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Neutral Zone Technique

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بسم الله الرحمن الرحيم

(يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ)

صدق الله العظيم

سورة المجادلة: الآية ١١

Certification of the Supervisor

I certify that this project entitled **" Neutral zone technique"** was prepared by the fifth-year student **Astbrk Osama fadil** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Date 2022

Dedication

This work is dedicated to my beloved parents who have been my source of inspiration and gave us strength when we thought of giving up, who continually provide moral, spiritual and emotional support. To my brothers and my faithful friends who always gave me the words of advice and encouragement to finish this work.

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Abbreviations	
VDO	vertical dimension of occlusion
NZ	Neutral zone
VPS	viscosity vinyl polysiloxane
CAD	Computer-aided design
CAM	computer-aided manufacturing
EBP	esthetic blueprint
CD	Complete denture

INTRODUCTION

Neutral zone: is defined as potential space between lips and cheeks on one side, and tongue on other side, that area or position where forces between the tongue and lips or cheeks are equal. **(glossary)** The goal of dentistry is for patients to keep all of their teeth throughout their lives in health and comfort. If the teeth are lost despite all eff orts to save them, a restoration should be made in such a manner as to function efficiently and comfortably in harmony with the muscles of the stomatognathic system and the temporomandibular joints **(Srivastava, 2012)**. The stable position of the teeth represents equilibrium of all the forces acting on them. If that position of equilibrium namely the neutral zone, is not found, the resulting dentition will not last long and will not be esthetically pleasing and the patients use of functional efficiency, maximum length of use and pleasing esthetics will not have been met **(Jacobson and Krol, 1983)**. To understand the stable position of teeth, the concept of neutral zone is important. Th e neutral zone concept in complete denture was proposed by Sir E. Wilfred Fish in 1931 **(Chaturvedi et al., 2019)**. Neutral zone approach to complete denture is to locate the area in edentulous space where the teeth should be positioned in such a way that the forces exerted by muscles will stabilize the denture **(Beresin and Schiesser, 2006)**. Neutral zone technique is the most effective way for patients who have unstable and unretentive dentures.

As the patient grows, the position of teeth, size and relationship of jaws are controlled by muscles, both in repose and in function. Similarly, when the natural teeth are lost, the shape and function of their artificial replacements must be determined by the muscles, if they are to be successful **(Agarwal et al., 2010)**.

Prosthodontic treatment is influenced by this concept. The lower denture commonly presents the most difficulties with pain and looseness being the most common complaint. This is because mandible atrophies at a greater rate than

maxilla and has less residual support for retention and support. With the increase in resorption rate, the influence of impression surface on denture retention and stability decreases. Neutral zone technique is most effective way for patients who have unstable and unretentive dentures **(McCord and Grant, 2000)**

AIMS OF THE PROJECT

To evaluate the available literature about the importance of neutral zone and different techniques used to record it.

Review of literature

Review of literature

1.1 Neutral zone

Neutral zone (NZ) 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" **(GPT, 2005).**

Neutral zone technique is one of the methods of management of severely resorbed mandibular ridge cases. Various materials can be used to record the neutral zone. Balanced occlusion is one of the parameters used to aid in the stabilization of the lower denture. In this case series we will discuss about different materials such as low fusing impression compound and tissue conditioner used to record the neutral zone with different form of occlusion. "where the forces of the tongue pressing outward are neutralized by forces of the cheeks and lips pressing inward" **(Agarwal et al., 2010).**

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 **(Fish, 1931).** Since then, several authors have contributed to the development of the neutral zone concept. Ohkubo 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" **(Ohkubo et al., 2000)**.

The **(N.Z)** Philosophy It is based upon the concept that for each individual, there is a denture space which is a specific area where the function of the musculature will not unseat the denture and where the forces generated by the tongue are neutralized by the forces generated by lips and cheeks.

Functional anatomy Oral functions involve the unique interplay of the oral structures and muscles. Any interference with their movements, by a denture, would result in denture instability.

The main displacing forces acting on a lower complete denture are the tongue, the lower lip and the modiolus. If the denture is placed in the zone that balances these dis- placing forces then the denture will be retained more effectively during function. If the denture strays outside the neutral zone it will be unstable during the activities of talking, swallowing and mastication.

The NZ technique is used to minimize the displacing forces of the surrounding structures.

