The importance of neutral zone in fully edentulous case with highly resorbed ridge

[1]Irvan Salim, [2]Agus Dahlan
[1]Prosthodontics Resident
[2]Prosthodontics Department
Faculty of Dental Medicine, Universitas Airlangga
Surabaya, Indonesia
Correspondence author: **Irvan Salim**, e-mail: **irvansalim@gmail.com**

ABSTRACT
Full edentulous is one of the most challenging cases for prosthodontist. One of the difficulties in treating that cases is the limitations in support and retention, especially in cases with highly resorbed ridge where the denture bearing area avalaible is minimum. One of the techniques to achieve the retention is by using the neutral zone technique. Neutral zone is the area where the displacing forces of the lips, cheeks, and tongue are in balance. It is in this zone that the natural dentitions lie and this is where the artificial teeth should be positioned. This area of minimal conflict may be located by using the neutral zone technique. The artificial teeth can then be set up in the correct positions. By using this concept it will be able to achieve retention, stability and support. This case report will share the usage of the neutral zone technique in treating fully edentulous ridge with highly resorbed ridge.
Keyword: fully edentulous, highly resorbed ridge, neutral zone, complete denture

INTRODUCTION
Achieving good retention and stability in complete denture is not an easy task. There are many factor that needs to be considered, especially in difficult cases such as highly resorbed ridges. In highly resorbed ridge the denture bearing area is limited; therefore, stabilization and retention is difficult to achieve, difficulties will also encountered in tooth arrangement phase where the ridges is often deformed into such a condition that makes difficult to position artificial teeth on the center of the ridges. Errors in this phase will create a displacement force from the cheek and tongue muscle which will decrease the retention and stabilization of our prosthesis. One of the techniques that can overcome difficulties in highly resorbed case is the neutral zone technique. Neutral zone (NZ) is the potential space between the lip and cheek on one side and the tongue on the other where the forces between the tongue and cheeks or lips are equal.[1-3]

Orofacial and tongue muscles play an important role in retaining and stabilizing complete dentures. This is accomplished by arrangement of the artificial teeth to occupy a NZ in the mouth so the teeth will occupy a space determined by the functional balance of the orofacial and tongue musculature.[2,4]

Despite the growing trend of implant treatment and its proposal as the standard of care for the edentulous population, conventional complete denture (CD) therapy remains a substantial and a more affordable treatment option for the majority of elderly edentulous patient, especially those with low social economic status. Although conventional dentures have been an effective treatment option for some patients, they are unsuccessful for others because of poor stability, compromised retention, inadequate facial support, poor aesthetic, inefficient tongue function/posture, poor mastication or speech, gagging and general discomfort, or the patient's inability to adapt.[5]

Neutral zone is especially useful in extreme geriatric and highly resorbed ridge cases where implant-supported dentures cannot be performed. Dental implants may provide stable mandibular CD for the atrophic mandible; however, there may be situations when it is not possible to provide implants on the grounds of medical, surgical or costs factors. The NZ technique is an alternative approach for these complex cases. The technique is not new but is one that is valuable yet not often practised.[6]

The concept of a NZ in the context of a keen understanding of patterns of alveolar ridge resorption enables the dentist to determine the arch form for the patient receiving treatment. Several techniques employ soft waxes, impression materials, and tissue conditioners as adjunctive efforts to func-tionally establish correct NZ for the arch form.[2]

This case report describes an extreme geriatric patient with highly resorbed ridge. So, the aim of this case is to rehabilitate fully edentulous jaw with NZ technique to improve the function of chewing, aesthetic and to maintain patient's oral health.

CASE
An 89-year-old female visited to Airlangga dental hospital to make a CD, patient directly came to

Figure 1A, B, C Intra oral view and **D** panoramic radiograph examination

prosthodontic department. Patient's last visit to dentist was more than 30 years ago. She got fully edentulous more than 25 years and has no experience with denture. In order to eat well and get more confidence she wanted to make a CD to change her smile into a new smile with proper aesthetic and function.

