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## Concept of rest position of mandible: An overview

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### Abstract

Physiologic rest position of the mandible is an important parameter to be considered in the fabrication of a complete denture as well as in a case of full mouth rehabilitation. Violation of the rest position would lead to detrimental effects on the facial musculature and the temporomandibular joint. This article reviews the various concepts pertaining to the rest position of mandible and its clinical implication.

**Keywords:** physiologic rest position, vertical dimension at rest, postural resting position, position of mandible

### 1. Introduction

Mandibular physiologic rest position has been defined as “The habitual postural position of the mandible when the patient is resting comfortably in the upright position and the condyles are in a neutral unstrained position in the glenoid fossa<sup>[1]</sup>. In 1906, Wallish was the first to define the physiological rest position of the mandible. According to him, rest position was the position of the mandible where in all muscle action is eliminated and with the mandible passively suspended and the opposing teeth do not contact. It has been claimed that mandibular rest position is endogenously determined and it is independent of the presence or absence of teeth, and that it remains stable throughout the life of the individual<sup>[2]</sup>. Conversely, in 1771 Hunter had stated that “In the lower jaw as in all joints of the body, when the mouth is carried to its extreme position in any direction, the muscle and ligaments are strained and the patient becomes uneasy.”

There are various factors which may affect the rest position of the mandible. It includes the lips, cheeks, tongue, teeth, dentures, head posture, body posture, neck muscles, respiratory requirements, emotional stress, drug therapy, age and time of the day. The lips, cheeks, and tongue contact the natural teeth when the face is in a resting state. The amount of pressure these tissues apply to the teeth is as yet unknown. Since the lips, cheeks, and tongue are rarely in the resting state for long periods of time, the pressures on the teeth vary continuously in degree and duration. Experiments with animals have shown that pressure on the teeth produces reflex depression of the mandible due to activation of the depressor and reciprocal inhibition of the elevator muscles<sup>[3, 4]</sup>. More recently, it has been suggested that rest position is altered by occlusal interferences, temporomandibular dysfunction, psychosocial stress, diurnal variation, nasal obstruction, and head position<sup>[5, 6, 7, 8, 9, 10]</sup>.

The exact mechanism of the clinical rest position has been somewhat elusive. Three explanations have been suggested based on muscle tonus, myotatic reflexes, and gravity-elasticity. The tonus theory maintains that the clinical rest position is the resultant of the balance of the tonic state of muscles; it is therefore thought of as a postural tonicity<sup>[11, 12, 13]</sup>. Rjamford<sup>[14]</sup> believed that the clinical rest position may depend more on the myotatic (stretch) reflex described by Sherrington<sup>[15]</sup> and Szentagothai<sup>[16]</sup>. Yemm and Berry<sup>[17]</sup> stated that the mandibular posture of rest may be maintained by passive internal and external forces governed by gravity and the elastic forces associated with the elevator muscles and other tissue.

The most common major sudden pathologic event which might affect the rest position is the extraction of the remaining occluding teeth. Vertical dimension at rest shows a decrease following extraction of natural teeth, the occlusal stops, and an increase on rehabilitation<sup>[18]</sup>.

It can be stated that vertical dimension at rest is not stable position and varies following extraction of natural teeth and rehabilitation. Following extraction of the natural teeth, the mandible may be positioned upward as well as forward. This position may account for the problem of apparently insufficient space between the crests of the residual ridges to accommodate artificial teeth in some edentulous patients.

## 2. Review of literature

Harris and Height (1936) reasoned that the vertical dimension of the face was dependent on the occlusal contacts in the closing movement of the mandible. They believed that reduction of vertical dimension of occlusion was caused by wearing down or abrasion of teeth, loss of posterior teeth, resorption of ridges under dentures and faulty dental work. Hence the correct vertical opening in edentulous patients was debatable. This suggested a variability in rest position of the mandible.

The presence of dentures provides artificial tooth contacts and pressure to the exteroceptors in the mucosa of the denture supporting area, mechano-receptors of temporomandibular joint and muscle which contribute to the regulating mechanism of mandibular posture<sup>[18]</sup>. In the edentulous mouth, pressure or tactile receptors in the mucous membrane investing the tongue, the residual ridges, and the lining of the lips and cheeks may be stimulated by dentures. Similar changes in the rest position may occur on removal of dentures as on removal of natural teeth and for a similar reason<sup>[19, 20, 21, 22, 23]</sup>. A study by Gattozzi *et al.* (1976)<sup>[24]</sup> determined that the vertical relation of rest is affected by the presence of dentures in the mouth.