1.1.1 The advantages of neutral zone technique

The advantages of neutral zone technique are improved stability and retention; posterior teeth will be correctly positioned allowing sufficient tongue space; reduced food trapping adjacent to the molar teeth; and good esthetics due to **(Gahan and Walmsley, 2005)**

1.1.2 The major muscles

The major muscles involved are:

1. The buccinator This muscle has a large role in determining the neutral zone. It extends anteriorly from the pterygomandibular raphe, from above the maxillary molars and below the mandibular molars to converge, with other muscles, at the modiolus. Some fibres pass through the modiolus to terminate in the orbicularis oris. The role of the buccinator during function is to position food on the occlusal surfaces of the teeth. This action is coordinated with the tongue to maintain the food in this position **(Gahan and Walmsley, 2005)**.

2.The modiolus the modiolus is a strong knot of muscle that alters the position of the angle of the mouth. The main muscles that converge at the modiolus are the buccinator, orbicularis oris, zygomaticus major, and the levator and depressor anguli oris. Free movement of this knot of muscle must be ensured if the lower denture is to be stable. The modiolus determines the position of the premolar teeth and the shape of the polished surface in that region. This produces a narrowing of the denture so that the polished surface does not hinder the movements of the modiolus during function **(Gahan and Walmsley, 2005)**.

3.The orbicularis oris and the mentalis 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. The ridge can also resorb to such an extent that the mentalis muscle displaces the neutral zone lingually and anterior tooth position becomes even more vital for the success of the denture. The NZ technique provides the correct tooth position to allow for the balancing of these muscular forces during function**(Gahan and Walmsley, 2005)**.

4.The tongue the tongue is a powerful group of muscles and it is in constant contact with the denture at rest and during function. Dur- ing rest the two critical areas for the tongue are the anterior lingual flange and posterior to the molar teeth. The pol- ished surfaces must be correctly shaped to allow for the tongue to lie unhindered in these areas. During function the position of the anterior and posterior teeth are critical. If the anterior or 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. The occlusal plane is also important for stability. It should not be too high as to 'wall in' the tongue but should allow it to lie on the occlusal sur- face during rest **(Gahan and Walmsley, 2005)**.

1.1.3 Analysis of functional forces

Understanding the unique and synergistic interplay and complex movements of muscles of cheeks, lips and tongue is the first step in construction of lower CD that is stabilized rather than being dislodged by movements of these structures. Description of forces applied to the lower CD purely on the basis of direction is an oversimplification, yet, it is quite useful for better understanding of the concept **(Gahan and Walmsley, 2005)**.

The outward forces are principally generated by the tongue and lingual frenum into which, genioglossus muscle is inserted. Teeth should be set and flanges should be contoured in harmony with tongue size, position and shape during rest and function. In rest position, the tongue rests on lingual cusps of posterior teeth and lingual flanges posteriorly and anteriorly. The tongue space determined by position of teeth is far more important during function. Setting teeth too lingually will encroach on this space and the tongue tends to dislodge denture in function. The height of posterior teeth is of a great importance in stability of lower CD as well.

Having the tongue resting on lingual cusps will reduce the horizontal (outward) force and apply force with vertical (downward) component which enhances stability and retention **(Rashid *et al*., 2013)**.

Inward forces are generated by cheeks resulting from contraction of the buccinator muscle that pushes food bullous on top of occlusal surfaces of posterior teeth. Flanges contoured and teeth set too buccal are at increased risk of being dislodged by the action of this muscle. Anteriorly, lip muscles (mentalis and orbicularis oris) are the source of inward forces generated during speaking and swallowing. Contraction of these muscles to attain seal during these activities can destabilize lower CD with teeth and flanges placed too far labially. The modiolus is a knot-like structure found in corners of the mouth where several muscles are inserted. Movement of this structure narrows the space available for flanges and teeth. The modiolus produces quite strong inward forces in premolar region. Thus, contouring flanges in harmony with its' functional movement is essential **(Gahan and Walmsley, 2005)**.

1.1.4 Rationale of neutral zone

The rationale of using neutral zone technique is to fabricate a lower CD that is optimally situated and in harmony with the structures and forces discussed above. By doing so, these forces are more likely to be stabilizing rather than unseating. The need for such a technique that is based on physiologic concepts is significantly increasing as emergence of several factors render a high proportion of conventionally made lower CDs unsatisfactory **(Lynch, 2006)**.

