Comparative Study Of Mandibular Dentures Made By Neutral Zone Concept With Conventional Mandibular Denture

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Citation

Abstract
Aim: To compare the relationship between the crest of the residual alveolar ridge, central fossa of the teeth, tissue surface area, volumes in conventional mandibular dentures and dentures made by using the neutral zone concept. Materials and methods: Ten edentulous patients were selected, aged between 50 to 60 yrs, with an edentulous period of six months, and mandibular ridges showing clinically moderate to severe ridge resorption. For every patient, two sets of dentures were fabricated. First set by the conventional method and the second set by the neutral zone concept. Three studies to evaluate the aim were carried out. Results: It was found that neutral zone moved lingual to the crest of the ridge in the anterior region, remained constant in the premolar regions and moved buccal to the crest of the ridge in the molar regions in the dentures made by the neutral zone concept. Increased tissue surface area and reduction in volume of the denture were also a finding. Conclusion: Neutral zone always moves according to the periods of edentulism, tonicity of the perioral musculatures and tongue. Arrangement of the teeth in neutral zone, increasing the impression surface area of the denture and reduction in the volume of the denture, provides good retention, stability and in addition to that it also provides more comfort to the patients.

INTRODUCTION
The loss of teeth, continuous resorption of residual ridge and force from the perioral musculature changes facial features. 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 “Neutral Zone” 1. 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. It is also referred to as the “Dead space” (or) “Zone of equilibrium” 2. It imposes a challenge to the prosthodontist in determining the correct tooth position to achieve optimal esthetics and functional needs of a denture for successful prosthodontic treatment. The positioning of the buccal cusps and fossae of the posterior teeth when directly over the crest of the ridge results in more stability and less lateral force since the pressure on the tooth falls close to the fulcrum and creates little or no torque 3. Leverage is a concern for the established concept of “teeth of the ridge” whereas the neutral zone considers muscular forces created during function 4. This study compares the relation between the crest of the ridge to the central fossa, the tissue surface areas and the volumes between dentures constructed by the conventional and neutral zone techniques.

MATERIALS AND METHODS
Ten patients between the age group of 50 to 60 years were selected based on the inclusion criteria which consisted of requirements such as six months of edentulism, completely healed ridges with clinically moderate to severely resorbed mandibles and absence of any pathological conditions. The materials used in this study were the basic armamentarium used to carry out the clinical and laboratory procedures in the fabrication of a denture. X-ray machine, pipette, beaker, water, tin foil, graph paper and 26 gauge stainless steel wire were used. The materials used were the same for every case thereby standardizing the technique. For every patient, two sets of dentures were fabricated using the conventional and the neutral zone concepts. The study involved three aspects namely; the relation between the crest of the ridge and central fossa, the tissue surface area contacting the residual ridge and the volume of the dentures.
FABRICATION OF THE CONVENTIONAL DENTURE

Maxillary and Mandibular primary impressions were made with addition silicon putty consistency material (Aquasil, DENTSPLY). Casts were made in dental stone and special trays were fabricated using self-cure acrylic resin (DPI, Cold cure). Border molding and secondary impression procedures were carried out with addition silicon putty consistency and medium body (Aquasil, DENTSPLY). Two sets of maxillary and mandibular casts were prepared. The first set of casts was used for the fabrication of conventional dentures. Self-cure acrylic record bases were fabricated and trimmed, following which wax (Hindustan Modeling Wax, India) occlusal rims were made and jaw relation recorded. Semi-anatomic teeth (Premadent, India) of appropriate size, shape and colour were selected and set by the lingualisation concept of occlusion. Once the teeth were set, the temporary record was tried in the patient’s mouth to evaluate aesthetics and occlusion. After the wax try in, a functional impression was made using the closed mouth technique, following which the denture was flasked and dewaxed. Two layers of separating (DPI, India) were applied, after which it was packed with heat cure acrylic resin (DPI, Heat cure). This packed material was bench cured, following a complete curing cycle and then cooled by bench cooling before deflasking. The fabricated dentures were trimmed, finished and polished. The dentures were inserted and checked for esthetics, comfort, speech, retention and stability. The patients were instructed to wear both the maxillary and mandibular dentures for 24 hours and then reviewed for sore spots and over extensions. Patients were instructed to use these conventional dentures for a week. After one week, the mandibular dentures were retrieved for one day for the purpose of this study.

