Review Article

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Muscles Influencing Complete Denture Fabrication

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ABSTRACT

Background: Complete dentures are primarily mechanical devices, but since they function in oral cavity, they must be fashioned so that they are in harmony with normal neuromuscular function. All oral functions such as speech, mastication, swallowing, smiling, and laughing, involve the synergistic actions of the tongue, lips, cheeks, and floor of the mouth which are complex and highly individual. Muscle action influences the fabrication of denture at every step. The oro-facial muscles influencing complete denture prosthesis are muscles of facial expression, muscles of mastication, muscles of tongue, muscles of soft palate, pharyngeal muscles, suprahyoid muscles, infrahyoid muscles. The coordinated activity of these muscles is briefly discussed.

Keywords: Muscles, Complete Denture, Buccinator, Modiolus, Orbicularis Oris, dislocating muscles, fixing muscles.

INTRODUCTION

Muscles and their action are important in almost every phase of denture fabrication and use. Muscles exert a direct or indirect influence on (1) the extent and thickness of denture peripheries (2) the vertical dimensions of rest and the vertical dimensions of occlusion and the interocclusal distance (3) centric relation position (4) the positions of teeth, both horizontally and vertically (5) the contour of the denture base (6) denture retention and (7) facial expression. In addition they are active during mastication, speech and deglutition. At least reasonable muscular coordination and control are essential for effective use of removable prostheses. As a diagnostic procedure the patient should be asked to make controlled movements of the mandible and tongue. An analysis of these functions, to be meaningful, must be based on a normal unstrained performance. Evidence of limited muscular coordination has many clinical implications.

The muscles that are intimately involved with prosthodontics are skeletal muscles. In the majority of skeletal muscles, the origins and insertions are in bone. However, many of the skeletal muscles involved in complete denture construction have a bony origin but insert into an aponeurosis, a raphe, or another muscle . The muscles of mastication have their origins and insertions in bone exception of the uppermost fibers of the upper head of external pterygoid insert into mandibular articular capsule and thus indirectly into the anterior border of the articular disk. Part of the upper head and the entire inferior head insert to the anterior surface of the mandibular neck. This knowledge is utilized in making jaw relation records, particularly centric relation or centric position. The non bony attachments of these muscles account for the various contours, borders, and positions of teeth that are seen in dentures. Impression techniques are influenced by these attachments so the muscles should not be stretched or left unsupported.[1]

INFLUENCE OF MUSCLES ON RECORDING PHASE: The recording phases start with the making of primary impression followed by border moulding

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and making of final impression and registration of jaw relations. The design of complete dentures particularly that of the lower denture, has therefore to take muscular displacement into account if stability is to be achieved.

Influence of muscles on lower denture

Complete dentures are prone to a variety of displacing forces of differing magnitude as they are resting on oral mucosa and are in close proximity. Brill et al in 1965 stated that the stability of a lower denture is dependent on the manner in which the surrounding musculature relates to the different surfaces and borders of the denture and divided them into two groups: (1) those muscles which primarily dislocate the denture during activity, and (2) those muscles that fix the denture by muscular pressure on its secondary supporting surfaces (Table I).[2]

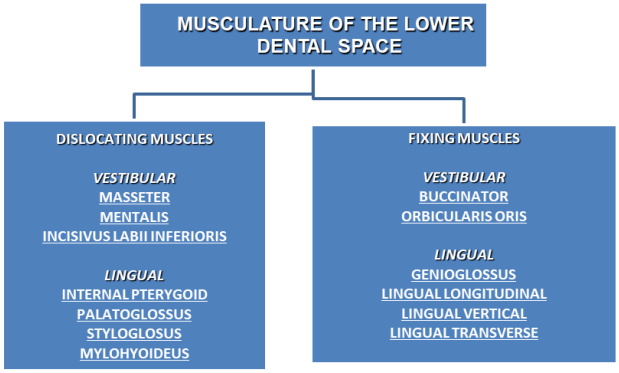

Table I: The musculature of the denture space is divided into two groups: (1) those muscles which primarily dislocate the denture during activity

(2) those muscles that fix the denture by muscular pressure on its secondary supporting surfaces.

MUSCULAR CONTROL OF THE DENTURE

The masticatory apparatus is kinematically and mechanically indeterminate system, with the complex architecture of these muscles contributing to the great variation in motor activity and adaptability to changing functional demands (Grünheid et al. 2009; Hiraba et al. 2000; Murray et al. 2001). Movement occurs through paired muscular activity. In order for a muscle to contract, its opponents must relax. Individual muscles may function by being prime movers, antagonists, fixators, or synergists. Prime movers are actually responsible for the movement, whereas antagonists are those muscles, which produce opposing movements. [3]A properly contoured polished surface of the denture aids in denture stability by active and passive muscle function.

