CASE REPORT

Neutral zone approach to denture fabrication for a severe mandibular ridge resorption patient: Systematic review and modern technique

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Abstract Conventional complete denture therapy for patients with severe residual ridge resorption is challenging. The dental implant therapy may be a treatment option for improving the denture support, retention, and stability. However, the neutral zone technique is also considered to be an important alternative approach to patients complaining of unstable dentures, particularly when implant therapy is not feasible. This technique is by no means new, but is not widely practiced due to lack of experience of dentists. The aim of this article is to describe historical perspectives on the neutral zone concept. In addition, a modified modern neutral zone technique is presented to reconstruct a lower complete denture for a patient with severe ridge resorption. The new definitive complete denture successfully improves stability, comfort, and function for the patient with severe mandibular ridge resorption.

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Introduction The stability of complete dentures is influenced by the surrounding neuromuscular system in the oral cavity. Oral functions, such as speech, mastication, swallowing, smiling, and laughing, involve the synergistic actions of the tongue, lips, cheeks, and floor of the mouth that are very complex and highly individual.1 Neuromuscular control is the key for the stability of dentures. Size and position of denture teeth and the contours of polished surface play a crucial role in denture’s stability as they are subjected to destabilizing forces from the tongue, lips, and cheeks if they interfere with the function of oral structures.2
The retention and stability of complete denture become unfavorable when ridge resorption gets more severe, especially in the mandible. Implant overdenture can provide long-term prognosis and more stable outcome compared with conventional complete dentures. However, for some medically compromised patients, this therapy may not be a superior choice to new conventional dentures. Therefore, techniques to improve retention and stability in severely atrophic ridge cases must be considered for fabricating a denture in harmony with forces exerted by the tongue, lips, cheeks, and floor of the mouth. The aim of the neutral zone technique is to construct a denture in muscle balance through physiologically optimal denture contours and physiologically appropriate denture tooth arrangement.

The neutral zone is defined as "the potential space between the lips and cheeks on one side, and the tongue on the other; that area or position where the forces between the tongue and cheeks or lips are equal," “where the forces of the tongue pressing outward are neutralized by forces of the cheeks and lips pressing inward”. It was first described by Wilfred Fish who reported the influence of the polished surfaces on retention and stability of complete dentures in 1931. He stated that the polishing surface contour should conform to the shape of the tongue, lips, and cheeks. These tissues, in function or at rest, would exert an elastic pressure on the dentures, and retain them in place rather than dislodge them. Since then, several authors have contributed to the development of the neutral zone concept. Brill and co-workers have mentioned that the dynamics present in relation to the surrounding tissues will determine the form of the denture, called "the potential denture space." Beresin and Schiesser also described the principle of neutral zone concept and suggested that positioning denture teeth in the neutral zone will not interfere with normal muscle function.

Clinical studies have shed light on the advantages of using the neutral zone technique. Stromberg and Hickey in 1965 found better patient adaptability to physiologically formed denture bases when compared with conventional ones. In another clinical study, Fahmy and Kharat reported greater comfort and improved speech clarity with dentures fabricated using the neutral zone technique compared with their conventionally prepared dentures. Barrenas and Odman found less postinsertion problems and better patient acceptance in neutral zone dentures when compared with conventional ones. These studies suggest that the neutral zone concept for denture fabrication may be helpful in certain edentulous situations.

The greater the residual alveolar ridge loss, the more important the neutral zone concept. Raja and Saleem published a clinical trial in which they compared patient acceptance of neutral zone dentures with conventional dentures in 128 patients. They concluded that both denture techniques showed satisfactory assessment results in patients with a shorter edentulous period (<2 years). However, better results and patient acceptance were reported with neutral zone dentures in patients who have been edentulous for more than 2 years. The advantages of neutral zone technique are (1) improved stability and retention; (2) posterior teeth will be correctly positioned allowing sufficient tongue space; (3) reduced food trapping adjacent to the molar teeth; and (4) good esthetics due to facial support.

