Oral Sensory Perception - A Useful Tool for Improvement of Speech - *A Case Report*

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ABSTRACT

Explicit considerations of nervous system anatomy and physiology underlying speech and language is critical to provide more concrete basis for linguistic communication. Recent studies indicate that speech motor control requires integration of multiple sensory signals with internally specified general motor goals.

The objective of the study was to achieve an improvement in speech by increasing the sensory awareness of the oral cavity in a patient with defective speech but with no anatomical or physiological defect. An appliance to increase the sensory perception of the tongue was introduced, as the patient had difficulty in pronouncing linguo alveolar sounds. Speech therapy sessions were simultaneously continued. Sensory awareness of the tongue was enhanced and speech analysis showed improvement in linguo alveolar sounds.

Increasing oral sensory perception can also be applicable to patients with anatomical or physiological defects of the oral cavity. Increasing oro-sensory awareness has a facilitatory effect on the pyramidal tract which is thus responsible for skilled or planned motion.

This report lays stress on the multi-disciplinary integrated approach with the help of prosthesis, in improving the speech by understanding the oral anatomy and neuro- physiology of speech mechanism.

INTRODUCTION

In our upwardly mobile highly competitive society verbal skill is greatly rewarded. There is nothing more elemental in our existence than communication; it is the very essence of life[1]. However there are many unfortunate people in this world who have a difficulty in speech. This case report is about a 16-year old boy who suffered from a marked speech disorder.

CASE REPORT

A 16 year old male 'Bhavesh Kulti' reported to Nair Medical Hospital, Dept. of Speech therapy in May 2000 with a chief complaint of inability to speak clearly, Bhavesh was a healthy male with no other complaints.

EXAMINATION

Oral and peripheral examination showed that all structures like lips, tongue, palate, velum & teeth were anatomically & physiologically normal.

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SPEECH ASSESSMENT

Speech assessment was carried out by asking him to say different words, narrate a paragraph & read a paragraph. This revealed that Bhavesh had defect in articulation of following sounds[2,3,5,8,11,12].

-Interdental
-Lateral
-Alveolar
-Palatal
-Retroflex

HEARING ASSESSMENT

Audiometry was used to test Bhavesh's hearing capacity. This revealed that his auditory skills were within normal limits.*(Fig. 1)*

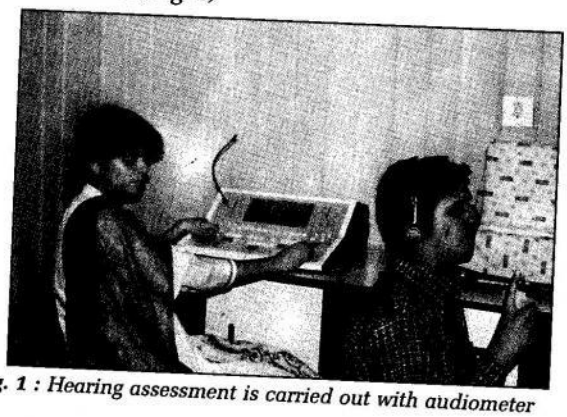

***Fig. 1** : Hearing assessment is carried out with audiometer*

SPEECH THERAPY

The patient was taken for conventional speech therapy for 19 sessions in which following techniques were used *(Fig. 2)*[5]

- Phonetic placement
- Constant drills of the sound.

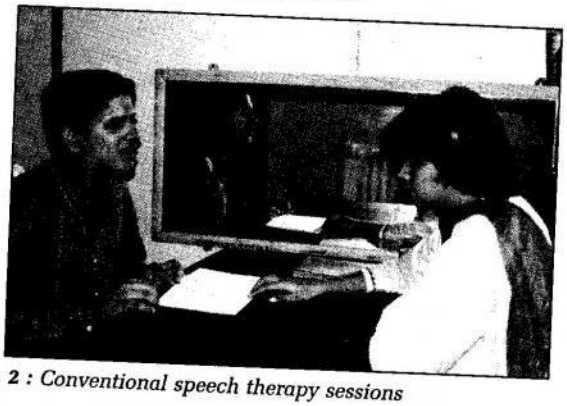

***Fig. 2** : Conventional speech therapy sessions*

Patient showed some improvement in alveolar sounds, however other sounds did not improve.