ACTIVE MUSCULAR FIXATION when forces of the tongue are directed against a lower denture, the denture will be easily dislocated if the forces are not counteracted by equal forces exerted by the musculature of the cheeks and lower lip. Their antagonistic activity can be used to stabilize dentures. Similar action of antagonistic muscle groups between the functioning genioglossus and orbicularis oris muscles will fix a lower denture by opposing forces on its anterior section.

PASSIVE MUSCULAR FIXATION: It is possible to fix a lower denture even if all the muscles of the cheeks, lower lip, and tongue are quite passive. The denture is fixed by the mass and weight of these structures and through the pressure exerted by muscle tonus. Two factors that help in this are 1. The inclination of the polished surfaces. 2. The position of the polished surfaces of the denture between the cheeks and the lower lip on the one side and the tongue on the other side.[2]

INFLUENCE OF PERIPHERAL MUSCLES

There is no occlusal scheme that can stabilize teeth if they are in an unbalanced relationship with muscular forces against them. To counter-act displacement by peri-oral muscles (muscles of the cheeks and lips) positioning the muscles associated with surfaces are important.

By directing the patient to smile, the Prosthodontist can use the modioli as reference point in determining the occlusal plane to develop the smiling line. Modiolus is formed by the intersection of several muscles of the cheek and lips. It is formed by nine muscles. They are divided into two groups

1. **Cruciate modiolar muscles** - Zygomaticus major, Levator anguli oris, Depressor anguli oris, Platysma pars modiolaris.

2. **Transverse muscles** - Buccinator, Risorius, Orbicularis oris, Incisivus superior & inferior.

Because none of these muscles contain fibers that have more than one bony attachment, they depend on the fixation of the modiolus to allow isometric contraction. Contraction of triangularis, caninus and zygomaticus muscle fixes the modiolus to allow buccinator to contract isometrically.

The modioli can be used to an advantage in stabilizing the maxillary dentures by placement of the maxillary premolars in a position above them. Thus, during functional activities involving elevation of the lips, there are fixing and elevation of the modioli and uplifting of the maxillary denture. In the premolar region the mandibular denture should exhibit both a shortened and narrowed flange to permit the action that draws the vestibule superiorly and the modiolus medially against the denture.[4]

INFLUENCE OF MUSCLES DURING FACIAL EXPRESSION

Facial muscles are important for coordination between prosthesis performance and facial expression of emotion. In smiling, there is contraction of the zygomaticus major (antagonist: orbicualris oris), which draws the modiolus, and the angle of the mouth upward and backward. The quardatus labii superioris (antagonist: orbicularis oris) elevates the maxillary lip, the corner of the mouth, and the ala nasi. The risorius (antagonist : orbicularis oris) works in synergistic action with the buccinator and draws the angle of the mouth backward, producing a grinning expression which may not of pleasant quality.[4]

MUSCLES OF PHARYNX - Superior constrictor is the pharyngeal muscle of greatest importance in removable prosthodontics. Contraction of superior constrictor limits the posterior extent of the retromylohyoid space and thus, the posterior extent of mandibular denture flange. Overextension of the denture may ulcerate the soft tissue and cause a sore throat.

MUSCLES OF SOFT PALATE -The muscles of the soft palate are the levator veli palatini, tensor veil, musculus uvulae, palatopharyngeus. The levator and tensor veli palatini muscles elevate soft palate and aid in determining the proper location of the posterior palatal seal. The action of the palatal muscles is not disturbed unless the border of the denture is carried too far posterior.

MAXILLOMANDIBULAR RELATION

Recording of jaw relations in the treatment of edentulous patients aims at facilitating the adaptation of the complete denture to the masticatory system to give them an optimal and comfortable function. To achieve this goal, the recording must include an approximate vertical dimension of occlusion, stable occlusal contacts in harmony with the existing TMJ and masticatory muscle functions.

