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Effect of positioning of artificial teeth, contouring and body forms following rehabilitation of resorbed mandibular ridges: Case reports

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Abstract
The successful rehabilitation of completely edentulous patient is a pleasant surprise for old aged patient and a reward to a prosthodontist. Although implant supported prosthesis have grown as a new treatment trend for edentulous patients but choosing the best form of therapy should reflect dentist's knowledge for effectiveness of treatment and at the same time patient understanding of treatment risks and also cost effectiveness. In developing countries, cost is being a major determinant of patient's choice specially with unemployed residual ridge. In this case report a clinical technique has been explained for physiologic registration of denture tooth position, denture base contours and body forms for resorbed mandibular ridges.

Keywords: Resorbed ridge, Neutral zone, Teeth arrangement, Complete denture.

Introduction
Constructing complete dentures for "difficult lower jaw" as suggested by Brill[1] presents a challenge to the dentists. Various structures of the oral cavity changes considerably when a patient becomes edentulous. Because of these changes the lips and cheeks are no longer supported by the teeth and bone, and therefore tend to "fall" into the oral cavity & simultaneously the tongue expands into the space formerly occupied by the teeth which is partly due to a growth of the tongue, and has been named proptosis lingualis.[2] In this way, characteristic spaces develop in the oral cavity of edentulous patient forming the so called denture space. The dynamics of the tissues surrounding this space determine the form of the denture.[1]

Resorption of bone causes the residual crest of the residual ridge to approach the musculature of the denture space. Frequently, this development terminates with the attachment of the mentalis and mylohyoid muscles located only 2 or 3 mm from the crest of the mandibular residual ridge.[3] Therefore, these muscles can easily dislodge a denture. Moreover, bone resorption also causes soreness on the surface of soft tissue that is firmly attached to the underlying bone to be reduced[4] thus eliminating well-defined vestibular and lingual sulci. All these events further complicate the construction of denture.

Thus before constructing a denture, one should be familiar about following detail: The surface of a denture can be divided into different regions, each with its own function. These are: the pressure receiving surface (the occlusal table); the pressure transmitting surface (the primary supporting surface or basal seat) and finally; the secondary supporting surface which is comprised of the polished surfaces of the denture and the lingual and buccal surfaces of the teeth. The junction of the primary supporting surface and the secondary supporting surfaces is called the denture border.

Fish[5] published a classic monograph in which he explained about three principal factors of mandibular stability as faithful reproduction of maximally available impression surface; proper management of occlusion; and modelling of the polished surfaces to function in harmony with the orofacial musculature. The importance of properly shaped external surfaces is best expressed by Fish, "If there is not much ridge, the impression and occlusal surfaces cannot resist lateral displacement. Therefore, the only hope lies in the third or polished surface. It must be fashioned to fit the lips, cheeks, and tongue, both at rest and in function."

A detailed protocol of recommended procedures and materials for accomplishing the neutral zone procedure should be followed in patients suffering from severe residual ridge atrophy and/or chronically reduced occlusal vertical dimension, the procedures discussed here may be used during most edentulous therapies, including those incorporating dental implants.

Case Report
Case 1
A sixty five years old female patient reported to the Department of Prosthodontics, Seema Dental College and Hospital with her broken lower denture and loosen upper denture and wanted replacement for the same. Patient gave a history of loss of teeth over a period of 3-5 years and was wearing denture since then. On clinical examination, patient Perioral soft tissue was slack and vertical dimension was also reduced. On intraoral examination, resorbed maxillary and mandibular ridges were seen. Maxillary arch showed deep anterior undercut in the labial vestibular region with small maxillary tuberosities. (Fig. 1) Mandibular ridge showed Atwood order-V type of ridge and broad and flattened tongue along with reduced buccal and lingual vestibular depth.

