Review Article

Conservative prosthodontic procedures to improve mandibular denture stability in an atrophic mandibular ridge

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Obtaining consistent mandibular denture stability has long been a challenge for the dental profession. In particular, "flat lower ridge" is associated with difficulties in providing successful dentures. Stability of lower denture in such cases is usually the distinguishing factor between success and failure. This article intends to acquaint the reader with the various conservative prosthodontic techniques which can be employed to improve mandibular denture stability in case of an atrophic ridge.

Key words: Atrophic mandibular ridge, stability

DOI: 10.4103/0972-4052.49179

INTRODUCTION

Stability is defined as resistance to horizontal displacement of prosthesis.[1] Providing a stable lower denture has been challenging for dentists. In particular it is more difficult to provide stable dentures in flat resorbed mandibular ridge.[2] A stable lower denture provides physiological comfort to the patient.[3] This article firstly evaluates the factors necessary to develop stability in lower denture and further discusses the various conservative procedures to improve mandibular denture stability in an atrophic mandibular ridge.

EVALUATION OF FACTORS NECESSARY TO DEVELOP MANDIBULAR DENTURE STABILITY

Wright C R describes the following factors which are necessary to create and maintain stability in lower complete dentures. (1) retention, (2) diagnosis, (3) functions of mouth, denture base outline, (5) occlusal plane, (6) arch arrangement, and (7) instructions and patient education.[4]

(1) Retention

Retention is defined as the quality inherent in the dental prosthesis acting to resist forces of dislodgement along the path of placement.[1] Retention is an important pre-requisite for stability.[5] Retention in turn depends upon the following factors (a) adhesion, (b) cohesion, (c) interfacial surface tension, (d) intimate tissue contact (e) peripheral seal, (f) gravity, (g) atmospheric pressure, (h) neuromuscular control.[3]

(2) Diagnosis

A thorough examination of edentulous mouth will provide information to make a diagnosis that will relate directly to the retention and stability of lower dentures. Patients who have a normal tongue position possess a set of conditions that are conducive to retention of mandibular denture. Patients who have a retracted tongue position lack the ability to develop or maintain retention without some degree of training.

Normal tongue position has the following characteristics

a It completely fills the floor of the mouth.
b. The lateral borders rest over the ridge.
c. Tip of tongue rests on lingual side of lower anterior ridge.

Retracted tongue position

a. The tongue is pulled back into the mouth exposing the floor of the mouth.
b. Lateral borders are inside or posterior to ridge.
c. Tip of the tongue is withdrawn into the body of tongue or lies in the posterior part of the floor of the mouth.

(3) Functions of mouth

The three structures of mouth that are important to understand the functions of mouth are tongue, teeth, and medial roll of buccinator.

Tongue

The tongue is considered to be the fastest acting and the most accurate muscular organ of the body. It performs the functions of sucking, swallowing,

receiving food in the mouth, mastication, vocalization and speech. The tongue can perform all these functions more efficiently when it is in a normal position.

Teeth

The primary function of teeth is to deal with food. Incisors incise the food, canines tear the food and molars and second premolars chew food. The first premolar neither tears nor chews food but performs other functions. The buccal surface of the first premolar forms a point of fixation for the medial roll of buccinator and other muscles at the corner of the mouth. This activity helps to keep the saliva and food inside the mouth during chewing and swallowing.

Medial roll of buccinator

The medial roll of buccinator is a band of muscle fibers within the larger buccinator muscle. At rest, the center of medial roll is slightly above the occlusal surface of the mandibular posterior teeth. The main function of the medial roll is to form the buccal wall of food trough and to retrieve food that is forced into the buccal pouch.

Food trough

The food is received by the tongue and placed on the molars to be chewed. The medial roll of buccinator moves inwards towards the teeth to form the buccal wall of food trough, while the tip of tongue forms the lingual wall of food trough. Once the food trough is formed the food is ready to be chewed. An understanding of the combined functions of the tongue, teeth, and buccinator will lead to better denture construction.