Vertical relation

Vertical dimension refers to the length of the face when the teeth (occlusal rim, central bearing points, or any other stop) are in contact and the mandible is in centric relation or the teeth are in centric relation.[5]The correct determinant for the mandible-to-maxilla relationship at maximum tooth contact is a result of the repetitive contracted length of the elevator muscles. This dimension at maximum intercuspation is controlled by the muscles, regardless of condylar position.[6]

Ricketts et al showed that lower facial height in adults stayed constant with age.[7] Niswonger (1934)[8] was first to study extensively the rest position of mandible by recording measurements on patients. During clinical recording of vertical dimension, if the vertical dimension of occlusion is decreased, there will be inadequate tongue space. This condition will cause frequent "strained" swallowing and a frequent return to the vertical dimension of rest position. Clinical verification of the interocclusal distance may be made by having the patient say "sixty six". The SILVERMAN'S CLOSEST SPEAKING SPACE is the closest relationship of the occlusal surfaces and incisal edges of the mandibular teeth to the maxillary teeth during function and rapid speech. The 2 mm space between the incisors at correct VDO when patient pronounces words containing **ch, s, and j sounds**. The closest speaking space measures VD when mandible and muscles involved are in physiological function of speech.[9]

Vertical dimension at rest

Faber in 1984 defined physiologic rest as a position in which the muscles of elevation and depression are in a state of tonic contraction sufficient only to maintain an upright position when the patient is at ease. When the muscles are in their resting stage, the space between the arches is called the freeway space.[10]

The mandible at rest is balanced between the resting lengths of the elevator muscles and the depressor muscles. The elevator group consists of the masseter and temporalis muscles, which are located more or less superficially, and the medial pterygoid muscle, which is located more deeply. Medial pterygoid and masseter muscle often function as co-ordinate unit as they cradle the mandibular angle in their anastomosed insertion. When the medial pterygoid muscle is considered individually, it exerts an upward, forward and inward force on the mandible.

The muscles of the depressor group are located in the floor of the mouth. This group consists of (from superior to inferior) geniohyoid, mylohyoid, and digastric muscles. The geniohyoid and mylohyoid muscles connect the hyoid bone with the body of the mandible. Geniohyoid is short and narrow muscle lies above mylohyoid elevates the hyoid bone and draws it forward, thus acting as a partial antagonist to stylohyoid. When the hyoid bone is fixed, it depresses the mandible. The depth and contour of the lingual flange of the mandibular denture is determined by the position of the mylohyoid muscle.[11]

Anything that affects the resting length of either group of opposing muscles can affect the critical relationship of the mandible with the maxilla at the resting position. Precise control and coordination existing between muscles enables them to apply powerful force to piece of food and yet bring teeth into occlusion without jarring, by the neuromuscular control. The contraction of the retractors and elevator muscles of the mandible during jaw closure is isotonic and isometric-isotonic to move the mandible and isometric to brace the jaw to teeth contact.[1]

SUPRAHYOID & INFRAHYOID MUSCLES suspend the hyoid bone, lower the mandible, and have prosthodontic significance in relation to physiologic rest position, speech, facial expression, mastication and deglutition. Mandible and the hyoid bone are movable bones suspended in frame of the skull. The two points of anchorage are the anterior part of the cranium and the sternum, and between are synergistic groups of muscles ("to work together") that move the skin and bone. Fixation muscles establish a stable basis by steadying a structure. For example the infrahyoid muscles steady the hyoid bone so that the suprahyoid muscles may contract lowering the mandible. In contrast, these muscles can relax and allow the hyoid bone to be pulled upward by the suprabyoid muscles during deglutition.

The hyoid bone can be moved forwards and backwards, upwards and downwards, and rotated around a transverse axis. Put in other words, the floor of the mouth can be lengthened or shortened antero-posteriorly, and can also be elevated or depressed with relation to the mandible. Such mobility confers a like mobility on the tongue, which possesses great intrinsic mobility of its own. The mobility of the floor of the mouth greatly increases the range of excursion of all the tongue movements. Tongue movement are important in speech, mastication, and swallowing. It affects lingual border extension, denture base contours and artificial tooth position.

The position of the hyoid bone along the antero-posterior range is determined by the relative lengths of the geniohyoid and stylohyoid muscles. Each of these muscles has a secondary elevating effect similar to that of the digastric. This is counterbalanced by the depressing effect of the infrahyoid strap muscles. The vertical position of the hyoid bone is determined by the upward pull of the posterior fibres of the mylohyoid muscle, balanced by the opposing infrahyoid muscles.

Supramandibular and inframandibular muscles working antagonistically with posterior cervical muscles to maintaining the head in balance. The posterior cervical muscles function continuously approximately two-thirds of each day, as center of gravity of the head is not directly over the atlas, the uppermost vertebra of the spinal column. Moving the head backwards tends to increase vertical dimension at rest, while tilting it forward has the opposite effect. Therefore, patient must sit in upright position with head unsupported while recording vertical relation

Horizontal relation

Centric relation (CR) is defined as the maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the anterior-superior position against the slope of the articular eminencies. This position is independent of tooth contact.[5] Centric relation is a functional position and relates to the muscle harmony of the patient. It is a musculoskeletal stable position in which loading of the joint, can be done.