Thus, Bhavesh was a patient who, in the absence of neurologic or organic pathology exhibited articulation disorders extremely resistant to traditional means of remediation. Such defects of articulation in patients with good mental capacity, normal auditory system & normal mechanical conditions need prosthodontic intervention.

ORAL SENSORY PERCEPTION

Sensory perception is the process of perceiving & interpreting external or internal stimuli as a meaningful information in the cerebral cortex. It occurs through stimulation of neurons in specialized areas of the cerebral cortex (somato-sensory area)[14,15].

Oral cavity is richly endowed with sensory receptors[13,14,15]. Tactile receptors of the tongue, mouth, pharynx & teeth play a significant role in articulation of speech. These receptors are excited by chemical or mechanical stimulation. Stimulation of these receptors was to be carried out to alter speech.

ORAL STEROGNOSIS

Whether oral sensory perception can be used as a treatment modality was detected by a test called Oral Sterognosis[5]. It is the ability to recognize 3-dimensional forms through senses. Small common 3-D objects are placed in the subject's mouth without knowing the shape of the form. Subjects identify the shape through recognition & discrimination (*Fig. 3*). It was seen that Bhavesh could identify the shapes correctly.

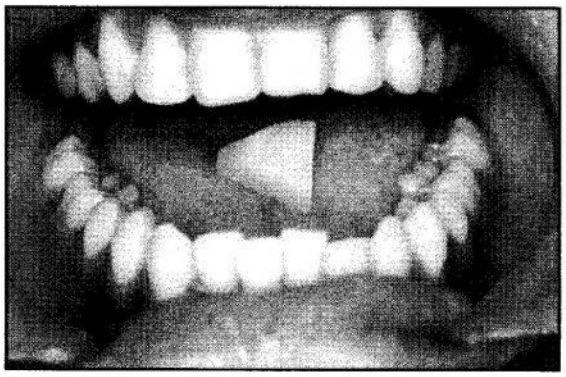

***Fig. 3** : Oral sterognosis test*

IMPLICATIONS

(1) Sensory receptors are functioning normally.
(2) Sensory pathways to the cerebral cortex are intact.
(3) Cortical sensory & association areas in cerebral cortex are also intact.

TREATMENT PLAN

After the above assessment a palatal plate was given to Bhavesh for continuous use. Speech therapy sessions were simultaneously carried out. 9 sessions were carried out at a rate of 2 sessions per week.

The same plate was then roughened in the anterior region & 5 speech therapy sessions were carried out.[3,5] This was done to take adaptation of receptors into consideration (Fig. 4).

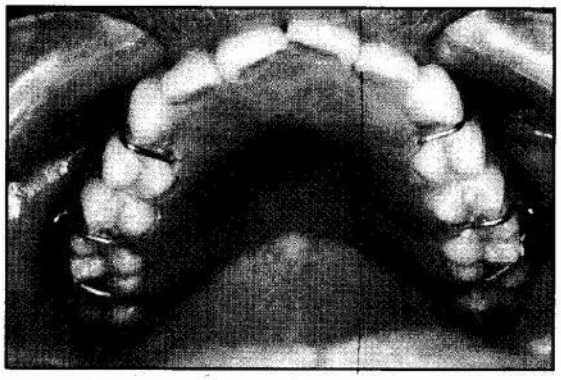

***Fig. 4** : Smooth palatal plate given for 8 speech therapy sessions*

Adaptation describes the response of nerves to continuous stimulation[14,15]. Some receptors respond only to application & removal of stimulus. These are rapidly adapting receptors. Others continue to respond as stimulus is applied. These are slowly adapting receptors.

To achieve further improvement in lateral & alveolar sounds palatal plate with spikes in anterior region was given & 8 speech therapy sessions were carried out (Fig. 5).