Increased access to dental care has led to patients losing their teeth at a later stage of life. Compounded by increased life expectancy, this has led to the majority of CD wearers to be elderly and has increased the proportion of those who have poor

neuromuscular control, poor adaptive capacity, severely atrophic ridges14 and atypical denture support area as a result of surgical interventions, poor planning for transition from partially dentate to edentulous state, untreated edentulism for long period of time, trauma or systemic diseases. Occasionally, patients with one or a combination of these conditions can be successfully treated by CD constructed by conventional techniques **(Raja, 2010)**.

1.1.5 Indications of neutral zone technique

In general, neutral zone technique is indicated when stability and patient's acceptance of lower CD are in question. Searching the literature, this technique is found to be used in the following clinical situations:

a) Severely atrophic mandibular ridge (Atwood's V) **(Memarian, 2011; Hina and Raja, 2009).**
b) Patients with prominent and highly attached mentalis muscle, lateral spreading of tongue as a result of poor transition from dentate to edentulous state and severe resorption **(Lynch, 2006)**
c) Patients with diminished neuromuscular control such as those with a history of stroke, Parkinson's disease or patients with impaired motor innervation to oral and facial muscles as a result of brain surgery **(Memarian, 2011)**
d) Patients with atypical shape or consistency of oral and perioral structures. For example, patients who have scleroderma, marginal or segmental mandibulectomy and partial glossectomy **(Pravinkumar, 2011)**.
e) NZ technique can be used to locate optimal position for implants in cases of implant-supported or -retained overdentures, which enhances the overall outcome of treatment **(Yasunori, 2006)**.

1.2 Clinical technique of neutral zone

Primary and secondary impressions are taken for maxillary and mandibular denture bearing areas as in standard complete denture treatment. Bite registration is then performed as in conventional treatment. Master casts with record blocks should be mounted on an articulator. In the lab, the lower occlusal rim is removed from baseplate and substituted with a baseplate with acrylic pillars in the premolar regions and/or wire loops on the remaining areas of the baseplate. The pillars preserve the VDO recorded in bite registration stage. It is essential the pillars are relatively thin bucco-lingually and are positioned directly over the ridge **(Basker, 2011); (Lynch, 2006).**

The base plate is then fitted in the patient's mouth and VDO and extensions are checked. Then impression material such as compound, plaster, wax, silicone, polyether or tissue conditioner is applied to the baseplate and retained by the wire loops and/or acrylic pillars (Figure 1-1). Before setting of material, patient is asked to perform functional movement such as, licking lips, swallowing, pronouncing some words or combination of these **(Kursoglu et al., 2007)**.

Care should be taken that the patient should continue performing functional movements until the full setting of material (Figure 1-2); otherwise, material might flow back and give inaccurate recording of the neutral zone. It is useful if the chosen material has relatively long working time to allow the required movements to be carried out before the material becomes rigid (Table 1-1). Also, it is worthwhile to mention that it is better to perform the NZ record while the upper occlusal rim or finished denture is fitted in the patient mouth as it may help to control recording

material and prevent it from being displaced in a labioocclusal direction **(Basker, 2011)**.

Figure (1-1) NZ baseplate with acrylic pillars and wire loop (Jum'ah, 2011)

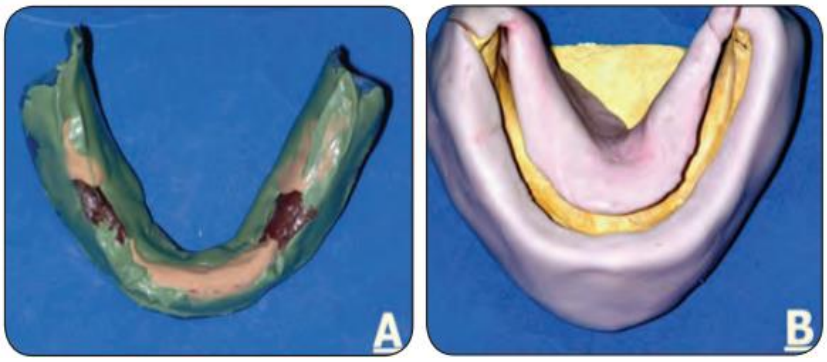

Figure (1-2) A: NZ impression taken with silicon. B: Putty index adapted around master cast (Jum'ah, 2011)