The planned treatment was immediate replacement for both upper and lower edentulous arches. Preliminary impressions for upper and lower arch were made using impression compound via admix technique (seven parts by weight of tracing compound and three parts by weight of impression compound) in nonperforated stock trays for better recording of available impression surface and poured in

TYPE II Gypsum product, i.e. Dental plaster. On these primary cast special tray were fabricated using self cure acrylic resin. Border moulding was done using low fusing tracing compound and final impressions were made using zinc oxide eugenol paste **(**DPI Impression paste) for both upper and lower arches. Master casts were poured in TYPE III Gypsum product, Dental Stone. Finally trial denture bases were fabricated using self cure acrylic resin for both upper and lower arch; and on these occlusal rims were fabricated using modelling wax and tentative jaw relation was recorded. This tentative record was mounted and then lower rim was removed. On a new denture base occlusal rim was fabricated with impression plastic to record neutral zone. In a hot water bath (140^0F) seven parts of green stick (DPI pinnacle tracing sticks) and three parts of impression compound (Y-DENT) by weight were taken and material was kneaded thoroughly and adapted on record base forming a recording rim. Edges were sealed using heated wax knife. These completed record base along with rim were kept in water bath for around two minutes.

For recording neutral zone the base and rim from the water bath was removed and quickly placed intraorally. The patient was instructed to swallow. Next, a cup of warm water was provided to the patient and was instructed to sip and swallow. Have the patient repeat this sip and swallow exercise several times. Then the patient was trained to perform various exercises like pressing his lips, swallowing, sucking, moving her tongue in oral cavity touching her palate, lips and cheeks and take sips of hot water and repeat all these exercises while keeping her mouth closed. In this way this coordinated muscle activity plastically shapes the rim to form the neutral zone. Observe the resulting volume of the neutral zone record as it defines the area in which the denture teeth will be placed and all muscle activity recorded on the rim made of impression plastic (Fig. 2).

When the neutral zone record has cooled and hardened, remove and inspect the record for accuracy and completeness. If necessary, we can repeat the procedure to ensure proper recording of the entire neutral zone. Eliminate excess modeling plastic impression compound displaced superior to the intended occlusal plane during the recording procedure and, if necessary, repeat the recording process, beginning with the warm water bath.

To develop neutral zone index, (Fig. 3) three notches were made on the mandibular cast, articulated in a mean value articulator; one in the anterior and two in the posterior regions. This was followed by applying separating medium on the cast, the record base, and over the neutral zone record. Boxing was done with modelling wax, and plaster of paris was poured to the upper surface. The plaster indices were sectioned into a labial and buccal index and lingual index in order to guide the removal and placement of these indices. Neutral zone record is then removed; separating medium is applied on the inner surfaces of indices which were then reassembled. Wax was heated and poured in the space representing the neutral zone, forming the new occlusal rim on the mandibular record base.

During teeth arrangement first maxillary and mandibular anterior teeth were arranged according to the lower rim and then mandibular posterior teeth were arranged following maxillary posteriors. In order to preserve the contours established no additional wax was added to the denture flanges. On the next appointment wax try-in was performed to evaluate the stability, aesthetics, intraoral occlusion and phonetics of the patient (Fig. 4). Patient performed all the movements mentioned earlier. Then these trial denture bases were processed with heat-cure acrylic resin. Dentures were polished and insertion was done again verifying the occlusion, phonetics and aesthetics of the patient (Fig. 5). Patient was recalled periodically to verify comfort and function.

Fig. 1: Intaoral view of resorbed mandibular arch

Fig. 2: Neutral zone recorded using admix technique

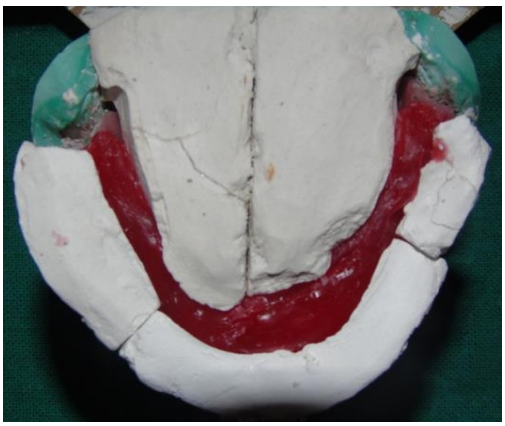


Fig. 3: Neutral zone index made using dental plaster

Fig. 4: Finished and polished dentures

Fig. 5: Denture insertion

Case 2

A 45 years old male patient reported to the Department of Prosthodontics, Seema Dental College and Hospital with chief complaint of difficulty in chewing and replacement of his old dentures which were loose. Patient was a old denture wearer, and his old maxillary denture comprised of suction disc. On examination patient showed resorbed maxillary and mandibular ridges and slight inflammation with palate. Patient was advised to stop using his old dentures so that inflammation can subside and was recalled after a week for new denture fabrication.