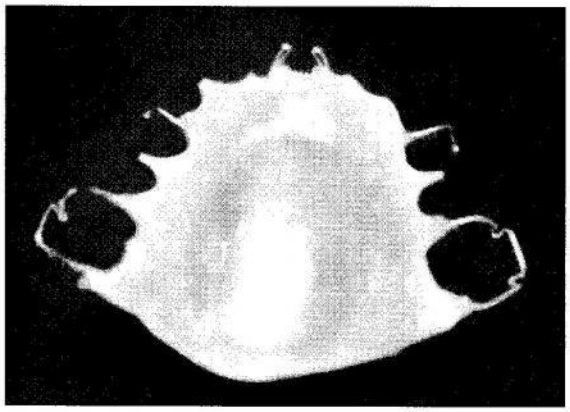

***Fig. 5** : Plate with spikes in the anterior region for improvement in linguoalveolar sounds.*

With this treatment modality the speech of the patient was improved. The use of plate was discontinued once stabilization of sounds was achieved.

DISCUSSION

Edwards, based on the principle of proprioceptive neuromuscular facilitation, reports success in improving sensorimotor planning & feedback. Tactile stimulation has a facilitating effect on the pyramidal tract which leads to a more skilled or planned motion.

Thus the fundamental premise of the present case is that generation of movements involves continuous utilization of sensory information from sensory receptors.

The sounds which Bhavesh was unable to produce depended on the position of tongue with respect to the palate & the alveolus. In view of the sounds he was unable to produce, the palatal appliance was given to give sensory stimulation to the tongue.

CONCLUSION

Though it is said, 'Speech is silver & silence is golden', in today's world speech is the single-most golden tool that enhances our own success. Using a basic & fundamental concept of oral sensory perception, speech of the patient was improved, thus paving a road for his success.

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Abstract

The role of surface topography in creating & maintaining bone at titanium endosseous implants

Statement of problem *- A variety of claims are made regarding the effect of surface topography on implant osseointegration. Many invivo & in vitro experimental observations have key limitations in their interpretations.*

PURPOSE

This review considers the major claims made concerning the effects of commercially pure titanium implants' surface topography on osseointegration.

RESULTS

Implant surface topography is not well defined in the marketplace or consistantly reported among experimental studies. Many in vitro evaluations are not predictive of or co-related with in vivo outcome.

In some culture models, increase surface topography positively affects pro-osteogenic cellular activities. Animal models reveal modess increases in bone-to-implant contact & increase in the biomechanical interlock of the implant with bone for implants of increased surface topography as a risk for perimplant inflammation.

CONCLUSION

Increased titanium implant surface topography improves the bone-to-implant contact & the mechanical properties of the enhanced interface. Growing clinical evidence for increased bone to implant contact at cultured c.p. titanium implants confirms the temporally limited observations made in pre-clinical studies. In the absence of controlled comparitive clinical trials, the aggregate experimental evidence supports the use of c.p. titanium implants with increased surface topography.

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Cranio-mandibular relations

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ABSTRACT

Though the primary function of teeth is mastication, teeth are not chewing organs by themselves. They are capable of performing their functions only when used collectively with other components of the gnathic system. The chewing mechanism consists of maxilla and mandible with its musculature, the temporomandibular joint and the teeth. Together they function in unison as the masticatory apparatus, which should be treated as one integrated unit. This is the fundamental philosophy of the science of Gnathology proposed by McCollum[12].

When teeth are lost or when the harmonious function of these components is disturbed, it is necessary to obtain vertical, horizontal jaw relation records, and face bow record to relate the prosthesis to the function of odonto-gnathic system. The accuracy of these records is therefore critical. These relationships are collectively discussed as the "Cranio-mandibular relations" (Table I and II).

The determinants of the Cranio-mandibular relation

Determinant I	-	Vertical jaw relation
Determinant II	-	Centric jaw relation
Determinant III	-	Condyle maxilla relation (face bow record)
Determinant IV	-	Mandibular side shift and Bennett movement
Determinant V	-	Eccentric occlusal relations

Determinant I - Vertical relation of the edentulous jaws

INTRODUCTION

For successful complete denture prosthesis, it is essential to record the vertical and horizontal relationship of the mandible to maxilla accurately and transfer these records to an articulator to maintain these relations. In the vertical plane, it is necessary to obtain an inter-arch distance, which is optimum for complete denture function, speech and appearance. Numerous studies[1,14,15,18,26,28] have shown that this is not identical to the inter-arch distance that existed when the patients natural teeth closed in centric occlusion before the loss of teeth. Since their compatibility is doubtful, pre-extraction records have a limited value.