Schlosser (1941) conducted a series of phonetic experiments indicating that the movements of the mandible during speech were subject to habitual fixation. He concluded that edentulous patients were repeatedly able to bring the mandible to an identical rest position by sounding the letter 'M'.

The tongue with its associated muscle complex bears a close anatomic relationship to the mandible. Fish (1964)<sup>[25]</sup> advanced the hypothesis that the rest position of the mandible is related to the posture of the tongue as a result of its respiratory function as part of the anterior wall of the pharynx.

Clifford (1984)<sup>[26]</sup> deliberated that when dentures are placed in an edentulous mouth, the anterior two thirds of the tongue is constricted and squeezed posteriorly. This constriction pushes the posterior third of the tongue distally toward the posterior wall of the pharynx, and, as a result, the lumen of the airway is reduced. By a downward movement of the mandible, the volume of the oral cavity is increased sufficiently to accommodate the tongue without its encroaching on the airway. Tongue-space encroachment, not initially, but in the longer term, results in an increase in vertical rest position of the mandible.

Ingervall and Schmoker (1990)<sup>[27]</sup> studied the effect of surgical reduction of tongue on the rest position of the mandible and found that after the surgical reduction, the tongue did not fill in the oral cavity as it did before the surgery. Hence, as a result, the freeway space was decreased.

The anatomy of the levator and depressor anguli oris muscles suggests that they may influence the rest position of the mandible as well as act as accessory elevator muscles (Martone, 1962)<sup>[28]</sup>. This additional role of the facial muscles has also been mentioned by Tulley (1953)<sup>[29]</sup> and Arstad (1965)<sup>[30]</sup>. The rest position of the mandible with the mouth

closed is governed chiefly by the lips. The elevator and depressor muscles, together with the tongue, maintain the position.

According to Ricketts (1952)<sup>[31]</sup>, great importance should be given in building the vestibular part of the occlusion rims so that they support the lips fully in order to give them harmonious position and movements prior to establishing the inter arch distance. The rest position with the mouth open is probably governed wholly by the balanced tonus of elevator and depressor muscles. A false rest position may often be seen in dentulous patients who have a retruded mandible and whose lips are unable to form a seal when the facial muscles are at rest. In these patients, the lip seal may be assisted by protruding the mandible into a new adaptive position.

Definitions of the mandibular rest position invariably include reference to the level of activity of the mandibular musculature. The elevator and depressor muscles have been variously described a "relaxed"<sup>[32]</sup>; "in reciprocal co-ordination" (Sweitzer, 1951); "in minimal tonic contraction" (Ramljord and Ash, 1971) and "in equilibrium in tonic contraction" (Academy of Denture Prosthetics, 1956). Thus, it would appear that the role of the muscles in the maintenance of the position is controversial and might range from a passive to an active contribution. The active theory is supported by Moller (1966), who demonstrated electromyographically that the elevator muscles exhibit slight activity when the mandible is in the rest position.

Leaf (1950) stressed that the muscle tone rather than the muscle length controls the rest position and that muscle tone can and does vary by exercise or excessive rest. Hypertonicity of mandibular muscles through grinding habits may interfere with the maintenance of a constant rest position and result in a reduction of the normal interocclusal distance.

Sicher (1954) believed that the mandibular rest position was completely dependent on the tonicity of the musculature and that only in disturbed muscle forms as in disease, over work and nervous tension could rest position vary from the normal and pointed out that since the muscle tonus is fairly constant for each individual, the mandibular rest position is a fairly constant position.

Mershon (1938) contended that muscles cannot lengthen to accommodate an increase in bony size, but rather bone adapts itself to the length of the muscles. Tench (1939) believed that the functional length of the muscles could not be increased after observing failures of restorations fabricated at an excessive vertical dimension of occlusion.

Brodie (1950)<sup>[33]</sup> and Thompson and Brodie (1942)<sup>[34]</sup> concluded that the rest position of the mandible is the result of coordination between the posterior cervical muscles and the muscles that lie anterior to the cervical spine that are used for inspiration, mastication, deglutition, and speech. Since the mandible is contained within this group of muscles, the rest position of the mandible is dependent on the balance of these muscles.