Primary impressions were made using impression compound and diagnostic cast were poured. Special tray was fabricated for upper arch and border moulding was performed using tracing compound and final impression was made. For lower arch special tray was fabricated along with two stoppers in molar region and impression was made using closed mouth technique using admix technique (Fig. 6) and patient was asked to perform all tongue and cheek movements as mentioned earlier. Again this impression was poured primary cast was obtained, on which a new special tray was fabricated and final impression was made. These impressions were poured in dental stone to obtain master casts.

Denture base were fabricated using self cure acrylic resin along with occlusal rims to record tentative jaw relation of the patient. Tentative record was mounted and a new rim using impression compound was made to record neutral zone by training the patient to perform all tongue and cheek movements (Fig. 7).

Neutral zone index was made using silicon putty material around the recorded impression of denture space. Indexing was made on side and centre of the land area of cast (Fig. 8). Putty was adapted into the tongue space of the neutral zone record so that it is in level of occlusal plane of record and extends over the posterior land area of cast. Likewise facial matrices were developed along the facial contours of the neutral zone record. Once polymerized, putty matrices were sectioned and removed from the cast. Impression compound is removed from base and replaced with wax using putty matrices.

Using the matrices anterior teeth arrangement for upper and lower arch followed by placement of mandibular posteriors and then maxillary posteriors were arranged. Waxed up denture trial (Fig. 9) was done and then dentures were processed and insertion (Fig. 10) was done. Patient was asked to perform all the movements explained earlier and was recalled periodically to check for retention and stability of dentures.

Fig. 6: Impression recorded using closed mouth technique

Fig. 7: Recorded neutral zone in impression compound

Fig. 8: Neutral zone indexing done using putty

Fig. 9: Try-in of waxed up denture bases in patient's mouth

Fig. 10: Denture insertion

Discussion

With the neutral-zone concept, the impression surface is called the "base" and the polished surface is called the "body" of the denture. In the past, we did not orient our thinking in this direction, and as a result, we were less aware of the problems and their solutions.

In neutral-zone procedure, the external contours are moulded by muscle function. The mouldable material used to locate the neutral zone also determines the shape of the arch and the angles and contours of the body of the denture. These three entities are determined by the size and function of the tongue and action and tonus of the lips and cheeks. Just as a primary impression is the first step in developing the impression surface of the denture, the compound rims which located the neutral zone can be considered the primary impression or the first procedure in developing the polished surface of the denture. The neutral-zone approach advocates the use of a closed-mouth impression technique.

Wright et al[6] demonstrated that in a large number of patients, the occlusal plane had a constant positional relationship to specific anatomic landmarks of one half to two thirds of the way up the retro molar pads and the corners of the mouth. The pads are relatively stable landmarks even with advanced ridge resorption. One plausible explanation of this phenomenon lies in the pressure/tension concept; that is, pressure causes bone resorption while tension in the region of muscle attachment preserves bone or even encourages the deposition of new bone.[7]

Regardless of the fabrication technique used, functionally inappropriate denture teeth arrangement or physiologically unacceptable denture base volume or contour have been implicated in poor prosthesis stability and retention, compromised phonetics, inadequate facial tissue support, inefficient tongue posture and function, and hyperactive gagging.

Arch arrangement is defined as the buccolingual position of the teeth with respect to the stress-bearing region or residual ridge in the horizontal plane. This consideration, combined with the proper shaping of the external surfaces, is the heart of the neutral zone philosophy.[11] Directives provided for optimal facial-lingual arrangement of posterior denture teeth have varied dramatically over the profession's long history of complete denture therapy.

Positioning artificial teeth in the neutral zone achieves two objectives. First, the teeth will not interfere with the normal muscle function. Second, the forces exerted by the musculature against the dentures are more favourable for stability and retention.

Boucher also concluded that when teeth are placed in the neutral zone, a lack of favourable leverage is compensated for by the controlling action of the orofacial muscles that confine the dentures.[13]

When the anterior teeth are positioned in harmony with muscle function, the lips will invariably have the proper aesthetic appearance. As a general rule, the orofacial muscles must have room to move, or they will move the denture. The concept of "available denture space" could lead to a philosophy of muscle avoidance wherein the prosthesis occupies as little space as possible. This is inadequate, because the goal is to enlist the neuromuscular system in the functional stabilization of the lower denture.[11]

Techniques described here are intended to emphasize and illustrate the clinical value of recording the physiologic dynamics of oral and perioral muscle function and of using this information to develop complete denture contours and denture tooth positions.