MANAGEMENT

The first stage when the patient came for a consultation was taking X-ray. From the radiograph, the edentulous jaw classification was determined. Maxilla in anterior considered Class V flat ridge form, which is inadequate in height and width. Both posterior sides are considered Class VI depressed ridge form, with some basalar loss evident. Mandibula in anterior is considered Class VI depressed ridge form, with some basalar loss evident, and in both posterior sides are considered Class V flat ridge form, which is inadequate in height and width (Fig 1).[7]

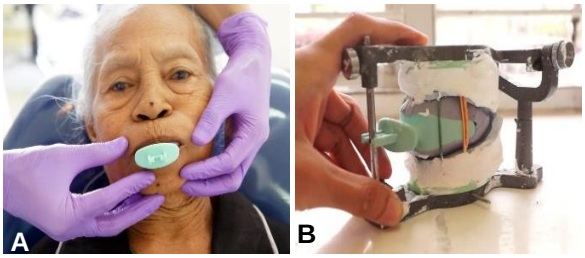

Figure 2A Determinating OVD; **B** Articulator mounting

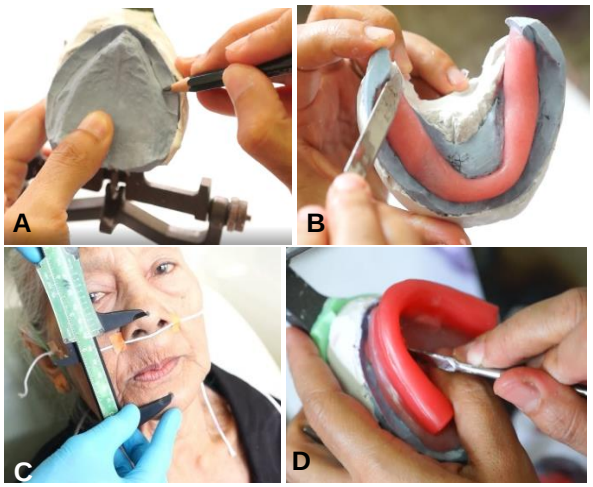

Fig 3A Drawing the outline, **B** baseplate making, **C** fabricating bite rim, **D** bite rim try in

Then, an initial impression using fabricated stock tray with impression material (GC, Aroma Fine Plus, Japan) was taken to obtain the anatomical model of the patient. This cast would be made for patients individual tray. After initial impression the OVD was determined using centric tray (Ivoclar Vivadent, Centric Tray, Liechtenstein) with the putty (Heraeus Kulzer, Variotime, Easy Putty, Germany) and the Niswonger technique. Centric tray makes it easy to determine the vertical relation between the patient's upper and lower jaw (Fig 2).

Draw a denture outline on cast model, then make baseplate using self-curing acrylic (S.Court Limited, Hillon, England) and make bite rim using wax (Cavex, Set up wax Regular, Netherlands). The baseplate bite rim was also used later as individual tray. Bite rim was inserted on patient and wax rims were contoured for lip support, future incisal edge position, occlusal plane, occlusal vertical dimension and midline. Bite registration was performed at correct vertical dimension (Fig.3)

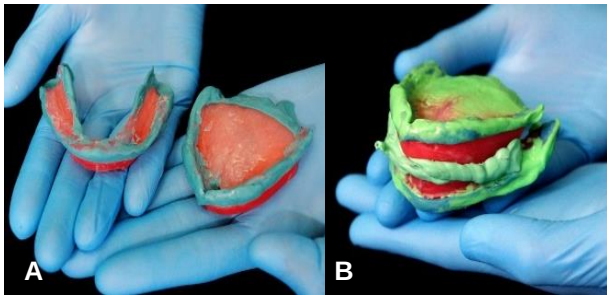

Fig 4A Moulding and **B** close mouth impression

Cover the acrylic baseplate edge with tray adhesive (DMG, Tray Adhesive, USA), then continued to border molding which gives compound material (DMG, Honigum Pro-Mono, USA) on the edge of individual tray to get the form of pheripheal seal which is useful for denture's retention. Impression with closed mouth technique was used with putty (Heraeus Kulzer, Variotime, Light Flow, Germany) because the patient had highly resorbed upper and lower ridge. Close mouth technique was also indicated for this patient as this patient can't open her mouth for a long time. After impression procedure, bite registration (Dentkist, Bite Fast-Charm Flex, South Korea) was used to stick upper and lower tray (Fig.4).

Fig 5A Rope wax sealing, **B** boxing processing, **C** impression compound wax (Hoffman's, Germany), **D** mounting cast on articulator.

Utility wax rope was used to seal around periphery at least 1-2 mm below the borders of impression, pour using dental stone and wait until completely set. Then continue with boxing processing and then mount the cast model on articulator.

