthodontist, poor retention and stability of complete denture is a common problem in patients with atrophic alveolar ridge. This problem is more common with mandibular

complete dentures. This is because the mandible atrophies at a greater rate than the maxilla and has less denture bearing area for retention and support [1]. The reduction of the mandible is particularly marked, being approximately four times as great as that of the upper ridge [2].

Bone is constantly remodelled and following loss of teeth, resorption of the alveolar ridge occurs. Alveolar bone may resorb until only basal bone remains. Moreover, the residual alveolar ridge will not remain in the same antero-posterior and medio-lateral position. MacGregor (1989) [3] stated that in the mandible, bone resorption occurs from both buccal and lingual sides in a downwards direction, more from the lingual side in molar region and more from the labial side in incisor region. In conventional dentures, artificial teeth are arranged in accordance with bone resorption pattern.

The eruption of the teeth in the oral cavity is not only determined by its genetic factor but also influenced by the forces exerted by tongue, cheeks and lips. These muscular forces collectively determine the final dental arch form and position of the tooth in the oral cavity. This muscular environment continues throughout life, even after teeth have been lost and greatly influences the potential denture space [4]. The tongue in an edentulous mouth has a tendency to expand and encroach on to the potential denture space. Sir Wilfred Fish called this potential space as the "Dead Space" [5] and later known as the neutral zone.

According to the Glossary of Prosthodontic Terms (2017) [6], the neutral zone is defined as "The potential space between the lips and cheeks on one side and tongue on the other; that area or position where the forces between the tongue and cheeks or lips are

equal".

Beresin and Schiesser (1976) [7] have suggested that the artificial teeth should be arranged in the neutral zone. The success of any prosthesis depends on the proper position of the artificial teeth within the neutral zone. Incorrect tooth placement and arbitrary shaping of the polished surfaces may have an adverse effect on the success of the complete denture. Neutral zone impression technique is used for recording neutral zone where during function the forces of the tongue pressing outward are neutralized by the forces of cheek and lips pressing inward. The main displacing forces acting on a mandibular complete denture come from the tongue, the lower lip and the modiolus [8]. The neutral zone technique is used to minimize the displacing forces of the surrounding structures.

By using neutral zone technique, the denture will improve retention and stability and posterior teeth will be correctly positioned allowing sufficient tongue space. Moreover, arrangement of artificial teeth in neutral zone and polished surface design which are in harmony with the surrounding muscles will give rise to a physiologically acceptable denture base volume and makes the patient more comfort.

### **Material and methods**

Fourteen completely edentulous patients with the age of 55 years and above, moderate to severely resorbed ridge with at least six months of edentulism attending the Department of Prosthodontics, University of Dental Medicine, Yangon were selected. For every patient, two sets of denture were fabricated using neutral zone concept and conventional method.

### **Denture Fabrication Procedure**

Primary impressions were made with irreversible hydrocolloid impression material. Closed fitting special trays were fabricated for peripheral tracing with thermoplastic green stick composition and wash impression with zinc oxide impression paste.

Two sets of maxillary and mandibular cast were prepared for fabrication of dentures by neutral zone concept and conventional method. Another two mandibular casts were prepared for radiographic assessments of tooth positions.

### **Fabrication of Denture by Conventional Method**

First set of maxillary and mandibular casts was used for the fabrication of denture by conventional method. In this method, artificial teeth should be arranged according to conventional means.

### **Fabrication of Denture by Neutral Zone Concept**

The second set of maxillary and mandibular casts was used for the fabrication of the denture by the neutral zone concept. Self cure acrylic resin record base and wax occlusal rim was fabricated on the maxillary cast. A record base with T-shaped occlusal stopper (one on anterior and two on molar regions with notches) was fabricated on the mandibular cast. The stoppers maintained the already established occluded vertical dimension and also helped in engaging the impression compound material by means of mechanical retention.