Table (1-1): Materials Used for NZ Impression (Jum'ah, 2011)

Impression plaster
Impression waxes
Impression compound
Regular bodied silicone
Tissue conditioner
Polyether
Hard relining material

In the lab, the baseplate carrying recording material is fitted on the master cast again and VDO is checked. A putty or plaster index is made around the NZ record. Placement of three orientation grooves is recommended as these helps in repositioning the index on the master cast. Impression material is then removed and replaced by wax; the use of the index will make sure that wax replicates the neutral

zone record. Subsequently, teeth should be set and flanges contoured according to the index that represents NZ (Table 1-2).

NZ impression technique has various modifications, not only in terms of materials used or retention provided by baseplate, but also in terms of the functional movements performed and refinement of the procedure. A further more defined NZ record can also be achieved in try-in stage. The wax below the teeth and covering the flanges can be cut back and tissue conditioning material or medium-bodied silicone applied. The patient is asked again to perform functional movements. The dentures are processed as usual. The same procedure has also been described after insertion of the denture but using hard relining material **(Mccord and Grant, 2000).**

Table (1-2): Summary of clinical and laboratory stages of NZ technique (Jum'ah, 2011)

Clinic 1: Upper & lower primary impressions using stock trays **Lab1:** Casting primary models and construction of special trays
Clinic 2: Upper & lower secondary impressions **Lab 2:** Casting master models and construction of record blocks
Clinic 3: Bite registration **Lab 3:** Mounting master casts using CR record on semi-adjustable or average value articulator. Removal of lower wax rim and fabrication of baseplate for NZ impression
Clinic 4: NZ impression **Lab 4:** NZ impression record mounted on lower master cast, orientation grooves placed on master cast, putty index adapted around NZ record and impression material removed and poured in wax Finally, setting of teeth completed
Clinic 5: Try-in stage. Afterwards, NZ impression refined by tissue conditioner applied to lower try-in denture **Lab 5:** Processing, finishing and polishing
Clinic 6: Insertion of finished dentures

1.3 Neutral zone technique for severe mandibular ridge resorption

The neutral zone technique described by **Yi-Lin *et al*., (2013)** is simplified to record the physiological dynamics of oral and 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 (Figure 1-3). They were made of autopolymerized tray resin.

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. Any underextended border could be corrected by border molding with plastic impression compound if needed. The individual tray should be stable during speaking, swallowing, and mouth opening **(Fahmy *et al*., 2001).**

Figure (1-3) The lower arch individual tray with a resin rim. Overextension and interference were carefully checked and reduced intraorally for its stability in functions of speaking, swallowing, and mouth opening (Yi-Lin *et al*., 2013)

Figure (1-4) Neutral zone impression with the polyether impression material (Yi-Lin *et al*., 2013)

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. Polyether impression material was loaded on the buccal and lingual sides of the lower individual tray after polyether adhesive was applied and dried. The individual tray was then rotated into the patient's mouth. Before the material sets, the patient was instructed to perform functional movements such as licking lips, sucking, puckering, smiling, grinning, swallowing, pronouncing some words, or combination of these. These actions should be repeated until the material has set. After setting, the displaced excess material was removed (Figure 1-4). 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 **(Yi-Lin *et al*., 2013)**.

The rubber base adhesive was applied on the tissue side and the border area of the tray. A final wash impression was accomplished with a polysulfide impression material. 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 (Figure 1-5) **(Yi-Lin *et al*., 2013)**.

Figure (1-5) Tissue-side final wash impression with the polysulfide impression material (Yi-Lin *et al*., 2013)

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 for preserving the neutral zone on the cast (Figure 1-6).

Figure (1-6) (A-C) Before the tray was removed, a silicone matrix was made to represent the neutral zone space (Yi-Lin *et al*., 2013)

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. 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 **(Yi-Lin *et al*., 2013)**.

After processing, finishing, and polishing, the dentures were delivered to the patient and tested for stability, retention, intercuspal relation, esthetics, and

phonetics. Fit checker was used to check the neutral zone space. The result had a little difference. However, no interference was noted (Figure 1-7).