In an edentulous person, centric occlusion position is lost with the loss of natural teeth. As a result, the vertical dimension of occlusion is also lost and the mandibular edentulous arch is free to move vertically to any distance until it contacts the maxillary arch. There is no precise method to recapture the vertical dimension of occlusion after an individual becomes edentulous. Inspite of the several methods recommended for recording vertical dimension of occlusion in edentulous subjects, none is considered as an absolutely accurate and reliable method. Further, some methods are obsolete. No one method will suffice to record this position of the jaws. Each method must be checked against the other. Obtaining the appropriate vertical dimension in complete denture prosthesis requires judgement and experience more than meticulously following a particular method.

Key words : vertical dimension of the jaws - vertical limit of occlusion - vertical threshold of occlusion.

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Vertical threshold of occlusion in complete dentures (VTO)

Vertical dimension of the jaws is influenced by several factors, which makes it inconstant. Experience has shown that there is no one correct vertical dimension for an individual. There is a range of acceptable vertical height for each person[8]. Among the different vertical heights, the clinician should arrive at the suitable vertical threshold of occlusion necessary for his patients. Beyond this, it is detrimental to the supporting tissues and TMJ. Vertical threshold of occlusion is the vertical allowance of space ideally required in centric occlusion.

Since it is difficult to measure this relation intraorally, we seek assistance extra-orally between facial landmarks[20]. Therefore, vertical measurement of face between any two selected points located above and below the mouth, usually in the midline is made to record a vertical dimension for the edentulous jaws which denotes the vertical threshold of occlusion necessary for function and esthetics.

Vertical Limit of Occlusion (VLO)

Vertical dimension of occlusion, vertical relation of occlusion, vertical occlusal relation, vertical height of occlusion and vertical clearance of occlusion are some common terms used to denote the ideal vertical allowance of space required for a complete denture in centric occlusion. It should be pointed out that vertical dimension is a general term, which merely denotes the measurement in one direction, while vertical relation simply means