For recording neutral zone, a small amount of the impression compound was softened, rolled and attached over the mandibular record base. It was lightly manipulated on the labial, buccal and lingual slopes. The record base was seated firmly over

the ridge and the patient was instructed to perform functional movements such as tongue protrusion, swallowing, sucking and moving lips and cheeks several times until the compound was hardened.

The record base was removed from the patient's mouth, and the excess compound was trimmed from the superior surface until the stoppers were exposed. The compound was re-softened and the functional movements were carried out until satisfactory retention, stability and comfort had been obtained. This potential space obtained by making functional movements became a neutral zone [9].

Condensation silicone putty consistency impression material was manipulated and adapted to the labial, buccal and lingual surfaces of the neutral zone impression. This impression was removed and reassembled the labial, buccal and lingual putty indices after applying separating medium on the inner surfaces of the indices. The space was filled with molten modeling wax.

Artificial teeth were arranged in such a way that central fossae of the posterior teeth and lingual fossae of the anterior teeth were exactly in centre of the neutral zone space. The superior surface of the putty indices and maxillary occlusal rim were used as a guide to maintain an occlusal plane. Only cervical curving was done without doing a waxing up. Maxillary teeth were set according to mandibular teeth.

### **Determination of tooth position**

To determine and compare tooth positions, a linear depression was created over the ridge crest of cast of conventional denture and 0.4 mm stainless steel wire was adapted and stabilized along that depression. After that, corresponding conventional denture was placed on the cast. And then, 0.4 mm stainless

steel wire was stabilized along the line joining the central fossae of the posterior and lingual fossae of the anterior denture teeth. Same procedure was made for neutral zone denture.

Both casts with their dentures were placed on the x-ray films at a distance of 90 cm or 3 feet from the source and an occlusal view was obtained. For the calculation of the error between the original object and the x-ray image, a metal ball of a known diameter was placed on the x-ray film while taking the radiograph [9].

After radiographic evaluation of tooth positions of both dentures, distances between the two images of wires for each denture were measured by using digital slide caliper. Where the two images (long wire on ridge and short wire on fossae) coincided, a zero score was assigned, whereas buccal and labial locations of short wires were assigned a positive, lingual locations of short wires were assigned a negative.

### **Measuring retention and stability**

The retention and stability of mandibular dentures was measured quantitatively by using a force gauge Analog Push-Pull Gauge at the time of denture delivery.

### **Assessment of patient satisfaction**

After the patients had worn the dentures for two weeks, the patients were asked questionnaires concerning their satisfaction with mandibular dentures by using Modified Smith's Questionnaire method [10].

### **Results**

Mean values of tooth positions of neutral zone dentures are less than that of conventional dentures in all regions of dentures and there were significant differences at left premolar, right premolar and right molar regions of

dentures ( $p < 0.05$ ) and comparison of mean tooth positions at different regions between two types of mandibular denture is shown in figure 7.

Mean value of retention of neutral zone dentures is 1.10 and mean value of retention of conventional dentures is 0.91. Neutral zone dentures were significantly more retentive than conventional dentures ( $p < 0.05$ ) and comparison of mean retention between two types of mandibular denture is shown in figure 8.

Mean value of stability of neutral zone dentures is significantly more than that of conventional dentures. Neutral zone dentures were significantly more stable than conventional dentures ( $p < 0.05$ ) and comparison of mean stability between two types of mandibular denture is shown in figure 9.

Higher score values of patient satisfaction are found in neutral zone dentures as compared to conventional dentures ( $p < 0.05$ ). For neutral zone dentures, out of 14 edentulous subjects, 11 (78.6%) subjects were very satisfied with their dentures while 3 (21.4%) were satisfied. However, for conventional dentures, out of 14 edentulous subjects, only 5 (35.7%) subjects were very satisfied with their dentures while 9 (64.3%) were satisfied and comparison of patient satisfaction (highest score) between two types of denture is shown in figure 10.