FABRICATION OF OCCLUSAL RIM FOR THE NEUTRAL ZONE CONCEPT DENTURE

The second set of casts was used for the fabrication of dentures by the neutral zone concept. Occlusal rim were fabricated on the maxillary casts. A record base with T-shaped occlusal stoppers (one on anterior and two on molar regions with notches) were fabricated on the mandibular casts. The stoppers helped maintain the already established vertical dimension and also helped in engaging the impression compound material with the help of its undercuts. The conventional dentures were inserted to verify the vertical dimension at occlusion. The mandibular denture was removed and the record base with the stoppers was inserted and checked and adjusted for the same vertical dimension at occlusion and then removed.

RECORDING A NEUTRAL ZONE

A small amount of the Impression compound that was softened, rolled and attached over the mandibular record base was lightly manipulated on the labial, buccal and lingual slopes. The record base was seated firmly over the ridge and the patients were instructed to suck and swallow several times until the compound hardened (Figure 1).

Figure 1

After the compound cooled, the record base was removed from the patient’s mouth, and the excess compound was trimmed with a Bard and Parker blade from the superior surface. The compound was re-softened and the functional movements were carried out until satisfactory retention, stability and comfort were obtained. To check the retention and stability, the patients were instructed to open their mouth and touch the vermilion border of the upper lip with their tongue, moving the tongue to both the right and left sides and also protruding it forward within functional limits. The compound was reduced from the superior surface until the stoppers were exposed.

RECORDING A CLOSED MOUTH IMPRESSION

Maxillary conventional denture was inserted. Denture
adhesive was applied on the intaglio surface of the mandibular record base to help in the adhesion of the impression material. Addition silicon (medium body) material was mixed and placed on the intaglio surface of the record base, after placing on the ridge, patients were instructed to close their mandible in centric relation and perform some physiologic movements like swallowing, moving the lips and cheeks (Figure 2).

Figure 2
Figure 2

The record base with the impression compound was then removed and examined for proper extension and the master casts were prepared in dental stone. Set impression material was removed and the record blocks were seated over the master casts. Autopolymerizing resin was added on the borders of the tray to get the complete extensions.

FABRICATION OF INDICES
Three notches were prepared on the cast, one in the anterior, and the other two in the posterior regions. Separating medium was applied on the cast, the record base and over the molded impression compound. Boxing was done using a wax sheet. Plaster of Paris was manipulated and poured up to the superior surface of the record block. Three saw cuts were made after it set, and the three indices were separated. The impression compound was removed and three stoppers were trimmed from the acrylic denture base. After applying separating medium on the inner surfaces of the indices, they were reassembled and the space was filled with molten modeling wax.

ARRANGEMENT OF TEETH IN NEUTRAL ZONE
Indices were removed, teeth were arranged in such a way that the central fossa of the posterior teeth and lingual fossa of the anterior teeth were exactly in centre of the neutral zone space (Figure 3).

Figure 3
Figure 3

In some cases, the buccal and lingual surfaces of the teeth were trimmed to accommodate the teeth in the neutral zone space. The superior surface of the plaster indices was used as a guide to maintain an occlusal plane. Only cervical carving was done without doing a wax up, following which this trial denture and maxillary occlusal rim were inserted, the previously recorded jaw relation was verified, maxillary teeth were set according to mandibular teeth, a wax try in was then done, dentures were acrylized and inserted in the patients mouth and reviewed after 24 hours. The patients were instructed to discontinue wearing the conventional dentures and were advised to wear these new dentures for a week. The dentures were retrieved from the patients for a day for the purpose of this study.

STUDY TO COMPARE THE RELATION BETWEEN THE CREST OF THE RIDGE TO THE FOSSA
A linear depression created over the crest of the ridge on both mandibular casts and 26 gauge wires were adapted and stabilized. Both the dentures were placed on their respective casts. Braided 26 gauge wires were stabilized in the central fossa of the posterior teeth and lingual fossa of the anterior teeth in both dentures (Figure 4).
Both the casts with their dentures were placed on the x-ray films at a distance of 90cm or 3 feet from the source and an occlusal view was obtained. To eliminate 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. This would facilitate the calculation of error. Where the two images (wire on ridge and braided wire on fossa) coincided, a zero score was assigned, whereas buccal and labial locations of the braided wire were assigned a positive, lingual location of braided wires were assigned a negative (Figure 5).