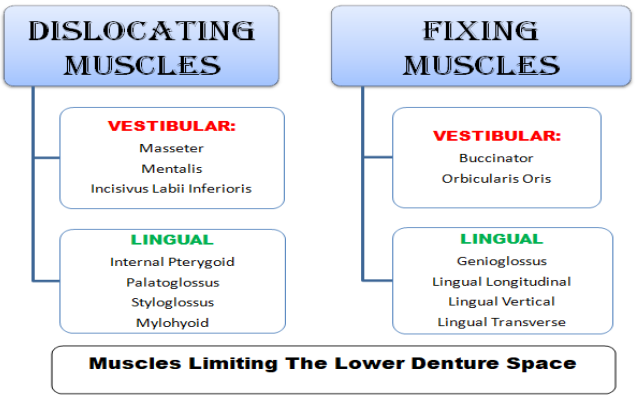
We all have had the experience of inserting a lower denture which moves upward as soon as the patient opens his mouth or starts to speak. The first assumption is usually that

the denture is overextended so that the denture periphery may be reduced. However, no matter how much the base is reduced, it still pops up. It is not unusual to end up with a denture base that is considerably smaller than the original size but that still lacks stability and moves during the slightest function. It is not the denture base that is the cause for denture instability but, rather, the body of the denture, that is: the tooth position and the flange form which was erected on top of the denture base.

Stability of a lower denture is dependent on Muscle function which affects: impression, occlusal plane, the arch arrangement, jaw registrations, occlusal patterns, aesthetics, the polished surface contour, food trough formation and mastication and neuromuscular skills.

Muscles and their functional activity affect impression procedures by power, anatomic attachment height and creation of valve-seal borders. When treating patients with above average muscular force, many dentists prefer to use the selective pressure method of impression making. The closer the frenum attachment is to the crest of the region, the less basal seat region is available for the physical factors of retention that include adhesion, cohesion, atmospheric pressure, capillarity, and interfacial surface tension. Proper border extension is an imperative of impression making, particularly where the mandible is concerned[1]. The labial and buccal vestibular muscles are primarily muscles of dislodgment.

The musculature of the denture space is divided into two groups: those muscles which primarily dislocate the denture during activity and those muscles that fix the denture by muscular pressure on its secondary supporting surfaces.



The vestibular muscles of facial fixation are the medial roll of the buccinator and the orbicularis oris muscles because they initiate function and facial expressions with the remaining six muscles of the modiolus. However, the buccinator muscle was shown by Lundquist [9] to affect stability only when the patient is a bilateral chewer. The study further showed that the muscle was incapable of adapting to changes in denture base contour.

The muscles of lingual fixation are the superior and inferior lingual longitudinals, the lingual transverse, the lingual vertical, and the genioglossus muscles. The first four are the intrinsic tongue muscles that control shape and form. Martonet[10] emphasized that the tongue, which rests upon the mandibular ridge, will stabilize the lower denture. The tongue is considerably more powerful than the lips and cheeks. The tongue can exert a force of 16.4 psi[12] while the lips and cheeks can exert only 4.3 psi.[10] The lingual therefore is the surface of choice when external contours are moulded. Considerable care must be taken, because the lingual influence can mitigate against stability.

Without muscular contraction and relaxation, movement of the mandible would be impossible. The act of depressing the mandible involves the suprahyoid and the platysma muscles, infrahyoid muscle and lateral pterygoid muscles. The muscles that elevate the mandible are the temporal, masseter and internal pterygoid muscles. The external pterygoid muscle is the guidance muscle of mandibular movement. The condyles and teeth only modify movement that is initiated by the neuromuscular system.[8]

A thorough understanding of the anatomy and physiology of structures that impact sound complete denture fabrication and function is important for successful treatment of edentulous patients. Use of the neutral zone method to identify and register the anatomy and physiology of oral tissues that impact the prosthesis stability may result in improved prosthodontic therapy for patients having resorbed mandibular ridges.

Conclusion

This article presents a clinical technique which emphasised on the appropriate arrangement of denture teeth and considerations for the contouring and body forms of complete denture polished surfaces. Neutral zone dentures showed significantly higher patient satisfaction in cases of severe resorption of mandibular ridge than conventionally fabricated dentures.

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Conflict of interest

None.

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