Figure (1-7) (A-F) Final complete dentures. (E and F) Fit checker was used to check the neutral zone space. The result was of little difference (Yi-Lin *et al*., 2013)

1.4 Recording the physiologic neutral zone for a dentate patient

Patients who have been edentulous for an extended period generally exhibit decreased facial muscle tone and a large tongue size, thereby affecting the retention and the stability of their prostheses. The neutral zone concept is applied to the edentulous patient to facilitate stability of the removable prosthesis and decrease food entrapment into vestibular spaces. Patients who have had significant loss of teeth, severely worn dentition, and reduced OVD (who may be candidates for immediate dentures and or full mouth restorations) often demonstrate decreased muscular tonicity and large tongue volume. Accurate registration of the neutral zone in these patients can be accomplished using a single clinical record called the cameogram. The cameogram aids in defining appropriate bucco-lingual position of

the prosthetic teeth and thickness, contours, and shape of the denture's cameo surface. During development of the cameogram, physiologic molding of impression material is accomplished so that the polished surfaces of restoration will be in physiologic harmony with the muscles of the lips, cheeks, and tongue **(Cagna *et al*., 2009).**

1.4.1 Clinical technique

High viscosity vinyl polysiloxane (VPS) impression material is injected under the lips to the full extent of the labial/buccal vestibules (Figure 1-8). The patient is instructed to perform the sequence of oral movements to mold the VPS registration material. Appropriate movements for molding the registration material include: puckering lips forward, smiling, opening and closing the mouth, and moving the mandible from side to side. These maneuvers are repeated several times. After adequate polymerization of the registration material it is carefully removed from the mouth and evaluated (Figure 1-9). Similarly, a high viscosity VPS impression material is injected on the lingual aspect of the mandibular arch to the full extent of the lingual vestibule (Figure 1-10a). Appropriate movements for molding the lingual registration include extending the tongue and moving it from left to right and licking the upper and the lower lips with the tongue. These maneuvers are repeated several times. After adequate polymerization, the registration is carefully removed from the mouth and evaluated (Figure 1-10b) **(Joseph *et al*., 2017).**

Figure (1-9) Maxillary (buccal) cameo impression (left); mandibular (buccal) cameo impression (right) (Joseph *et al*., 2017)

When there are significant areas of missing teeth a record base with a modeling plastic impression compound rim is fabricated to record the neutral zone in the edentulous spaces. The rim is heat softened and placed into the mouth. The patient swallows to register the inward forces of the cheeks and the outward forces of the tongue as described above ("Recording the physiologic neutral zone for edentulous patient.")

Finally, VPS putty matrices are fabricated to surround these registrations and, oriented to an indexed position on the master casts (Figure 1-11). These matrices will later be used to transfer physiologic boundaries of the registered neutral zone to cameo surface contour of transitional and / or definitive prostheses **(Joseph *et al*., 2017)**.

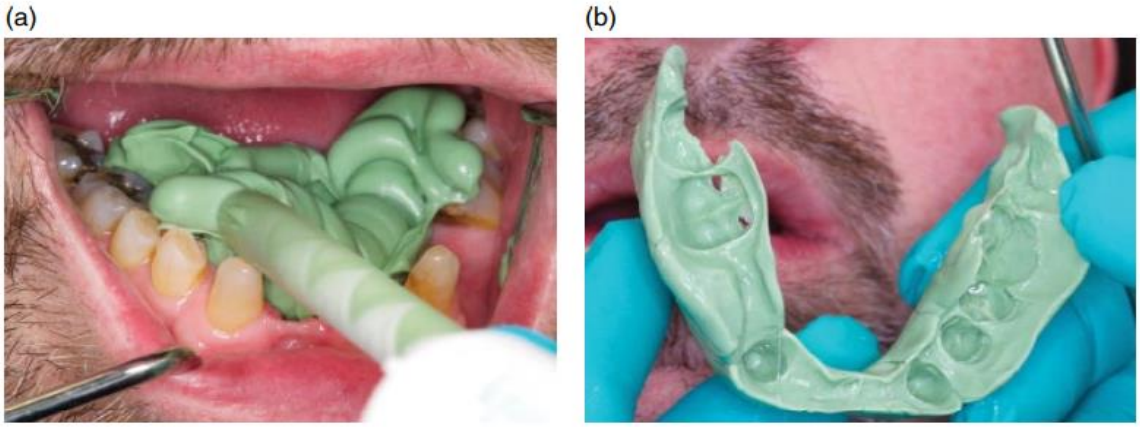

Figure (1-10) (a) VPS impression material injected on the lingual surface of the mandibular arch; (b) mandibular (lingual) cameo impression (Joseph *et al*., 2017)