(4) Denture base outline

A properly formed denture base outline develops a seal that can be maintained during most normal oral functions. The labial flange extends from one buccal frenum to other. The buccal flange extends from buccal frenum to retromolar pad. The posterior border extends to completely cover the retromolar pad. The lingual vestibule is divided into three areas: the anterior lingual vestibule (sublingual crescent area), the middle vestibule, called the mylohyoid area; and the distolingual vestibule (lateral throat form or retromylohyoid curtain).[5]

Sublingual crescent area and clinical technique to record sublingual crescent area:

Extension of the denture over the resting tissues of sublingual crescent area completes the border seal and increases the covering surface of the denture, resulting in greater retention by allowing the tongue to hold the denture in place.

Procedure: A custom acrylic tray is trimmed 2 mm short of the floor of the mouth and tracing compound is added to the border. Soften the material to flowing consistency with the aid of a torch, temper and seat it into position. Instruct the patient to close his mouth and relax. The tongue should be in the normal rest position with the tip lightly touching the lingual surfaces of the mandibular anterior ridge.[6]

Lateral throat form and technique to record lateral throat form

The lateral throat form is bounded anteriorly by the mylohyoid muscle, laterally by the pear shaped pad, posterolaterally by the superior constrictor muscle, posteromedially by the palatoglossus muscle, and medially by the tongue.[5]

Procedure: A custom acrylic tray is trimmed 2 mm short of the floor of the mouth and tracing compound is added to the border. The lateral throat form area is recorded by asking the patient to protrude the tongue. This action activates the superior constrictor muscles, which supports the retromylohyoid curtain. The dentist then applies downwards force on the impression tray while asking the patient to close the mouth. This records the action of medial pterygoid muscle on the retromolar curtain.[7]

(5) Occlusal plane

The superior-inferior position of occlusal plane is an important factor which affects stability. A mandibular plane that is too high can result in reduced stability. First, lateral tilting forces directed against the teeth are magnified in case of a raised occlusal plane. Second, an elevated plane prevents the tongue from reaching over the food table into the buccal vestibule. This compromises stability and makes the control of food bolus and denture difficult.[3] An occlusal plane that is too high creates unnecessary trouble, while an occlusal plane that is slightly low causes no problems.[4]

(6) Arch arrangement

The term arch arrangement indicates the buccolingual relationship of teeth to the crest of ridge or the stress bearing area. The anterior teeth are set on the anterior part of the crest of the ridge with an incisal tilt of 20° and posterior teeth are set over the center of stress bearing area of basal seat.

(7) Patient education

Information regarding proper use and care of denture should be given to the patient. Patients with retracted tongue position should be trained and given the following exercises.

Exercise 1: Tongue is thrust in and out rapidly.

Exercise 2: Tongue is moved rapidly from side to side.

Exercise 3: Tongue is extended fully and quickly retracted.

Exercise 4: Tongue is raised to its highest position well forward in the mouth as the sound "ee" is articulated and dropped down as sound "yup" is articulated.

These exercises should be practiced twice daily for a period of 5-10 minutes.[4]

The following treatment procedures can be employed to enhance lower denture stability (a) over dentures, (b) neutral zone in complete dentures, (c) dynamic impression methods, (d) flange technique, (e) metal denture bases, (f) neutrocentric concept, (g) Linear occlusion concept (h) Single stage border molding (i) implants

(a) Over dentures

The mandibular anterior ridge can be preserved by maintaining one or more endodontically treated roots and placement of an over denture. Preservation of the ridge can be attributed to the following factors (1) masticatory force is transmitted to the root and periodontal ligament, thus simulating normal physiological function, (2) removal of coronal and pulpal tissues in the apical canal make no change in the proprioceptive response of the patient, (3) retained roots substantially increase lateral stability of denture thereby reducing trauma to the edentulous ridge.

The advantages of an over denture over conventional dentures are (1) denture has more horizontal stability, (2) increased vertical stability during functional loading, (3) soft tissues over the residual ridge are spared of abuse due to support of abutment teeth, (4) patient acceptance is excellent,[8] (5) better occlusal awareness, biting forces and neuromuscular control.[7]

(b) Neutral zone in complete dentures

Potential space between lips and cheeks on one side and tongue on other; that area or position where the forces between the tongue and cheeks or lips are equal.[1] The aim of neutral zone is to construct a denture which is in harmony with its surroundings to provide optimum stability, retention and comfort.[9] Various materials have been suggested to record the neutral zone - modeling plastic impression compound, soft wax, polymer of dimethyl siloxane filled with calcium silicate, silicone, tissue conditioners and resilient lining materials.[10]