### **Discussion**

The ultimate goal of complete denture treatment is to restore the form, function, and esthetics of the patient. To achieve basic requirements such as masticatory efficiency, comfort, esthetics, a complete denture should be retentive and stable. When the alveolar ridge is favorable and not severely resorbed, it is not a great concern in order to obtain good denture retention and stability. However, in a severely

resorbed ridge, rehabilitation of a patient with a complete denture therapy is the most challenging.

Fish (1933) [5] described a denture have three surfaces namely, impression surface, occlusal surface and polished surface. Beresin and Schiesser (1973) [11] indicated that the more the ridge loss, the less the area of the denture base and the less the influence the impression surface area will have on the stability and retention of the denture. The denture stability and retention are more dependent on correct position of the teeth and contour of the polished surface of the denture.

The dental profession has been more emphasized on the impression and the occlusal surfaces than polished surface. In other words, the dental profession has always been concerned with the vertical forces and has ignored the importance of horizontal forces exerted on the polished surface of the denture [11].

The neutral zone concept and neutral zone impression technique is not new to our dental profession, but this impression technique is not widely used in clinical practice. This study evaluated the usefulness of the neutral zone concept in complete denture treatment of patients with severely resorbed ridges.

In comparing tooth positions, tooth positions of neutral zone dentures were not as far away from the crest of the ridge as that of conventional dentures in all regions. In left premolar, right premolar and right molar regions, there were significant differences.

In molar regions, tooth positions of neutral zone dentures were not as far lingually as that of conventional dentures, and results in providing more tongue space. During function, the position of the teeth is more critical. If the

anterior and posterior teeth are set lingually, the tongue will be cramped and the denture will be displaced during function. There must be sufficient tongue space to allow for movement.

Rilandi and Sharry (1963) [12] pointed out that the tongue increases in size about 10% in edentulous patients if they are not provided with complete dentures. Furthermore, Wright (cited in Faber, 1992) [13] stated that if the sizes of the mandibular teeth are too large, or if the posterior teeth are set even 1 mm lingual, the tongue is deprived of approximately 1000 mm<sup>3</sup> of its functional space and if the mandibular anterior teeth are moved 1 mm lingually, the tongue will lose 100 mm<sup>3</sup> of functional space. In this study, the mean value difference between neutral zone and conventional dentures was 1.25 mm in right molar region and this 1.25 mm lingual positioning of the posterior teeth in the conventional dentures would surely encroach on to the tongue space.

The orbicularis oris, caninus, zygomaticus muscle, quadratus muscle, risorius muscle and mentalis which meet at the modiolus play an important role in denture stability. In premolar regions, tooth positions of neutral zone dentures were more directly on the crest of the ridge than that of conventional dentures. It allowed the modiolus muscles which are located at the angle of the mouth to be move freely without interfering the stability of the denture.

In the anterior regions, tooth positions of conventional dentures were slightly more labial to the crest of the ridge than that of neutral zone dentures but there was no significant difference. In the highly atrophic mandible, positioning of the anterior teeth can be problematic. The movement and interaction of the lip and the tongue determines the position of the lower

anterior teeth. If they are positioned too far labially the contraction of the lip will displace the denture posteriorly.

In comparing retention and stability, neutral zone dentures were significantly more retentive and stable than that of conventional dentures. Arrangement of artificial teeth in the neutral zone and correctly contouring of the polished surface made the denture more stable. Together with the result of increasing stability, neutral zone dentures may become more retentive. This is because the proper polished surface designs of neutral zone dentures incorporate the mechanical, biologic and physical factors of denture retention and also maximize the retentive potential of the functioning orofacial musculature. On the other hand, the lack of stability often makes ineffective the factors involved in retention [14].

When comparing patient satisfaction, there was significant association between patient satisfaction and different types of mandibular denture. Higher score values of patient satisfaction were found in neutral zone dentures as compared to conventional dentures. Arrangement of artificial teeth in the neutral zone and physiologically acceptable polished surface design of the denture gave the patient a more stable denture and made the patient more comfort. A more stable and comfort denture improved the chewing ability of the patients with their dentures. This is the reason that the patients were more satisfied with their neutral zone dentures rather than conventional dentures.