TABLE 1
Significant Cranio-Mandibular Relations and Positions

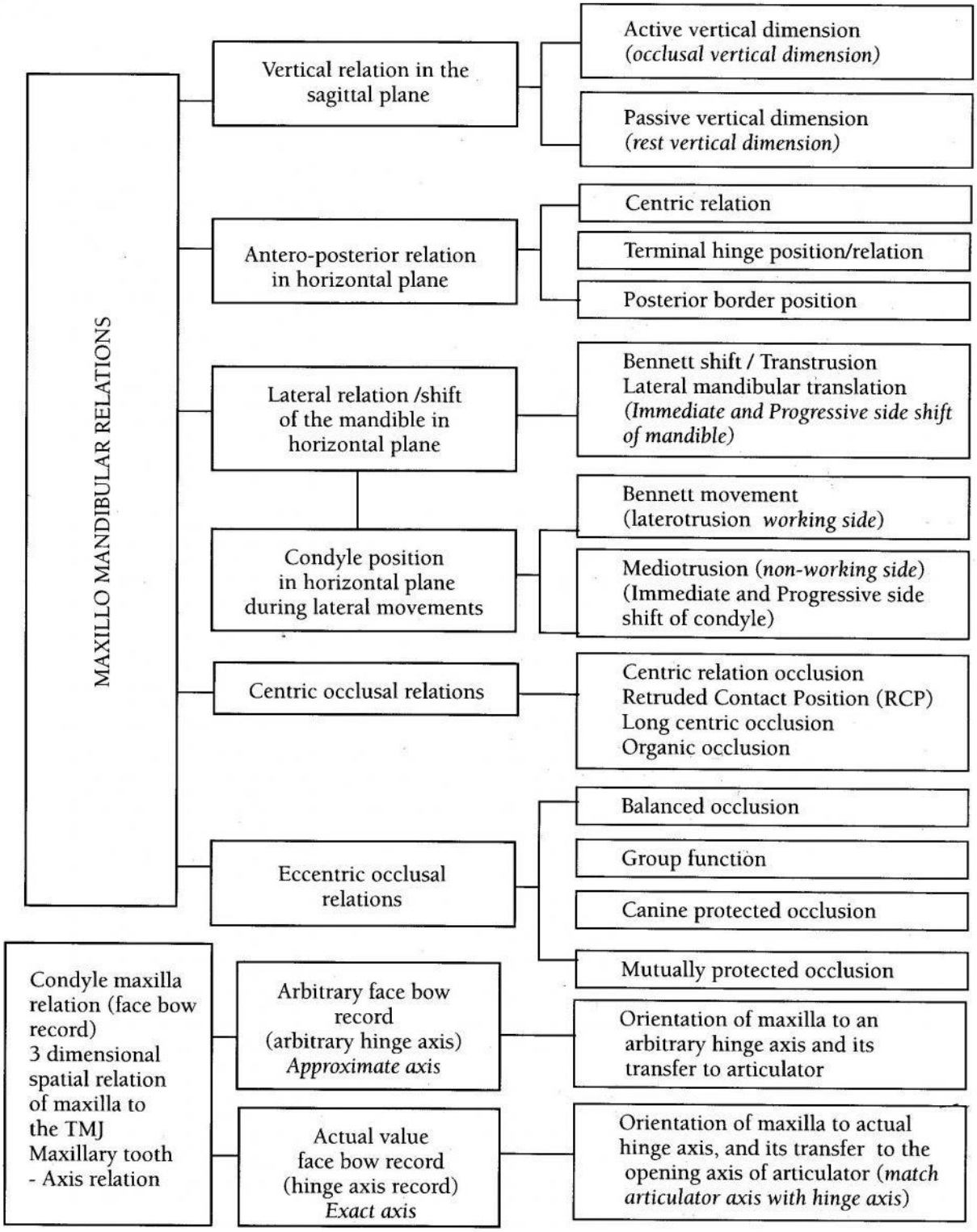
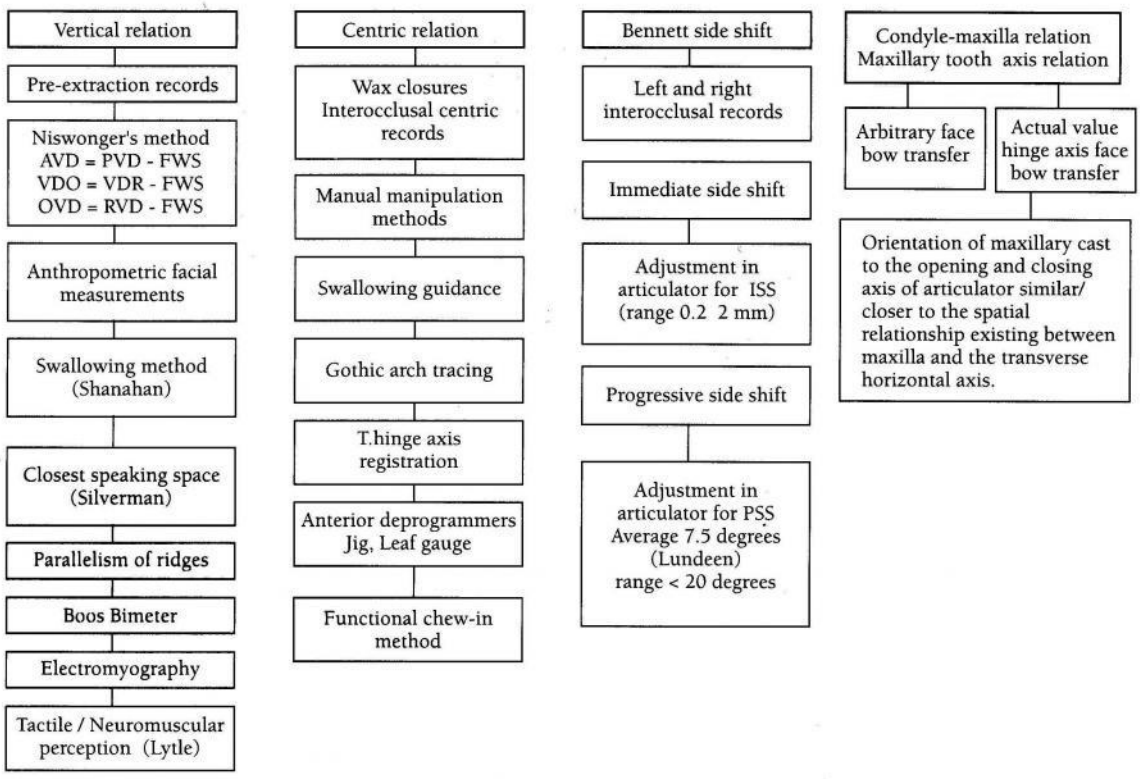