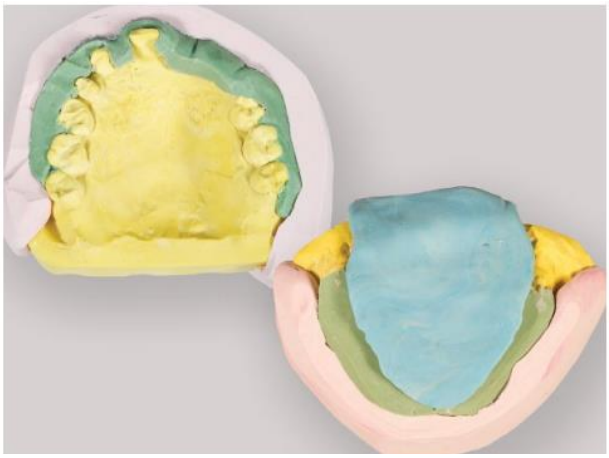

Figure (1-11) Indexed facial matrix developed around the cameo impression of the maxillary arch using laboratory putty (left). Indexed facial and lingual matrices developed around the cameo impression of the mandibular arch using laboratory putty (right) (Joseph *et al*., 2017)

1.5 Use of CAD/CAM technology for recording and fabrication of neutral zone dentures

Computer-aided design / computer-aided manufacturing (CAD/CAM) technology has been used in dentistry since the early 1980s. Andersson envisioned the use of titanium for crown fabrication and pioneered the CAD/ CAM fabrication

process, which resulted in cementation of the first CAM fabricated titanium crown in 1982 **(Andersson, 2007)**. Mörmann developed a prototype CAD/CAM system in 1983 and placed the first chairside fabricated ceramic restoration in 1985 **(Mörmann, 2004; Mörmann, 2006)**. Since that time, CAD/CAM technology has been used for the fabrication of intracoronal and extracoronal crowns, fixed partial dentures, and implant prostheses. Recently, CAD/CAM technology has been applied to the fabrication of complete dentures **(Baba, 2016; Goodacre *et al*, 2016).** By milling complete denture bases from prepolymerized pucks of acrylic resin (AvaDent system, Global Dental Science, Scottsdale, Arizona), the polymerization shrinkage inherent in the traditional methods of fabrication is eliminated. The digital milling process also provides a precise and a reproducible record of the prosthesis design, permitting the fabrication of a duplicate or replacement denture without having to obtain clinical records again.

The digital process of fabricating complete dentures involves scanning conventional complete denture records **(Bidra *et al*, 2016; Saponaro *et al*, 2016)**. It is also possible to scan the neutral zone record **(Beresin *et al*, 1979; Cagna *et al*, 2009)** and the esthetic blueprint (maxillary occlusal rim with the clinically set anterior prosthetic teeth) along with the definitive impression and the interocclusal record, to locate prosthetic teeth positions and to determine the contour and form of the cameo surface of the denture. The CAD/ CAM software can also be used for printing record bases and wax trial dentures using stereolithography. Several techniques that can be used to incorporate the neutral zone into the CAD/CAM fabrication of complete dentures are described below.

1.5.1 Registering the neutral zone during impression making

The neutral zone record can be registered at the time of making definitive impressions **(Yi-Lin *et al*, 2013)**, using VPS impression material, and then it can be incorporated in the CAD/ CAM fabrication of complete dentures. The following steps should be performed during impression procedure.