### **Conclusion**

According to the results of this study, the qualities of dentures fabricated by neutral zone concept are generally greater as compared to those fabricated by conventional method.

Many practitioners seem to be believed that the neutral zone impression not only needs to adjust extra costs for material used but also more chair-side time in the clinic. In fact, to record neutral zone, impression compound can be used which is also familiar to a general practitioner and its manipulation is very easy and no additional visit requires as it can be done in all together with jaw relations registration procedure. Therefore, application of neutral zone concept and neutral zone impression making is crucial in mandibular complete denture construction for atrophic ridges.

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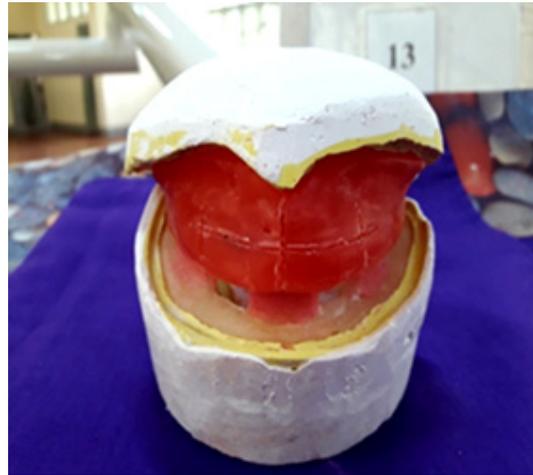


Figure 1. A record base for neutral zone impression on the mandibular cast



Figure 2. Neutral zone impression



Figure 3. Neutral zone impression with putty indices



Figure 5. Artificial teeth arrangement in neutral zone



Figure 4. Potential denture space within putty indices

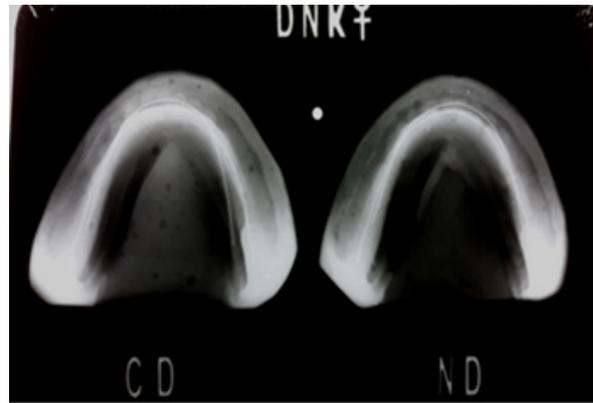


Figure 6. Radiographic assessment of tooth positions (relationship of the crest of the residual ridge to central fossae of the posterior teeth and lingual fossae of the anterior teeth)

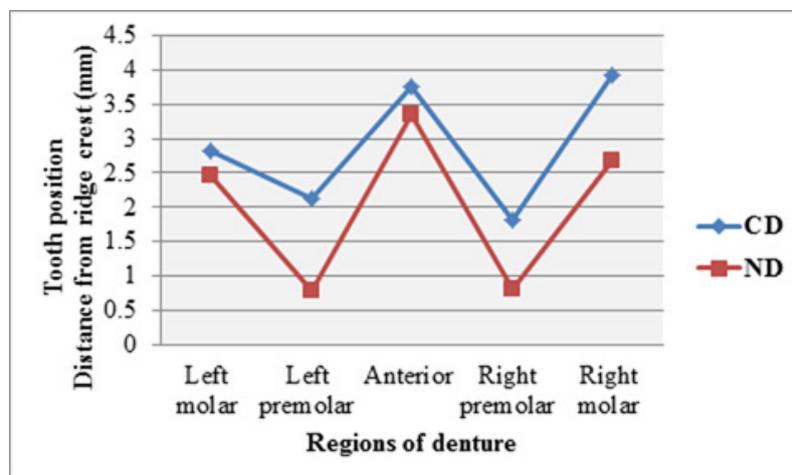


Figure 7. Comparison of mean tooth positions at different regions between mandibular dentures fabricated by neutral zone concept and conventional method