TABLE 2
Transfer of Cranio-mandibular Relations



reference. Terms such as occlusal vertical dimension and occlusal vertical height is vague as it does not precisely indicate the occlusal height which would be physiological or harmful to an individual. None of these terms indicate what is ideal. It is possible to have several vertical dimensions of occlusion or vertical occlusal heights in an edentulous person; among these we should establish a vertical height which is ideal.

The term "limit" however is a specific prefix, which denotes the physiological limit of tolerance of the vertical dimension in a denture wearer. In human physiology, "limit" is often used to express a boundary, degree, extent or amount permitted beyond which it is harmful. Therefore, it will be in accord if this term is used to qualify vertical dimension of the edentulous jaws in complete denture wearers.

Once the proper occlusal vertical height is established, then this is the vertical limit of occlusion the denture wearer can tolerate. It is the limit of tolerance by the denture wearer, beyond which the vertical dimension is detrimental to the health and function of the gnathic system. When it exceeds this limit or threshold, the vertical dimension is in excess and when it is below the limit, the vertical dimension is then reduced.

Further it should be pointed out that the vertical dimension recorded by two clinicians is seldom identical and rarely the same. This shows that there is a range of acceptable vertical dimensions and the operator's judgement plays a decisive role in establishing it in a denture wearer. There is an upper and lower vertical limit of occlusion. The correct vertical dimension can be anywhere between these two vertical limits.

Vertical limit of occlusion is therefore an expressive term in preference to the various other terms currently used. Moreover, the term vertical limit of occlusion also underlines the risks and consequences of exceeding the vertical limit in dentures. Vertical limit of occlusion is the vertical threshold of occlusion for a complete denture.

Clinician's decision based on patients requirement, denotes the selection of an appropriate vertical limit of occlusion which will fulfill the functional and esthetic requirements (Table III).

Commonly used terms for vertical jaw relation

Vertical dimension between maxillary and mandibular ridge measured at the face between two fixed points when mandible is at rest is referred as vertical dimension of rest (VDR). It is a passive vertical dimension (PVD) in contrast to vertical dimension of occlusion (VDO), which is an active vertical dimension (AVD), measured when the teeth occlude in centric relation.

Vertical Jaw relation (Synon) - Vertical dimension / Vertical height of the jaws

ACTIVE VERTICAL DIMENSION (AVD)	PASSIVE VERTICAL DIMENSION (PVD)
Occlusal Vertical Dimension (OVD) ..GPT -7	**Rest Vertical Dimension (RVD)..GPT -7**
Occlusal Vertical Relation (OVR)	*Rest Vertical Relation (RVR)*
Occlusal Vertical Height (OVH)	*Rest Vertical Height (RVH)*
Vertical Dimension of Occlusion (VDO)	**Vertical Dimension of Rest (VDR)**
Vertical Relation of Occlusion (VRO)	*Vertical Relation of Rest (VRR)*
Vertical Height of Occlusion (VHO)	*Vertical Height of Rest (VHR)*
Vertical Clearance of Occlusion (VCO)	*Vertical Clearance at Rest (VCR)*

Vertical Limit of Occlusion (VLO) Syn. - Vertical threshold of occlusion

Vertical limit of occlusion = VDR *minus* FWS
RVD *minus* FWS

Note :

Passive vertical dimension is only a reference position to achieve active vertical dimension. The active vertical dimension is significant, as it governs the vertical limit of the jaws necessary for function, esthetics and comfort. It also controls the quantum of freeway space required in a denture wearer.