According to Miles (2007)<sup>[35]</sup>, the rest position of the mandible must be the result of passive visco-elastic forces in perioral soft tissues. These forces are also sufficient to limit vertical jaw movements even when the head moves gently up and down during slow walking. When the head moves more vigorously during running, however, postural stretch reflexes are activated that limit the vertical movement of the mandible, thereby preventing collision of the upper and lower teeth, and possible damage to perioral soft tissues.

An electromyographic study by Watkinson (1987)<sup>[36]</sup> suggests that the clinical rest position and the position of

minimal muscle activity as determined electromyographically do not coincide. EMG methods used to elicit the rest position may result in the establishment of an interocclusal clearance which is greater than that obtained by conventional clinical techniques.

Kawamura *et al.* (1967) <sup>[37]</sup> evaluated the electromyography of the jaw closing muscles. The results indicate that some fibers in the masseter and temporalis muscles show spontaneous EMG activities even when the mandible is at rest. Such muscle activities were concerned with maintenance of the postural position of the mandible.

Shpuntoff and Shpuntoff (1956) <sup>[38]</sup> studied the physiologic rest position and the centric position by electromyography using biofeedback. Examination of other muscles of the masticatory mechanism indicated that when one muscle of the myotatic unit is at physiologic rest, the others are also silent.

Peterson *et al.* (1983) <sup>[39]</sup> studied the mandibular rest position in subjects with high and low mandibular plane angles. The low Frankfort horizontal-mandibular plane angle group exhibited a greater clinical rest position than the high angle group.

Kiliaridis (1995) <sup>[40]</sup> *et al.* studied the influence of fatigued masticatory muscles on the head posture, and whether this influence is related to the rest position and the movement characteristics of the mandible. The results showed an increase in the freeway space after the fatigue test in the subjects which exhibited an increase in the duration of the masticatory cycle in that period. No significant associations could be found between the changes in the head posture and the mandibular movement characteristics.

Rugh and Drago (1981) <sup>[41]</sup> suggested that vertical rest position of the mandible was a specific point in space where jaw muscles were most relaxed and that this position could be identified through electromyography.

Yemm (1975) <sup>[42]</sup> concluded that the equilibrium between the force of gravity and the elastic properties of the tissues alone, and in the absence of muscle activity, can account for the maintenance of the rest position. The clinical method used to induce the mandible to assume the rest position results in the adoption of a steady level of masseter muscle activity which is reproducible.

Prieskel (1965) <sup>[44]</sup> showed that the postural position of the mandible may vary with head position. Body position, proprioception from the dentition, pain, and emotional factors affecting muscle tone are also acknowledged to influence the postural position.

Garnick and Ramjford (1962) <sup>[45]</sup> observed electromyographically, a resting range rather than a well-defined mandibular rest position in the elevator and depressor muscles studied. The limits of the resting range were determined occlusally by the temporal muscles and in opening by the digastric muscles. The clinically determined rest position was located occlusally to the electromyographically determined resting range of the muscles. The resting activity of the jaw muscles or tonus is dependent on the stretch reflex and also on the gamma efferent system as influenced by the central nervous system and peripheral impulses from, occlusal disharmony of the teeth.

Wessberg *et al.* (1982) <sup>[46]</sup> evaluated the mandibular rest positions in subjects with diverse vertical dentofacial morphology. The resting vertical dimension (RVD) and transcutaneous electrical stimulated position (TESP) of the mandible are two distinctly different biologically dynamic neuromuscular entities. They differ with respect to their spatial position in that the RVD is 2.6 mm closer to centric

occlusion than TESP. A physiologic range of neuromuscular adaptability exists within each diverse morphologic group. Adaptations are apparently mediated by the central nervous system and the musculoskeletal complex. The interocclusal distance at the TESP is inversely related to the vertical dentofacial morphology.

Van Sickels (1985) <sup>[47]</sup> studied the electromyographic relaxed mandibular positions in long faced subjects. The findings showed that long-faced subjects have large EMG rest positions in contrast to the results reported by Wessberg *et al.* (1982) <sup>[46]</sup>.

Jarabak (1957) <sup>[48]</sup> found that a correct vertical dimension of occlusion coupled with an adequate interocclusal distance between the teeth of the upper and lower dentures is essential to maintain the muscles of mastication at their most efficient functional length.