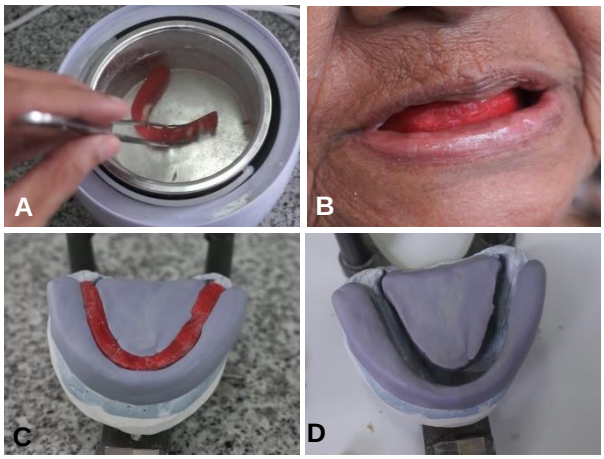

Figure 6A Modeling plastic impression compound occlusal rim immersed in a warm water bath set at 140° F, **B** muscle trimming and swallowing motion with rim inside **C** matrices; **D** lower jaw NZ obtained.

A modeling plastic impression compound occlusal rim (Hoffman's, Abdruckmasse Rot, Germany) should be fabricated prior to the record appointment to accomplish the procedure in a timely manner. The mandibular record base with the modeling plastic impression compound occlusal rim is immersed in a warm water bath set at a temperature of 140°F (Figure 6A). Once the modeling plastic impression compound is uniformly softened and removed from the water bath and quickly placed in the patient's mouth. A maxillary record base is not used for this procedure because eliminating the maxillary record base eliminates the compressive forces that may arise during the recording of the NZ.

The patient was given a cup of warm water and was asked to swallow, then sip warm water and swallow again. Suggested actions include asking the patient to smile, grin, pout/purse lips, talk aloud, pronounce the vowels, sip water, swallow, slightly protrude the tongue and lick the lips. These actions were repeated several times until the rim has completely set (Figure 6B). The thermoplastic plastic impression compound was molded through the action of muscles. This action resulted in muscles of the cheeks and lips functioning inward and muscles of the tongue expand-ing outward thereby forming the NZ registration.

When the modeling plastic impression compound has been hardened, the NZ record was removed rim from the mouth and evaluated for accuracy. If necessary, the procedure is repeated to achieve a proper recording of the NZ area. Next the NZ record was seated on the mandibular definitive cast and indexed lingual and facial index are developed around the NZ record using putty (Heraeus Kulzer, Variotime, Easy Putty, Germany). This index was used for potensial teeth space and guidance in teeth setting. With this has, hardened zone was recorded and tooth can set exactly in the NZ (Fig.6C &6D).

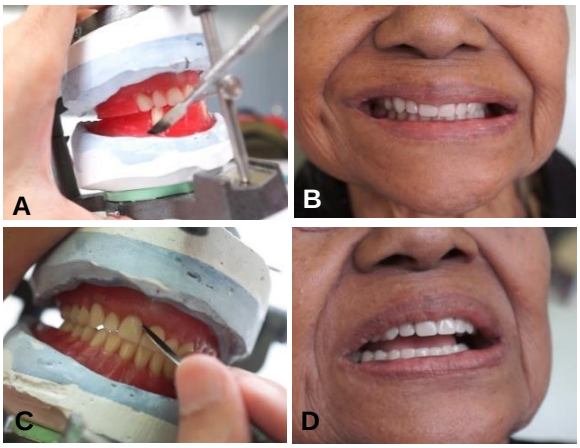

Figure 7A Set the artificial teeth, **B** wax denture try in **C** Festooning; **D** Denture try in

Shade guide (Ivoclar Vivadent, AD shade guide, Liechtenstein) was used to match artificial teeth shades. Then the teeth (Union Dental, OrtoLux top, Spain) were set up in the desired occlusal scheme, asssuring proper form and function. During the setting up of the teeth their position can be checked by putting the index together around the wax try-in. Most of the information necessary for the selection of teeth should be gathered during the diagnosis and the treatment planning stage. The shade selection, mold selection, and positioning and arrangement for maxillary anterior teeth may

be based on the age, sex, and personality of the patient. After finishing the setting of the artificial teeth, countinue with wax denture try in, it for evaluate accuracy of mounting, occlusal vertical dimension, esthetics and phonetics. Perform modifications as necessary.

If the wax denture try-in stage has no problem, the festooning stage was proceeded; carving the denture base to simulate the contour of natural tissues that are being replaced by the denture, after festooning send to laboratory or flasking. Denture was processed by laboratory with heat-cure acrylic resin, but during processing wax to acrylic, certain dimensional changes occurred. To fix this kind of problem, remount the model and denture to articulator and do selective grinding on articulator until the vertical pin touching the table.