Objectives of recording an optimum vertical dimension in complete dentures

1. To maintain the esthetic harmony of the face
2. To be able to speak without tooth contacts
3. To satisfy functional requirements
4. To provide comfort to the ridge, masticatory muscles and TMJ
5. To preserve the alveolar residual ridge.

Note : Vertical dimension and centric relation co-exist (GPT-4 & 5 definition on centric relation). Therefore a correct vertical dimension is mandatory to establish centric relation. Centric relation is dependant on the degree of jaw separation (GPT definition). It changes with different mouth opening. An ideal centric relation, is when there is an ideal vertical dimension.

A CRITICAL APPRAISAL OF THE THEORIES AND METHODS OF RECORDING VERTICAL JAW RELATION

The following are the several methods devised from time to time to record an ideal vertical dimension of occlusion for complete dentures. Methods based on rest position of the mandible, phonetics, swallowing guidance, face dimensions, esthetics and tactile neuromuscular perception have found wide acceptance. Some of the methods are of historical importance, while others are useful as a research tool and a few have become obsolete. Neverthless, these

TABLE 3
Establishing the vertical limit of occlusion in edentulous subjects

Phase I At the jaw relation stage

Basic method of recording VDO
Based on rest position of the mandible
(Assistance from pre-extraction records if available)

↓

Verification of the VDO obtained by the basic method
Assessment of vertical dimension by other check methods
(face measurements, speech tests, tactile and neuromuscular perception)

↓

Vertical dimension of occlusion is a range
Establish the vertical limit of occlusion

↓

Clinical judgement of the operator

↓

Patients acceptance and tolerance

Phase II - During trial stage

Verify the vertical limit of occlusion
(for appearance)

↓

Verify the quantum of inter-occlusal clearance / space
during rest vertical dimension
(by direct observation and by speech tests)

↓

Justify the appropriate vertical limit of occlusion
obtained with the trial dentures in the mouth

(Patient satisfaction based on esthetics and comfort)

theories and methods give the reader an overview of the concept practiced in yesteryears and many found useful today.

PRE- EXTRACTION RECORDS

Pre-extraction records appear to be the nearest means to obtain the correct vertical dimension. However this is possible only if the patient's records are available with the dentist, when he had his natural teeth. Not all edentulous patients present themselves to the dentist before the extraction of teeth. Pre-extraction records are based either on the premise of physiological rest position of the mandible, or on its relation to occlusal vertical dimension.

Validity of pre-extraction records

Dentulous vertical dimension of occlusion as a pre-extraction record

A few textbooks recommend the pre-extraction occlusal vertical dimension to be maintained in complete dentures. In fact this is claimed to be a distinct advantage with immediate denture service. However, it is now doubtful whether the patient's pre-extraction vertical dimension of occlusion should be reproduced in complete dentures. There is a decrease in occlusal vertical dimension from dentulous to edentulous state, therefore the vertical dimension of occlusion provided by natural teeth is not necessarily that which is required for complete dentures[15,28].

It has been the experience with immediate denture patients who have been provided with complete dentures, which reproduces exactly the same occlusal vertical dimension of natural teeth, generally appear as having an increased vertical height. Some of these patients return with all the symptoms associated with wearing dentures with increased vertical dimension. The removal of natural teeth (occlusal stops) is followed by an adoption of new rest position of mandible, usually with the jaws coming closer to each other.[14,15,26] Therefore the claim that immediate denture service provides an ideal occlusal vertical dimension is debatable.

Rest position of the mandible as a basis for pre-extraction record

The constancy concept of rest vertical dimension has been disproved by clinical and roentgenographic studies. Rest vertical dimension decreases after extraction of remaining natural teeth,[1,15,18,26,28] with the adoption of a different rest position of a mandible. Therefore, the inter-relationship established between the rest vertical dimension in dentulous condition, as a pre-extraction record for complete dentures may not be truly applicable after extraction of teeth is completed. This should be considered while indicating pre-extraction records based on rest vertical dimension for determination of vertical dimension in complete dentures.