Besides patients with a severely atrophic ridge, the neutral zone technique for complete denture or removable partial denture (RPD) reconstruction can also be suggested for patients of advancing age and/or long-term edentulism with decreasing facial muscle tonicity, anatomic deformity or insufficiency due to postcancer oral surgical resections, or those suffering stroke or Parkinson’s disease, leading to either atypical movement or an unfavorable denture bearing area.

The neutral zone approach to complete denture construction is by no means new but is a valuable one. Unfortunately, it is not a widely practiced procedure while the proportion of patients that may benefit from this technique is significant. This may be mainly attributed to a lack of knowledge and experience of clinicians to this technique. In addition, the complex procedures not only increase chair time and laboratory cost but also prohibit their clinical use. The aim of this article is to describe historical perspectives on the neutral zone concept. In addition, a modified modern neutral zone technique is presented to reconstruct a lower complete denture for a severe ridge resorption patient.

Case report

An 88-year-old female came to our department and asked for new upper and lower complete denture fabrication. Her upper residual teeth were extracted 3 days previously in our oral surgery department, and therefore her old upper RPD was not wearable. She also complained of lower complete denture loosening. Although her lower complete denture was refabricated many times, she was not happy with it. Because of financial constraints and her medical history of diabetes and hypertension, she did not agree to implant overdenture therapy.

Intraorally, the upper arch form was ovoid with adequate height. However, the lower arch revealed severe ridge loss combined with a knife-edge form. The vestibule disappeared and movable tissues were extended onto the residual ridge (Figs. 1 and 2). A panoramic radiography showed the lower arch with severe ridge resorption (Fig. 3). The diagnostic classification of the edentulism is the American College of Prosthodontics Index, based primarily on anatomic factors and other modifiers. From the radiographic finding, the least vertical height of mandibular bone was found to be approximately 10–15 mm, defined as Type III. A clinical examination showed that only the posterior lingual vestibule remains. Thus, the muscle attachment classification is Type D.

Clinical procedures

The preliminary impressions of upper and lower arches and master impression of upper arch were performed using the conventional complete denture method. The upper recording base and wax rim were then fabricated. The lower individual tray was specially designed, with a resin rim on it (Fig. 4). They were made of autopolymerized tray resin (Instant Tray Mix package; Lang Dental Mfg Co.,
Wheeling, IL, USA). The rim was relatively narrow (3–5 mm) in the buccolingual dimension, and the height was designed in the conventional way. The rim was built right on the central line of the alveolar ridge but somehow fabricated wider to have room to adjust. The individual tray and rim were then carefully examined and adjusted in the patient’s mouth to reduce any overextension or interference from tongue movement and lip or cheek pressure using a fit checker (Fit Checker, GC Co., Tokyo, Japan). Any underextended border could be corrected by border molding with plastic impression compound (Impression Compound; Kerr Corp, Orange, CA, USA) if needed. The individual tray should be stable during speaking, swallowing, and mouth opening.

The upper recording base with wax rim was inserted. The occlusal plane, phonetics, and lip support were checked. The lower individual tray was then inserted to verify the vertical dimension of occlusion (VDO). The resin rim was adjusted to ensure it is in contact with the upper rim evenly at centric relationship in a proper VDO.

To record the neutral zone, the patient should be in a comfortable, upright position with the upper wax rim inserted. The occlusal plane, phonetics, and lip support were checked. The lower individual tray was then inserted to verify the vertical dimension of occlusion (VDO). The resin rim was adjusted to ensure it is in contact with the upper rim evenly at centric relationship in a proper VDO.

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The neutral zone technique described in this article is simplified to record the physiological dynamics of oral and lips, sucking, puckering, smiling, grinning, swallowing, pronunciating some words, or combination of these. These actions should be repeated until the material has set. After setting, the displaced excess material was removed (Fig. 5). The extension and accuracy of the neutral zone impression area was assessed using a fit checker and then the borders were trimmed to a thickness of 2 mm.