An inaccurate determination of VDR in a patient with poor head and neck posture may result in clenching and grinding of teeth, resorption of tissue, temporomandibular joint dysfunction, pain, and loss of esthetics <sup>[38, 49, 50]</sup>. A study by Darling (1984) <sup>[51]</sup> suggests that an increase in VDR occurs with an increase in the angle of habitual head posture. With these increases, less retrusion of the mandible was also evident. With forward head posture, the posterior cervical muscles are shortened isometrically while the anterior submandibular muscles are stretched to cause retrusive forces on the mandible.

Yemm and Berry (1969) <sup>[17]</sup> suggested that the mouth is held open by the action of depressor muscles opposed by the elasticity in the elevator muscles and associated tissues. In the wide-open state, some activity is seen in the elevators, but as closure starts, this disappears. During slow mandibular closure, there is decrease in the activity of the depressor muscles and no activity at all in the elevator muscles. But during the movement from the rest position to the occlusion, there is activity in the elevator muscles.

A two year follow up of mandibular posture following an increase in occlusal vertical dimension beyond the clinical rest position with fixed restorations was studied by Ormianer and Gross (1998) <sup>[52]</sup>. The study showed that the increased resting face height remained stable after increasing the OVD over 1 and 2 years in eight subjects.

Lambadakis and Karkazis (1992) <sup>[53]</sup> studied the changes in the mandibular rest position after removal of remaining teeth and insertion of complete dentures and concluded that the mandibular rest position of the edentulous patient is an unreliable means to re-establishing the vertical dimension of occlusion that the patient had before extractions. Certain factors such as vertical bone loss and neuromuscular adaptation may lead to a consistent trend of changes in the mandibular rest position.

Manns *et al.* (1981) <sup>[54]</sup> investigated the changes in electrical activity of the postural muscles of the mandible upon varying the vertical dimension. The study showed a gradual decrease of EMG activity starting from the occlusal position, passing through a range of maximum reduction at a certain interocclusal distance, and gradually increasing to the highest values close to maximum jaw opening. Recordings with static variations points out the exact VD at which minimum basal EMG activity is observed in each muscle studied (10 mm for the masseter muscle, 13 mm for the anterior temporal muscle, and 16 mm for the posterior temporal muscle).

Michelotti *et al.* (1997) <sup>[55]</sup> analysed the relation between mandibular rest position and electrical activity of masticatory muscles and compared clinical and electromyographic rest

position in subjects with different vertical facial morphologic features. Clinical rest positions and electromyographic rest positions (EMGRPs) are independent entities and both correspond to different vertical mandibular positions. EMGRP is always more caudal than clinical rest position, with a mean difference of 6.3 mm. Clinical rest position was significantly related to the facial morphologic features, which was lower in the high-angle group.

Thüer (1989) <sup>[56]</sup> studied the changes in the functional position of the mandible during activator treatment. Although the anteroposterior position of the mandible in rest position was unchanged, there was an increase in the freeway space during the period of treatment. This increase was largest when an activator combined with high-pull headgear was used. It may be that the increase in the freeway space is a result of retarded vertical maxillary growth caused by the treatment and that this effect is largest when the activator is combined with headgear.

Sperty (1989) <sup>[57]</sup> evaluated the rest position of the mandible and malocclusion and concluded that the rest position of the mandible in class II malocclusion cases were anterior to that of the class I control groups while it was posterior in class III cases compared to that of class I control cases. Moller (1976) <sup>[58]</sup> also reported that when a subject whose jaw is in the rest position moved from an upright to a supine position, a reduction in the electrical activity of the temporalis muscle could be demonstrated and was cited as evidence for a servo-controlled mechanism producing a response to changes in position.

Ayub *et al.* (17) <sup>[59]</sup> reported an increase in the rest vertical dimension of the mandible following the correction of a forward head posture in an edentulous patient. Extension of the head reduces the interocclusal distance and retrudes the mandible, while head flexion increases the freeway space <sup>(18)</sup> <sup>[60]</sup> A forward head posture has also been associated with a decreased interocclusal dimension <sup>[7, 51]</sup>. When moving into an upright rest position, the mandible tends to rotate in a clockwise direction, with a movement similar to normal opening. When moving into a supine rest position, the mandible tends to rotate in a counterclockwise direction, with the center of rotation close to the incisors <sup>[61]</sup>.