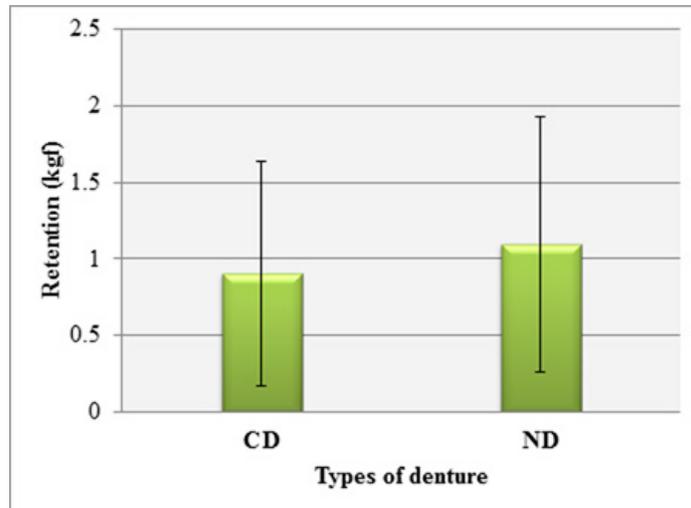


Figure 8. Comparison of mean retention between mandibular dentures fabricated by neutral zone concept and conventional method

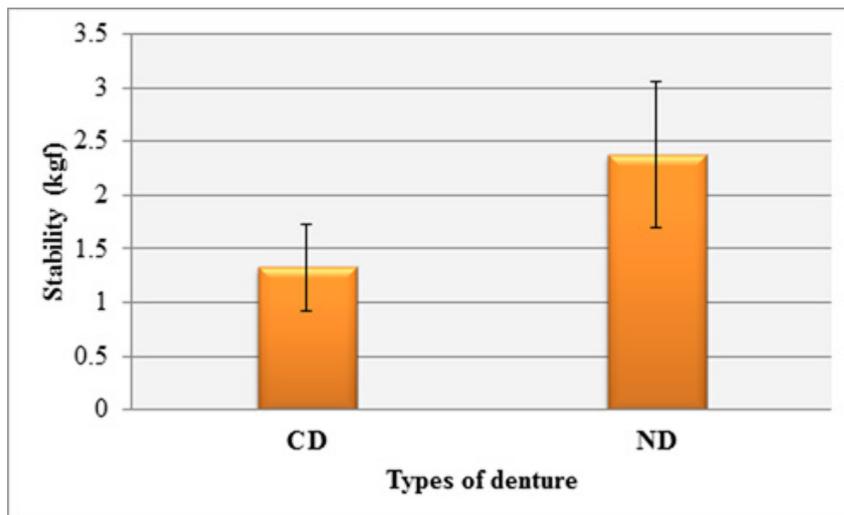


Figure 9. Comparison of mean stability between mandibular dentures fabricated by neutral zone concept and conventional method

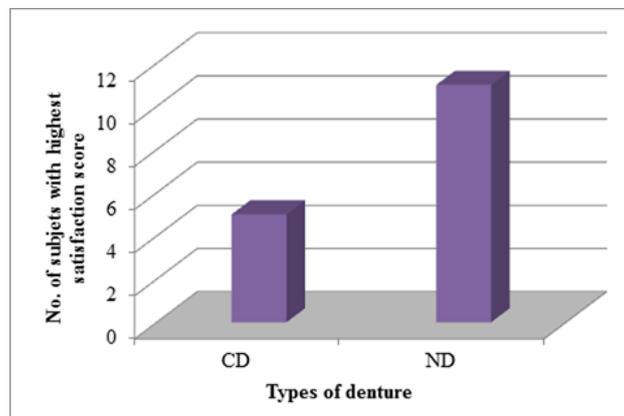


Figure 10. Comparison of patient satisfaction (highest score) between mandibular dentures fabricated by neutral zone concept and conventional method