The rubber base adhesive (GC America, Alsip, IL, USA) was applied on the tissue side and the border area of the tray. A final wash impression was accomplished with a polysulfide impression material (Kerr Co., Romulus, MI, USA). The patient was asked to repeat the rehearsed muscular movements. Therefore, the form of the neutral zone was refined and the tissue surface was recorded in an anatomic form (Fig. 6).

After beading and boxing, the lower master impression was poured. Before the impression was removed, tongue, lip, and cheek matrices were made of silicone putty material (Aquasil Easy Mix Putty; Dentsply, Konstanz, Germany) for preserving the neutral zone on the cast (Fig. 7A–C).

Wax was poured into the space confined by the putty matrices to make a wax rim, which exactly represented the neutral zone on the newly formed baseplate on the lower cast. VDO verification, bite registration, and facebow transfer were then performed as with conventional complete denture methods.

The artificial teeth were positioned within the matrices (Fig. 8). Zero degree teeth were chosen and arranged to balanced occlusion. Vertical dimension, centric relation, esthetics, and phonetics were rechecked during wax denture try-in. An external impression can be performed at this stage to refine the final wax contour of polishing surface if needed.

After processing, finishing, and polishing, the dentures were delivered to the patient and tested for stability, retention, intercuspal relation, esthetics, and phonetics (Fig. 9A–D). Fit checker was used to check the neutral zone space. The result had a little difference. However, no interference was noted (Fig. 9E and F).

These dentures were followed up for more than 1 year and the new definitive complete dentures successfully improved stability, comfort, and function for the patient.

Discussion

The neutral zone technique described in this article is simplified to record the physiological dynamics of oral and

![Figure 1](image1.jpg) The upper arch form is ovoid with adequate height.

![Figure 2](image2.jpg) (A and B) The lower ridge is tapered and severely atrophic.
perioral muscle functions. Detailed information has been provided that can be used to determine complete denture contours and denture teeth positions.

The principle of the neutral zone concept remains the same since it has been described. However, the neutral zone impression technique has various modifications, not only in terms of impression materials used or recording base designed, but also in terms of the functional movements performed and refinement to the initial record. A number of different neutral zone impression methods have been suggested. For example: (1) without inserting the upper recording base, the neutral zone impression is made using impression compound as occlusal rim to record the neutral zone contour before the final impression is completed.\(^1,6,11,15\) (2) After the master impression and determination of VDO, the neutral zone is registered with a special recording base and maxillary wax rim at the selected vertical dimension.\(^5,19\) (3) Refining the polished surface of the trial wax denture with the impression material,\(^1,12,18,20,24,26\) or relining the polished surface of delivered denture by the functional impression activities.\(^23\) All the methods can be used individually or combined according to the clinician’s preference. It is important to note that the technique presented here slightly differs from the Method 2 described in the preceding text. In our approach, the neutral zone impression and tissue side impression were combined in one appointment instead of taking the final impression first and then the neutral zone record in different appointments. However, it is crucial that the preliminary impression and individual tray should be functionally accurate and stable. The retention part of baseplate (individual tray) in this case was resin rim instead of wire loop. It is because that the autopolymerized tray resin is more accessible and the polyether impression material we used can be securely retained on it by applying the polyether adhesive. Care must be taken to ensure that the resin rim is narrow and slightly buccally placed, especially in the anterior region, when compared with the conventional wax rim.