Heit *et al.* (20) <sup>[62]</sup> investigated the effect of the physiological rest position of the mandible on cerebral blood flow and physical balance. He concluded that the physiologic rest position of the mandible might have an effect on balance by showing a trend in enhancing cerebral blood flow as measured by transcranial Doppler.

### 3. Discussion

Rest position is obtained either through verbal instruction and observation or by monitoring muscle activity <sup>[6, 13, 14, 19, 20]</sup> but different methods have been shown to induce variations in recorded rest position in the same subjects <sup>[6, 14, 19, 21]</sup>. Rest position has been typically measured with external soft-tissue landmarks <sup>[22-25]</sup>, manual intraoral distances between the incisors <sup>[1, 26, 27]</sup>, kinesiograph recordings <sup>[14]</sup> and radiographic inter incisor or bony landmark distances. A variety of techniques has been used clinically and experimentally in the location of the rest position. These include the act of swallowing (Niswonger, 1934), phonetic methods (Jarabak, 1957) and lip licking (Atwood, 1956). A combination of lip licking followed by swallowing is advocated by Grant and Johnson (1983). Tallgren (1957) found that the face height, measured cephalometrically, resulting from swallowing and phonetic techniques was similar to that produced when

subjects were asked to relax both physically and mentally. This study was undertaken to compare the level.

Wagner (1971) <sup>[63]</sup> compared four methods to determine the rest position of the mandible; REST, M,M,M, SWALLOW and OPEN – CLOSE method. The REST method, based on natural relaxation, appeared to be an acceptable method to determine the rest position, because the measurements presented less high and low readings. The M,M,M method tended to produce a large rest vertical dimension and the swallowing method a smaller one. The instability of the mandibular rest position was of similar magnitude for all of the methods.

Niswonger (1934) <sup>[64]</sup> concluded that rest position of the mandible with its attached tissues is noticeably present in infant, adult and the aged, regardless of presence or absence of teeth. This theory has been referred to as Concept of constancy of height. He further observed that a variable amount of space exists between the lower and upper teeth, when the mandible is in rest position, and that this space (free-way space) averaged 1/8 th an inch. This distance can easily be measured on the soft tissue from a point at the juncture of the philtrum with the nasal septum to a point on the center of the chin. Such soft tissue measurements are positive enough to be used successfully in denture construction and for building up occlusal and incisor surfaces on natural teeth. He suggested that since the extensor and flexor muscles of the mandible are in equilibrium in this position, it should be designated as the neutral position of the mandible.

George and Boone (1979) <sup>[65]</sup> conducted a clinical study of the rest position of the mandible using Kinesiograph and Myomonitor. The Kinesiograph is able to measure the mandible as it moves freely or during tooth contact in the frontal, sagittal, and horizontal planes simultaneously. The Myomonitor was used to relax the musculature by a light myopulse induced electronically. The results showed that the myomonitor relaxed the facial muscles as well the masticatory muscles to a great extent and this was the reason for an increased vertical dimension at rest following the use of a myomonitor. Thompson <sup>[2]</sup> noted that in cases involving extensive restorative procedures or orthodontics, classification of malocclusion should be based on the vertical dimension of rest position and not on the occlusion of teeth. Clinically, then, the Kinesiograph could be of great benefit and could relate rest position to maximum intercuspation. Combining two or more of these techniques would help the clinician in determining a patient's rest position of the mandible.

### 4. Conclusion

The concept of rest position of the mandible being stable for the entire life of an individual has been disregarded by many since studies shows that it depends on various factors including presence or absence of teeth and denture, tongue posture, orofacial muscles, head posture and body posture being some of them. A resting range rather than a resting position and an increased vertical dimension at rest (VDR) electromyographically compared to the clinical VDR have been observed. Techniques described for the determination of the VDR includes swallowing, phonetics method, lip licking, electromyography and kinesiograph. An inaccurate determination of the VDR may cause detrimental effects to health of the oral tissues like clenching and grinding of teeth, tissue resorption, TMJ pain and dysfunction and loss of esthetics. Hence, it is important to consider the VDR in prosthodontic rehabilitation of a patient and to fabricate the

prosthesis accordingly.

Since the constancy of the rest position is still not definitely established, as also the relationship between the rest position, centric occlusion position and the freeway space, the entire procedure for obtaining the vertical dimension is empirical. Actually the clinical procedures record a highly artificial situation, which is likely to be inaccurate. In the absence of any better method as reviewed above, clinical judgement and integrity are essential for successful results.

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