**Figures 4 and 6**

The foils were removed and spread over graph sheets (Figure 7) on which the outlines were drawn.

**Figure 5**

**STUDY TO COMPARE THE TISSUE SURFACE AREAS**

Tin foils were adapted from the deepest point of the impression surface of the dentures to the borders and the excess foil was trimmed (Figure 6).

**Figure 6**

The number of squares were counted and tabulated as cm$^2$. Wrinkles were formed during the adaptation of the tin foils, and as it happened in both dentures, the errors were overlooked.
STUDY TO COMPARE THE VOLUMES

Each denture was immersed in a 200ml measuring beaker containing 150ml of water (Figure 8).

Figure 8

The increased level of water from both the beakers was removed by a pipette until the levels reached 150ml. The water in the pipette indicates the volume of the dentures. The measurements were tabulated.

RESULTS

In both the mandibular dentures, the relationship of the crest of the residual ridge to central fossa in the posterior teeth and lingual fossa of the anterior teeth were compared. These values were statistically analyzed, summarized and tabulated (Table 1, 2).

<table>
<thead>
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<th>NO</th>
<th>Left molars</th>
<th>Left premolars</th>
<th>Anterior premolars</th>
<th>Right premolars</th>
<th>Right Molars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+3.5mm</td>
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<td>0mm</td>
<td>-2.5mm</td>
<td>-1.0mm</td>
</tr>
<tr>
<td>2</td>
<td>-1.0mm</td>
<td>0mm</td>
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<tr>
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<td>0mm</td>
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<tr>
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<tr>
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<td>+1.5mm</td>
<td>+0.5mm</td>
<td>+2.0mm</td>
</tr>
</tbody>
</table>

The mean value of the Neutral zone dentures in left and right molar regions was higher than that of the conventional dentures left and right molar regions, the P value was <0.01 level (Table 3).
Table 3 Means, standard deviations and statistical significance

<table>
<thead>
<tr>
<th>Denture</th>
<th>Left molars</th>
<th>Right molars</th>
<th>Anterior</th>
<th>Right premolars</th>
<th>Left premolars</th>
</tr>
</thead>
<tbody>
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<td>Conventional mandibular Denture</td>
<td>1.2500</td>
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<td>-2.000</td>
<td>1.9500</td>
<td>1.1500</td>
</tr>
<tr>
<td>STD</td>
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<td>2.260</td>
<td>0.9500</td>
<td>1.1700</td>
<td>1.1700</td>
</tr>
<tr>
<td>neutral zone mandibular Denture</td>
<td>0.9000</td>
<td>-0.3000</td>
<td>-0.5500</td>
<td>-0.5500</td>
<td>0.9500</td>
</tr>
<tr>
<td>STD</td>
<td>0.9000</td>
<td>1.09</td>
<td>0.01</td>
<td>0.68</td>
<td>0.001**</td>
</tr>
</tbody>
</table>

* -Significant
NS –Not significant

The values suggested that the neutral zone moved buccal to the crest of the ridge in molar regions, but in conventional dentures, the neutral zone was located lingual to the crest of the ridge. In the premolar region, neutral zone moved slightly lingual to the crest of the ridge on both right and left sides. In conventional dentures, the neutral zone was located exactly on the ridge, with no statistical difference between two dentures. In anterior region, the neutral zone moved slightly lingual to the crest of the ridge but in conventional dentures, the neutral zone is located labial to the crest of the ridge. Statistically, it was also proved that there is significance at p<0.01 level.

Surface area and volume of the conventional mandibular denture and neutral zone mandibular denture were compared and statistically analyzed (Table 4, 5).

Mean value, standard deviation, T-value and P-value summarized in (Table 6).
The mean value of the neutral zone denture tissue surface area is higher than the conventional denture. Statistically, it was proved that there is significant difference, and P value shows <0.01 level. Mean value of the neutral zone denture volume is lower than the volume of the conventional denture. Statistically, there was a significant difference between two dentures volume.

Overall all the patients were more comfortable and movement of the dentures during functions was negligible.