Sir W Fish described a denture as having three surfaces: the impression surface, the occlusal surface and the polished surface.[11] In case of a highly resorbed ridge the area of impression surface decreases and the area of polished surface increases, and denture stability and retention are more dependent on correct positioning of teeth and contour of external surface of denture.[12] Dentures constructed using the neutral zone have the following advantages

a. Improved stability
b. Posterior teeth are correctly positioned providing more space for the tongue.
c. Reduced food trap in the molar teeth region.
d. Good esthetics.[9]

The neutral zone technique

The usual sequence for complete dentures is to make primary impressions, construct individual trays, make final impressions, and then fabricate stabilized bases. Occlusion rims are used to establish the occlusal vertical dimension and centric relation. With the neutral zone approach to complete dentures, the procedure is reversed. Individual trays are constructed first. These trays are very carefully adjusted in the mouth to be sure that they are not overextended and remain stable during opening, swallowing, and speaking. Next, modeling compound is used to fabricate occlusion rims. These rims, which are molded by muscle function, locate the patient's neutral zone.[11] The mandibular neutral zone rim is indexed with plaster placed on the buccal and lingual surfaces. Teeth are set up exactly following the index.[9]

(c) Dynamic impression methods

In case of advanced mandibular residual ridge resorption, muscle attachments are located near the crest of residual ridge, and the dislocating effect of the muscles is great. The range of muscle actions as well as space into which denture can extend, can be recorded by dynamic impression methods.

Dynamic impression method 1

For dynamic impressions irreversible hydrocolloid is the impression material of choice as it can be mixed to desired consistency. A perforated acrylic resin individual tray is made on diagnostic cast which does not interfere with muscle movements. To obtain correct thickness of impression material against denture bearing tissue, stops are made using green stick compound or thermoplastic impression material (3 stops 2 mm high, one each in region of molars and one in the region of central incisors). Mandibular rests are placed in the molar region on the occlusal surface of the tray. These rests are made using thermoplastic impression material at a height corresponding to mandibular rest position.

Sufficient irreversible hydrocolloid is mixed (with 50% extra water) and placed directly into the mouth to cover the lower ridge and sublingual denture space. A small amount is placed in the tray and the tray is placed in the patient's mouth. The tray is pressed with digital pressure until the stops are firmly seated on the residual ridge. Next, the

patient is asked to close his mouth firmly until the rests have obtained firm contact with the maxillae. The patient is made to swallow three to four times at ten second intervals. He should forcefully protrude the tongue and vigorously contract the buccinator muscle between swallows. This procedure develops a proper registration of the denture space. After the impression material has set the tray is removed from the mouth and the cast is poured immediately.

Dynamic impression method 2

Here an old denture is used as an individual tray for dynamic impression. The vertical dimension of occlusion would have decreased in an old denture, so stops are built to a height that will reestablish the correct vertical relationship. Mandibular rests are built in the lower denture occluding surface to include the inter occlusal distance. The denture is now perforated and made dry. Irreversible hydrocolloid impression material is placed directly into the oral cavity and the denture base is filled with the impression material as the impression is made.

Dynamic impression method 3

The denture is first processed on the basis of conventional impression. Then, a corrective dynamic impression is made in the denture base and the denture is relined. Rests are made on the occluding surface of the denture to include the inter occlusal distance. Stops are contraindicated as the vertical dimension of occlusion of the conventional first stage denture is considered to be correct. Tissue conditioners are the impression material of choice as the thickness of impression material will be critically thin, and irreversible hydrocolloid cannot be used.

Advantages of dynamic impression methods

a. Dislocating effect of muscles on denture border is avoided
b. Every possibility of active and passive tissue fixation of the denture is utilized.[13]

(d) Flange technique

The flange technique involves making an impression of the soft structures of the mouth adjacent to the labial, buccal, lingual and palatal surfaces of the dentures and incorporating the extensions obtained in the final denture. These extensions obtained will be described as flanges. The flange technique can be used to

1. Determine physiological alignment of arch form of the anterior and posterior teeth on the occlusal rims.
2. To secure an accurate impression of structures surrounding the trial dentures and thus determining the form of the polished surfaces of the dentures.
3. To improve the retention, appearance and speech of otherwise acceptable finished dentures.