Various materials have been recommended by different authors for recording neutral zone. The impression materials that are used in the neutral zone impression technique are modeling plastic impression compound,\(^1,2,6,8,15,19\) soft wax,\(^20,25\) silicone,\(^12\) polyvinylsiloxane,\(^5,21,26\) tissue
conditioner, and polyether. The medium viscosity, repeatable or addible properties of these materials will be advantageous for the clinicians. Repeatable and addible properties facilitate refining the detailed area. The lower the viscosity is, the better the fine detail reproduction will be. Geriatric patients may not have sufficient muscle tone to push away impression material, which has high viscosity. However, the usage of low viscosity material may be technically sensitive to control the excess material flow. Reasonably slow setting material has also been suggested previously by Lynch and Allen. The reason for using polyether impression material in this work when compared with other recommended materials for recording the neutral zone is that it has sufficient viscosity, good flow, easy to manipulate, hydrophilic, and addible properties. It is cautioned that excessive material will interfere with the accuracy of the record. In addition, patients would suffer from swallowing activities. Improving the impression material would aid in more convenient performance and thus a detailed result can be obtained.

Different functional movements for recording the neutral zone have also been reported by different authors. Some authors recorded the neutral zone with the maxillary denture or recording base at selected vertical dimension and with even contact. This will support the facial muscles and allow the tongue to be positioned on the palatal contour during phonetics. However, some authors recorded the neutral zone without inserting the upper recording base for that maxillary recording base exerting compressive interference with occlusal contact. Especially for those patients with reduced vertical dimension, the swallowing procedure during neutral zone registration will exert compressive interference at a reduced vertical dimension. In our experience, the overjet of upper rim/denture tends to house more recording material and thicken the buccal side of the neutral zone, especially when the overjet is more obvious. This affects the width of the neutral zone.

The effect of various functional activities that patients perform in recording the neutral zone has been investigated by morphologic comparison of phonetic and swallowing neutral zone impression techniques. It is concluded that the neutral zone recorded in the phonetic technique is significantly narrower when compared with that recorded in the swallowing technique. Clinical dentures fabricated using one functional movement to shape the neutral zone may be unstable during other functions. Thus, in our impression procedures, the patient was instructed to open her mouth, move her tongue, and lick the lips for shaping the lingual aspect first. Then she was asked to close mouth, suck, swallow, and smile. The actions finished with pronouncing some words loudly. These actions will need to be rehearsed, so that they are performed effectively and smoothly.

The width, shape, and position of the recorded neutral zone are individual and reproducible. However, they are affected by a variety of conditions, such as different impression materials, different functional movements, different techniques, different vertical dimensions, different muscle tones, the period of edentulism, the uncontrolled transitional tooth extraction. The contours resulting from neutral zone impressions show anterior proclination and generalized convexities along the buccal surfaces of dentures, particularly in the molar regions and for patients of advancing age with decreasing facial muscle. This observation coincides with the findings of

Figure 7 (A–C) Before the tray was removed, a silicone matrix was made to represent the neutral zone space.

Figure 8 The teeth were arranged within the neutral zone.
Lott and Levin that the size of the buccal flange is molded much thicker than the size of the conventional flange when the flange is formed by the buccinator muscle.\textsuperscript{25} Denture teeth of the neutral zone denture is positioned in the neutral zone, buccally/lingually to the ridge crest. The longer the period of edentulism, the more buccally/lingually located is the neutral zone.\textsuperscript{15} More frequently, however, hand-waxed denture contours yield incorporated concavities along the facial prosthetic surfaces and the denture teeth are arranged directly over the crest of ridge.

The neutral zone technique for denture fabrication takes advantage of the stabilizing potential of surrounded soft tissues, instead of being dislodged by them. Retention and stability of dentures are improved, especially in the severely atrophic ridges. When patients cannot undergo an implant overdenture therapy, this article provides an alternative, time-saving, and relatively simple way to obtain a favorable result. A disadvantage of this technique involves the laboratory aspect. Increased laboratory time and cost are necessary, and the laboratory technician must be trained to support this clinical procedure.

References


Figure 9  (A–F) Final complete dentures. (E and F) Fit checker was used to check the neutral zone space. The result was of little difference.