1) A conventional clinical impression is made of the edentulous ridges using VPS impression material in stock edentulous impression trays **(Massad *et al*, 2007)**. Note that caution should be exercised to ensure that the thickness of the underlying tray and impression is not excessive, or else registration of the neutral zone will be distorted.
2) Excess impression material that extends onto the occlusal surface of the impression tray is trimmed away with a scalpel blade ensuring that a minimum of 5mm of the recorded borders is retained.
3) The occlusal surface is coated with a suitable VPS adhesive and medium-viscosity VPS impression material is applied and extended occlusally and posteriorly up to the level of the center of the retromolar pad (recorded in the definitive impression). Limiting the extension to this height (center of the retromolar pad) permits recording of the neutral zone without having to use an excess amount of VPS material.
4) The impression is accurately seated in the mouth and the patient is asked to swallow three times consecutively while pressing the lips together and then maintaining the lip and tongue positions until the completion of the polymerization of the impression material. Swallowing causes contraction of the lip, cheek, and tongue muscles, with the lateral borders of the tongue producing a depression in the lingual surface of the impression material. Many authors have suggested placing the occlusal plane at the same level as the lateral border of the

tongue **(Nagle *et al*, 1962; Ghosn *et al*, 2012)**. Thus the occlusal extent of the lingual depression can be used as a guide to determine the level of the occlusal plane.

5) A scalpel blade is used to slice through the polymerized impression material horizontally up to the occlusal level of the lingual depression, and the neutral zone is identified and the record is developed by further sculpting of the VPS material.
6) The impression is scanned to record both the intaglio surface and the occlusal surface (neutral zone record). A virtual cast (with defined neutral zone) is generated in the software. The opposing arch impression and the interocclusal records are also scanned. A mold of teeth is selected and incorporated into the virtual neutral zone in the software. After establishing the desired occlusion of the prosthetic teeth in the software, trial dentures are milled using the desired shade of tooth-colored resin. After trial placement and making final revisions, the definitive dentures are milled using either a monolithic denture design where the teeth and base are one unit or by bonding the manufacturer's prosthetic teeth into recesses milled in the denture base.

1.5.2 Registering the neutral zone during maxillo- mandibular records

The process of registering the neutral zone during maxillo-mandibular records appointment using modeling plastic impression compound are **(Cagna *et al*, 2009):**

1) The mandibular record base with a modeling plastic impression compound occlusion rim is immersed in a warm water bath set at a temperature of 140 °F and uniformly softened. It is removed from the water bath and quickly placed in the patient's mouth carefully, avoiding distortion.

2) The patient is given a glass of warm water and is instructed to swallow, then sip more warm water and swallow again. The sipping and swallowing procedures are repeated several times to mold the compound through the action of the cheek and lip muscles moving inward, and the muscles of the tongue moving outward
3) Once cooled and solidified, the neutral zone record is removed from the mouth, its accuracy is verified, and the excess material is trimmed using a sharp blade (Figure 1-12).
4) The neutral zone record is placed on the cast and it is scanned along with the cast. The esthetic blueprint (EBP) and the opposing cast with interocclusal record are also scanned. A three-dimensional electronic image is created of the interarch and neutral zone relationships. Using collective data of the scanned images, denture teeth are digitally planned and positioned to lie within this established space using the planning software program (Figure 1-13) **(Joseph et al., 2017).**

Figure (1-12) Neutral zone impression made using modeling plastic impression compound (Joseph et al., 2017).

Figure (1-13) (a) Scanning the neutral zone record and mandibular cast (left). Scanned image of the neutral zone record (right); (b) Scanning the EBP wax rim along with the maxillary cast (left). Scanned image of the EBP wax rim (right); (c) scanning the opposing casts with the interocclusal record; (d) a three-dimensional electronic image depicting the interarch relationship and neutral zone space of the mandibular arch; (e) Top, neutral zone used to identify prosthetic teeth positions; Bottom, maxillary and mandibular teeth digitally arranged (Joseph et al., 2017).

1.5.3 Registering the neutral zone during the trial placement

The neutral zone record can be registered at the trial placement appointment and then be incorporated in the CAD/CAM fabrication of complete dentures.