Centric relation becomes starting point to plan and execute the occlusion. One of the most difficult tasks to accomplish in complete denture treatment is retruding the mandible to obtain the centric relation record. Difficulties arise from the lack of coordination in groups of opposing muscles when the patients are requested to close in the retruded position.

The posterior and middle portions of the temporalis and suprahyoid muscles (primarily the geniohyoid and digastric) appear to be responsible for placing the mandible in centric relation position. It should be observed that there is no muscle attached to the condyle to pull it vertically upward, nor there is any muscle attached to posterior part of the neck of the condyle to retrude the mandible from behind. The function of mandible is done by the temporalis placed superiorly having its attachments in front of the condyle at the coronoid process and at the inferior level by the diagastric muscles. In this way these two muscle acts like sling attached to the upper and lower parts of the mandible so that mandible is stabilized during retrusion. This is nature mechanism to have harmonious retrusion in centric relation. Again, to retrude the mandible in centric relation there is no muscle attached posterior to the mandible or behind the mandible to draw the mandible backwards. But this is done by temporalis which is attached in front of the condyle at the coronoid process. Protrution is achieved by contraction of medial and lateral pterygoids.

When posterior teeth are lost, mastication is performed on anterior teeth, or long period of edentulism abnormal habits of chewing are developed with loss of the delicate balance between the groups of muscles and the protrusive muscles become dominant, and leads to difficulty in recording anteroposterior occlusal relationship.

When one analyzes the action of the muscles that move the mandible, one notes that depressors are, relatively speaking, weak as compared to the elevators. The muscles which protrude and move the mandible from side to side are much stronger than the retractors. Temporalis does not participate in biting force when mandible is in protrusion and can be used as a test to determine if patient is closing in centric relation.[1]

INFLUENCE ON TEETH ARRANGEMENT

Prosthetic teeth arrangement generally must conform to the horizontal position determined by the neutral zone. The neutral zone is that area in the potential denture space where the forces of the tongue pressing outward are neutralised by forces of the cheeks and lips pressing inward. As the area of the impression surface decreases with ridge loss and the polished surface increases, denture stability and retention are more dependent on correct position of the teeth and contour of the external surfaces of denture. Prostheses which set teeth outside this zone risk problems such as discomfort, cheek or tongue biting, and instability of the denture.

Because of the variation in resorption patterns, the neutral zone in anterior region may or may not coincide with a position over the crest of the residual ridge. Lammie has shown that as the alveolar ridge resorbs, the ridge crest falls below the origin of the mentalis muscle. As a result, the muscle attachment folds over the alveolar ridge and come to rest on the superior surface of the ridge crest. The result is a posterior positioning of the neutral zone and with it, the need to place the lower anterior teeth further lingually than had been the position of the natural teeth. Recording of tongue positions and movement receives close attention in the neutral zone approach. Wright and associates pointed out that the border seal area for the mandibular denture extends downward to the floor of the mouth and posteriorly into the lateral throat form. Rinaldi and Sharry refer to a study that indicated that the tongue of aged persons showed no atrophic tendencies, which is not true for other tissues. It is advantageous to record the position of the tongue during sucking, swallowing and

movement. As the buccinators muscle contracts, the cheeks are pressed against the teeth, the neutral zone concept records their action. Lott and Levin noted that sizes of the buccal flanges are moulded much thicker than that of the conventional flange when the flange is formed by the buccinators muscle. Conversely, there may be an intrusion of buccinators muscle in the second molar area.[12]

PATIENT'S SKILL

The patient's ability to accept and learn the skills required to control the new dentures determines the complete denture success. Adaptability, acceptance and usage of dentures require adaptation of learning, muscular skills and motivation. Muscular skill refers to the capacity to coordinate muscular activity to execute movement. As a result habituation process occurred.[13]

ESTHETIC CONCERN

Although certain esthetic factors may be considered with the face in the static state, final esthetic determinations should never be made with the face in repose. The vital movements associated with speech and facial expression are actually esthetics in action. Dentures must serve in harmony with such functions. Therefore, the mouth in action must be the testing environment.

CONCLUSION

A properly constructed denture helps to restore the health of stomatognathic system of which muscle are a part. It helps muscle to function in its physiological limit and maintain tonicity**.** Understanding and recording the steps in fabrication of prosthesis should harmonize with the functioning anatomy of which the dentures are to become a part.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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