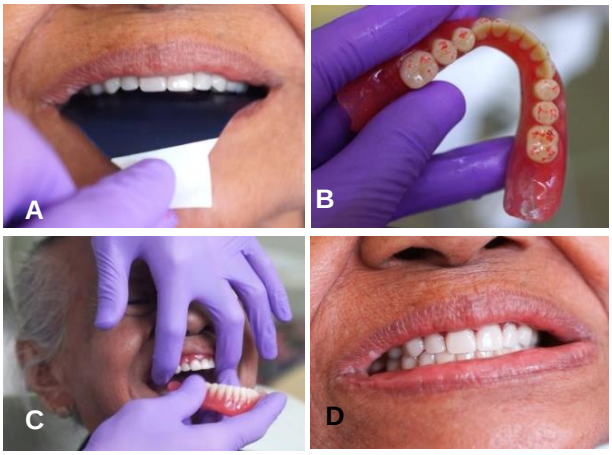

Figure 8A, B Selective grinding, **C** insertion, **D** follow up and after care

Selective grinding was performed to correct occlusion. To maintain vertical dimension, occlusal interferences must be corrected by carefully determining specific areas to be grounded to attain a mechanically balanced occlusion.

Following selective grinding, the denture must be polished and smoothed with polishing mops and paste to create a natural-looking luster before insertion. After polishing and inserting the denture, the patient was told that a follow-up may be needed first and three days after insertion then a week and a month after insertion. She was quite satisfied with retention stability and esthetics of the new set of denture.

Figure 9 Intra oral view after inserted with CD

DISCUSSION

The success of a CD relies on the principles of retention, stability and support. The prosthodontist's skill lies in applying these principles efficiently in critical situations. Severely resorbed

Figure 10 Extra oral view before and after inserted with the CD

edentulous ridges that are narrow and constricted with increased inter ridge space provide decreasing support, retention and stability. Extensive volume of the denture base material in prosthesis due to increasing inter-arch space results in a very heavy prosthesis. Retaining such prosthesis requires additional efforts to be made. Various methods have been recommended and selecting the appropriate method is dominated by the existing clinical situation[8].

The mandibular denture commonly presents the most difficulties with pain and looseness being the most common complaint. This is because the mandible atrophies at a greater rate than the maxilla and has less residual ridge for retention and support. The NZ is an alternative technique for the construction of lower CDs on highly atrophic ridge. It is especially useful in cases where dental implants are not possible and the copy technique would be inappropriate. The aim of the NZ is to construct a denture in muscle balance, as muscular control will be the main stabilising and retentive factor during function. The technique is relatively simple but there are increasing chair time and laboratory costs.[6]

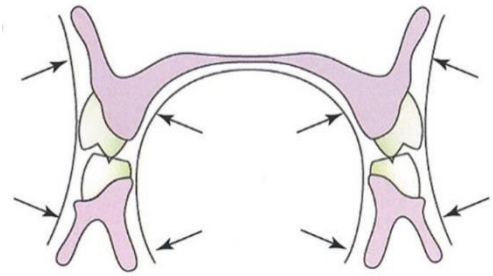

Figure 11 The neutral zone (Source: Zarb GA, Hobkirk JA, Eckert SE. Prosthodontic treatment for edentulous patients. 13th ed. St.Louis: Mosby El-sevier; 2013.[2]

The NZ was first discribed by Wilfred Fish, who indicated that the denture's polished surface should be contoured so that it approximates the moveable muscles of the lips, cheek, and tongue. In addition to simply replacing missing oral tissues, CDs serve to structurally redefines true spaces and potential spaces within the oral cavity. To provide CDs that reside within the theoretically stabilizing boundary conditions of the NZ, careful attention must be given to the dynamic physiologic and functional nature of the edentulous oral cavity.[9]

Clinicians must understand, NZ registration identify, induce, and record the neuromuscular dynamics of the functioning oral tissues using a single static registration. Once accomplished, this information can then be applied to the 3D construction of the definitive prosthesis. One procedure for registering the NZ is using modeling plastic impression compound. The thermoplastic plastic impression compound allow to mold through the action of muscles and forming the NZ registration. The NZ record helps establishing the contour of the mandibular prosthesis arch form, defining the width of the occlusal surfaces, and facilitating optimal selection of the size and position of the mandibular posterior teeth. The information carried by the NZ record should be maintained by developing an index, which subsequently serves as a guide for developing the wax trial denture.[9]