Technique to determine physiologic alignment of teeth

The usual procedures of denture construction are carried out to the point where the casts are mounted on the articulator, centric relation has been verified, the articulator guidance has been adjusted, and the teeth have been selected. A keel (a small, elongated metal ellipse one inch long and three sixteenth of an inch wide) is embedded flush with the occlusal surface of the rims and in the center both anteroposteriorly and transversely, and as nearly as possible, exactly opposite the one in the opposing occlusal rim.

The occlusal rims (made of base plate wax) with the keels embedded in them are now modified by narrowing them buccolingually to the width of keels, and to more or less a knife-edge in the anterior region. A soft flange wax (or tissue conditioner) is used to build the occlusal rims back to slightly greater bulk than that of the resorbed structures. Soften the overlying flange wax with a bench torch to avoid softening the hard base plate wax that supports the keels. Coat the occlusal surfaces with a little petroleum jelly and insert the occlusal rims in the patient's mouth. Direct the patient to read aloud and rapidly. Reading aloud requires more strenuous muscular movements than reading quietly. And reading rapidly produces more saliva and causes more numerous swallowing actions. Direct the patient to forcefully grin and purse the lips as final requirement. These actions will cause the natural functions of most, if not all the muscles involved. The patient is asked to rinse the mouth with cold water and remove the occlusal rims.

Place the perfected occlusal rims on the cast. Surround the cast and occlusal rim with a wax boxing and pour in plaster matrix. Remove the flange wax and keels from the occlusal rims and arrange the teeth using the plaster matrix as the guide to tooth position.

To determine the form of polished surface

The second and the most valuable use of this technique is to determine the form of polished surfaces of dentures. Remove all the excess base plate wax from the buccal, labial and lingual surfaces of both trial dentures. Retain only enough of wax to hold the teeth in position over remaining base plate wax. Add flange wax to buccal, labial and lingual surfaces of trial dentures. Soften the flange wax that has been added taking care not to soften the base plate wax supporting the teeth. Now place the trial denture

in patient's mouth. Make the patient swallow, grin broadly, pucker the lips, read aloud for few minutes and make other movements of the mouth. Chill the trial dentures in the mouth and remove them. The increase in size of flanges is often surprising. Process the denture in such a way as to preserve the general contour established by the flange wax.

Improvement of unsatisfactory dentures

The flange technique can also be used to improve the retention of unsatisfactory dentures. To improve retention, grind away the denture base material of the flanges to make space for the flange wax. Add the flange wax in the same manner as described for trial dentures. Make a zinc oxide and eugenol reline impression. Make the patient mold the wax on the flanges as described for trial dentures.

Advantages of flange technique

1. The area of intimate contact of the denture bases with the underlying and adjacent structures is considerably increased by the flanges. This gives a substantial improvement in stability, function, comfort and appearance of the dentures.
2. The location of dental arches is more physiologic.
3. The tongue position may be established with confidence.[14]

(e) Metal denture bases

In 1957, Faber advocated using metal bases for snugness of fit of the mandibular denture. Faber has given the following advantages of metal denture bases. (1) prevention of acrylic warpage, (2) more strength, (3) increased accuracy, (4) less tissue change under the base, (5) less porosity and therefore easier to clean and keep clean, (6) thermal conductivity, (7) less deformation in function.[15]

However in a patient with severely resorbed alveolar ridge the metal base may frequently shift and irritate residual alveolar ridge tissues which are often atrophic and minimally resistant to stress. A metal-based denture with soft liner often meets the needs of these patients. The metal base provides the weight necessary to facilitate retention while maintaining strength in denture with modest extensions. The soft liner accommodates the ridge irregularities and changes such as excessive resorption, minimal keratinized ridge epithelium, and thin lamina propria.[16]

(f) Neutrocentric occlusion

The neutrocentric concept was developed by DeVan. DeVan has suggested embodying the two key objectives of his occlusal scheme (1) Neutralization of inclines, (2) Centralization of forces.