**DISCUSSION**

The primary objective of complete denture prosthesis is to satisfy the three basic requirements of an edentulous patient: maximum comfort, masticatory efficiency and esthetics. These objectives can be achieved only if dentures are retentive. The size and form of the basal seat, quality of the impression, form of the polished surfaces and the appropriate location of the teeth play an important role in the stability of the complete dentures. Oral and facial musculature can significantly contribute to developing the polished surface and arrangement of the teeth. Sir Wilfred Fish explained the importance of the shaping of the polished surface of the denture so that there are a series of favorable inclined planes as related to the lips, cheeks, and tongue. The neutral zone is that area in the mouth where, during function, the forces of the tongue pressing outward are neutralized by the forces of the cheeks and lips pressing inward. Since these forces are developed through muscular contraction during the various functions of chewing, speaking and swallowing, they vary in magnitude and direction in different individuals and in different periods of life. The soft tissues that form the internal and external boundaries of the denture space greatly affect the stability of the dentures. Boucher stated formerly that all teeth were placed “over the ridge”\(^5\). In this study, after radiographic evaluation of both conventional and neutral zone dentures, the central fossa was moved 1.5mm lingual to the crest of the ridge in molar region, 0.4mm lingual to the ridge in premolar region and lingual fossa was moved 2.0mm labial to the ridge in conventional denture. But in dentures made by neutral zone concept, central fossa was moved 1.0mm buccal to the crest of the ridge in molar region, 0.3mm lingual to the ridge in premolar region and lingual fossa was moved 0.6mm lingual to the ridge.

According to Fahmi, the neutral zone moves buccal to the crest of the ridge\(^6\). Faber stated that the final position of the teeth should be in harmony with the forces of the cheek and tongue\(^7\). Beresin and Schiesser have suggested that the teeth should be arranged in the neutral zone\(^8\). Wright stated that if the sizes of the mandibular teeth are too large, or if the posterior teeth are set even 1mm lingual, the tongue is deprived of approximately 1000mm\(^3\) of its functional space\(^9\). The Orbicularis Oris, Caninus, Zygomatic muscle, Quadrant muscle, Risorious muscle and Mentalis play an important role in denture stability. Unless the external surface of the dentures are properly positioned and contoured by narrowing in the premolar area, the modiolus may constantly unseat the denture.

The influence of the lip on the lower denture stability becomes more critical as resorption of the ridge increase with an increase in age. Lammie has shown that during ridge resorption, the crest of the ridge falls below the origin of the Mentalis muscle. As a result, the muscle attachment folds over the alveolar ridge and rests on the superior surface of the crest\(^10\). Tench stated that the increase tongue size would increase the force or stress on the teeth\(^10\). Schiesser stated that the arrangement of the teeth should follow the neutral zone space\(^11\). Faber stated that the labial positioning of the teeth must be considered along with the activity of the orbicularis muscle, its fibers and attachments, tone of the lips must have room to move or they will disturb the denture\(^7\).

Accurate functional molding of the borders can be obtained only in closed mouth impression technique. Surface area of the impression surface is more in closed mouth technique than open mouth impression technique (Figure 9).
There is an approximate difference of 3 cm$^2$ in the area between the neutral zone denture tissue surface area and conventional denture tissue surface area. Defrenco and Sallustio stated that the closed mouth impressions provide maximum coverage, support and stability for the denture $^{12}$. Shanhan stated patients with advanced resorption of mandibular ridges need a dynamic impression for more comfort and stability $^{13}$.

When comparing the dentures volumes, the neutral zone dentures were expected to have an increase. During the wax try in of a denture being fabricated by the neutral zone concept a layer of zinc oxide eugenol paste is applied over the teeth and wax which is then molded by the patient’s functional movement. Only cervical carving is then carried out to expose the teeth. This method was not followed during this study thereby reducing the thickness of the dentures. Therefore, the results showed a decrease in volume of the neutral zone denture as compared to the volume of a conventional complete denture. This result may also be attributed to the fact that the patients selected were edentulous for a short span of one year and showed good tonicity of the tongue muscles and perioral musculature. Reduction of the denture volume resulted in more comfortable dentures.

CONCLUSION

Arrangement of the teeth in the neutral zone, increasing the impression surface area of the denture and reduction in the volume of the denture, together provide good retention and stability in addition to improved comfort for the patients.

References

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