The technique is:

1) Conventional complete denture impressions are made and beaded and boxed appropriately, ensuring that the desired amount of the impression borders are visible (Figure 1-14) **(Powter *et al.*, 1981; Rudd *et al.*, 1986)**. The boxed impression is then scanned and the scan data is used to print multiple record bases, using stereolithography.
2) A gothic arch tracing device (Massad Jaw Recorder, Nobilium Company, Albany, NY), is attached to the printed record bases and maxillo-mandibular relationship records are registered (Figure 1-15) **(Massad *et al.*, 2004)**.
3) An undercontoured wax occlusal rim is added to another printed maxillary record base. Shell teeth (Visionaire Dental Shells, Nobilium Company, Albany, NY) are waxed on the rim and their positions are verified clinically so as to achieve optimal esthetics.
4) The casts with the maxillo-mandibular records and the wax rim with the shell teeth (EBP) are scanned. The information obtained from the scanned data guides the digital arrangement of the prosthetic teeth. Prosthetic teeth are digitally arranged in the software, and virtual trial dentures are generated and then printed using stereolithography.
5) The trial dentures are used for esthetic evaluation and also to record the neutral zone (termed cameo surface impression) using VPS impression material on the cameo surface of the printed trial denture (Figure 1-15).

6) The clinically verified printed trial dentures with cameo surface impressions are scanned and used to mill definitive dentures (Figure 1-16).

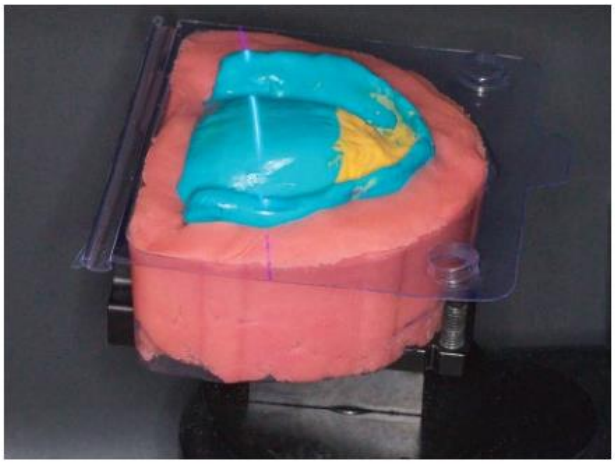

Figure (1-14) Impression boxed to expose the borders (Joseph *et al.*, 2017)

Figure (1-15) Maxillary printed record base with attached tracing plate and completed gothic arch tracing (upper left); mandibular printed record base with central bearing pin assembly attached (upper right); interocclusal record made with gothic arch device (bottom) (Joseph *et al.*, 2017).

Figure (1-16) Cameo surface neutral zone impressions made on printed trial dentures (Joseph *et al.*, 2017).

Figure (1-17) Definitive milled dentures (Joseph *et al.*, 2017).

1.6 Using zinc oxide eugenol to record neutral zone

Zinc oxide eugenol impression paste is used with a little modification to prolong the setting time. Setting time of the zinc oxide eugenol paste was prolonged by the addition of 1 ml of olive oil **(Singh, 2011)**, to an equal length of 10 centimetres of base and catalyst paste. This not only prolonged the setting time but also reduced the rigidity of material that helped in more accurate recording of neutral zone **(Makzoume, 2004).** Additional steps taken, in addition to the use of olive oil in prolonging setting time were to cool the mixing spatula and mixing slab in refrigerator for half an hour just before use and then mix the paste within 30 seconds.

The mixed paste was quickly applied on the denture base with compound rims in the window and taken into the mouth, the same movements were carried out by the patient as were done with the tissue conditioner. Compound rims with denture bases were removed after 20 minutes and again adapted back to the articulator. Markings were made in a similar way and point micrometer range 0-25 mm was used to measure the bucco-lingual width at the same at four predetermined and marked points, on the material which was moulded. Similar procedure was also carried out 2 times in each patient. After recording neutral zone patients were followed by try-in procedure and complete denture were fabricated and inserted **(Raja, 2010)**.

Conclusion

Conclusion

1. Neutral zone is an mean technique for the construction of complete dentures on highly atrophic ridges. It is especially useful in cases where dental implants are not possible.
2. The aim of the neutral zone is to construct a denture in muscle balance, as muscular control will be the main stabilizing and factor during function. The technique is relatively simple but there is increased chair time and laboratory costs.
3. The neutral zone technique for denture fabrication has an advantage that it stabilizes the denture with the surrounding soft tissues, instead of being dislodged by them. and stability of dentures are greatly improved, especially in the severely atrophic ridges.
4. When patients cannot undergo an implant overdenture therapy due to medical and dental contraindications, the neutral zone technique 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. Considering the benefits of this technique, it is recommended that clinicians should incorporate it in their routine prosthodontic management of edentulous patients

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