The neutralization of inclines and centralization of occlusal forces aids in stability without interfering with speech, appearance and chewing capacity. The five elements of this scheme are

(1) Position: the position of posterior teeth should be centralized over the residual ridge so that the forces are perpendicular to the support areas. This avoids tensile and shearing forces.
(2) Proportion: DeVan reduced the teeth width by 40%. This reduced the vertical stress on the ridge. Horizontal forces are reduced because friction between opposing surfaces is decreased. The forces are thus centralized without encroaching on the tongue.
(3) Pitch: This is the inclination or tilt of the occlusal plane. It is oriented parallel to the underlying ridge and midway between them. This directs the forces perpendicular to the mean osseous foundation plane.
(4) Form: Flat teeth with no deflective inclines were used so that there is no interference with mandibular movements.
(5) Number: The number of posterior teeth was reduced from eight to six. This reduced the magnitude of occlusal force and centralized it to second premolar and first molar.[17]

(g) Linear occlusion

William H. Goddard introduced the concept of linear occlusion.[18] Frush described occlusion in geometric terms as one dimensional (linear), two dimensional (flat) and three dimensional (cusped).[19] Groans and Stout explained how anatomic and non anatomic occlusal schemes transmit lateral forces to the denture and reduce stability and suggested that the linear occlusal scheme has the potential for creating the smallest lateral force component.[20]

Linear occlusion consists of the following basic parameters:

1. Zero degree teeth (flat teeth) are opposed by bladed (line contact) teeth in which the blade is a straight line over the crest of the ridge.
2. Mandibular teeth are set to flat occlusal plane.
3. The arch which requires the greatest stability receives the bladed teeth (the mandible most often requires greater stability and receives bladed teeth).
4. There is no anterior interference to protrusive or lateral movements.
5. This non-interceptive occlusion provides a consistent vertical seating force in both centric and eccentric; hence transverse vectors are eliminated.[18]

(h) One stage border molding

The primary objective of the complete denture impression is to accurately record the entire denture bearing area to produce a stable and retentive prosthesis while maintaining patient comfort, esthetics, and

preservation of the remaining tissues. The selective pressure technique is the most widely used technique to achieve optimal final impression. However, one of the most demanding and time-consuming parts of this technique is the border-molding step that establishes the impression borders to assure optimal extensions for the final prosthesis. Through the use of elastomers in conjunction with a selective pressure technique, predicable results can be achieved in making a properly extended, accurate final impression.

The use of elastomers for border molding has several advantages over the traditional modeling plastic impression compound:

1. The elastomeric impression materials are easy to use, with less waste of material.
2. The material can be accurately applied only to the areas to be border molded.
3. There is no need for additional equipment such as a water bath set at the correct temperature or a torch to permit adequate manipulation of the materials.
4. Infection-control procedures are simplified through the use of disposable mixing tips rather than needing to sterilize / disinfect the water bath and torch.[21]

(i) Role of Implants in severely resorbed edentulous mandible

A dental implant is a prosthetic device made of alloplastic material(s) implanted into the oral tissues beneath the mucosa or / and periosteal layer, and on / or within the bone to provide retention and support for fixed or removable dental prosthesis.[1] Dental implants are currently considered a valuable treatment modality in prosthodontic management of edentulous patients. The treatment options available for restoration of extremely resorbed mandible with implants can be categorized as:

1. Endosseous implants in combination with fixed or removable prosthesis.
2. Augmentation of mandible by distraction techniques or augmentation procedures, followed by placement of endosseous implants in combination with fixed or removable prosthesis.

The installation of transosseous implant system in combination with removable prosthesis.

a. The choice between a mandibular implant supported overdentures and a mandibular full arch implant fixed prosthesis is dependent on
b. Anatomic factors (inter foramina space, inter maxillary relationship).
c. Oral hygiene
d. Speech related factors
e. Patient preference
d. Cost factor.[21]

CONCLUSION

Stability of complete lower dentures has challenged dentists and patients alike. In particular, a “flat lower ridge” is associated with difficulties in providing successful dentures. A proper understanding of the factors involved in stabilizing a lower denture is necessary. A lower denture which covers the entire supporting area available to it with its flange extensions in harmony with the surrounding musculature will certainly show improved stability.

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Source of Support: Nil, **Conflict of Interest:** None declared.