Speech capacity was in fact closer to normal in patient with CD made with NZ technique than that with conventional ones. Speech is the most accurate and fastest mechanism of the body, and its clarity has been directly related to patient's adaptability. Even a small change in tooth position may affect the pronunciation of some phonemes. Because the NZ represents the most physiological position, it allowed the participants to adapt faster and speak more clearly with their CD made with NZ technique. Moreover, the tongue plays an intricate role in the formation of vowels and consonant sounds. Positioning teeth in the NZ of equilibrium and the harmonious relationship between the denture and the tongue improve speech clarity.[10–12]

Masticatory ability was also significantly higher with CD made with NZ technique for all types of food. Wright reported that the tongue, teeth, and medial roll of the buccinator muscle are the main structures of importance for mastication. The premolar buccal surface forms a point of fixation for the medial roll of the buccinator. This helps to keep food and saliva inside the mouth during mastication and provides the buccinator with sufficient leverage so that, with the aid of the tongue, it creates a peristaltic movement essential to mastication. The second premolar assists in food mastication while the first molar initiates mastication. He concluded that a harmonious relationship between these 3 structures is essential for receiving and the subsequent mastication of food. Positioning teeth in the NZ achieved this harmonious relationship. Furthermore, the enhanced retention and stability of the denture may also have been influential in the participants' masticatory efficiency.[5,11]

As retention increases, EMG amplitudes of masticatory muscles increase, indicating an increase in muscle force which is usually reflected

in improved masticatory efficiency. Likewise, enhanced stability decreases denture movements during function, allowing the full power of the masticatory muscles to be directed toward crushing and grinding the food rather than partly masticating and stabilizing the denture.[5] Generally, patient is more satisfied with CD made with NZ technique. However, satisfaction with dental prostheses is multifactorial involving technical, patient-dentist interactions and patient-related variables, such as age, sex, educational level, patient adaptability, and period of denture use.[5]

Complete denture made with neutral zone technique offers significantly higher patient satisfaction levels in all functional aspects (retention, stability, masticatory ability, and speaking) as well as in comfort levels and appearance than conventionally fabricated dentures.

REFERENCES

1. Rahn AO, Ivanhoe JR, Plummer KD. Textbook of complete denture. 6th ed. Shelton: People's Medical Publishing House; 2009.
2. Zarb GA, Hobkirk JA, Eckert SE. Prosthodontic treatment for edentulous patients. 13th ed. St. Louis: Mosby Elsevier; 2013.
3. Driscoll CF, Freilich MA, Guckes AD. The glossary of prosthodontic terms. J Prosthet Dent 2017;117(5s): 1-105. doi:10.1016/j.prosdent.2016.12.001
4. Singh NK, Bathala LR, Jupudy SVB. Neutral zone in complete dentures. Int J Sci Res Sci Technol 2015;1(4): 222-5.
5. Al-magaleh WR, Swelem AA. Effect on patient satisfaction of mandibular denture tooth arrangement in the neutral zone. J Prosthet Dent 2018;121(3):440-6. doi:10.1016/j.prosdent.2018.06.020
6. Gahan MJ, Walmsley AD. The neutral zone impression revisited. Br Dent J 2005;198(5):269-72. doi:10.1038/sj.bdj.4812118
7. Cawood J, Howell RA classification of the edentulous jaws. Int J Oral Maxillofac Surg 1988;17(4):232-6. doi:10.1016/s0901-5027(88)80047-x
8. D KP, Mehra D, D AP. Prosthodontic management of compromised ridges and situations. Nitte Univ J Heal Sci 2020;4(1):141-8.
9. Massad JJ. Application of the neutral zone in prosthodontics. New Jersey: Wiley Blackwell; 2017.
10. Al-magaleh R, Swelem AA, Mohamed N. Setting up of teeth in the neutral zone and its effect on speech. Saudi Dent J 2012;24(1):43-8. doi:10.1016/j.sdentj.2011.11.004
11. Wright CR. Evaluation of the factors necessary to develop stability in mandibular dentures. J Prosthet Dent 1966;16(3):414-30. doi:10.1016/0022-3913(66)90045-x
12. Goyal BK, Greenstein P. Functional contouring of the palatal vault for improving speech with complete dentures. J Prosthet Dent 1982;48(6):640-6. doi:10.1016/s0022-3913(82)80020-6.