In the past years, pre-extraction records were useful in recording vertical dimension of occlusion. However, considering the changes in vertical dimension of rest and vertical dimension of occlusion after the loss of teeth, its accuracy is doubtful. Nevertheless, some of the pre-extraction records are valuable adjuncts to the various clinical methods presently used for recording vertical dimension and are also useful as a verification record..

The following are some methods based on pre-extraction records.

a) Profile roentgenograph
b) Profile photograph
c) Profile soft wire tracing
d) Face mask
e) Articulated plaster casts
f) Willis method
g) Wrights method

Profile roentgenograph

Profile X- ray is a useful pre-extraction record. A 1 : 1 ratio of cranium to image radiograph is obtained with a cephalostat when the mandible assumes physiological rest position or is in centric occlusion, and measurements are made between bony landmarks in the maxilla and mandible. This is later used as a reference while obtaining vertical dimension after the person becomes edentulous, when his present radiograph is compared with the previous radiograph.

Vertical dimension obtained by this procedure may appear scientific, but it is time consuming and cumbersome. Profile X- ray method is not practical for the practitioner in a routine dental office. It can be used for research purpose. Since the constancy of rest position and occlusal vertical height from dentulous to edentulous condition is disputed, the use of profile roentgenograph that is based on the principle of rest position of mandible or centric occlusion is questionable.

Profile Photographs

Profile photographs have also been mentioned as a pre-extraction record. It involves taking photographs before extraction with the subject in physiological rest position and using it as a guide to develop vertical dimension after teeth are extracted. Profile photographs appear to be logical, however the accuracy of this procedure is very doubtful. It can serve as a guide to compare the fullness of the lower third of the face after establishing vertical dimension of the jaws.

Soft wire tracing

Soft wire tracing technique is yet another means of obtaining a pre- extraction record. A soft lead wire is bent to fit the profile of the face when the patient is in active vertical dimension with his own teeth. This lead wire is then carefully placed to fit precisely against the edentulous patient's profile in OVD. It can also be placed on cardboard and the lead wire outline is traced on it. The cardboard is cut along this line and then used to fit against the patient's face profile during jaw relation procedure to obtain the OVD. Cardboard cut out is preferable to lead wire, as wire

is likely to bend during storage and while fitting on the face.

This method is again not simple. The possibility of change in facial contour and vertical height subsequent to extraction of teeth should be considered while advocating this technique.

Face mask

Facemask is also used as a pre-extraction record. A hydrocolloid impression of the patient's face is taken. This is reinforced with plaster before it is removed from the face. The impression is poured in stone plaster and a 2 or 3 thickness base plate wax is adapted on this cast. This wax face mask is then processed in clear acrylic resin. The transparent mask is placed over the patient's face at the time of determination of vertical dimension. When the correct vertical dimension is arrived, the subject's face will fit accurately to this mask.

There are several difficulties with this cumbersome method. Hydrocolloid impression, requires precise procedures, large quantities must be warmed to the correct temperature, and then painted on the face. During this procedure, the subject should be in a supine position. In supine position, rest vertical dimension cannot be accurately established. Face mask should therefore be made with subjects jaw in active vertical dimension. It is less accurate than the profile soft wire tracing method, even though the principle in both the methods is the same. Both of these methods displace skin; with an inaccuracy up to 2 mm or more has been reported.

WILLIS METHOD

Willis[34] (1935) observed that the distance from the base of the nose to the lower edge of the mandible is equal to the distance between the pupil of the eye and rima oris. He therefore stated that the vertical dimension could be considered correct when these two distances are equal to each other. He based this on the fact that in several individuals who have all their natural teeth in good condition; these measurements were found to be similar when the lower jaw was at rest. Willis method is also known as the eye-lip-nose-chin method, as it was also once thought that the distance from the eyebrow to the corner of the lip would be equal to the distance from the tip of the nose to the bottom of the chin.

Willis introduced a calliper like device known as Willis gauge to measure these facial distances. It is a flat L-shaped metal scale graduated in millimetres with a parallel-sliding arm attached to it, that can be locked against the reading on the scale. The movable horizontal sliding arm of the bite gauge can be adjusted to any face height and the sliding arm can be locked in that position.

Willis method appears to be simple but has several limitations. Firstly, it is difficult to generalise anthropometric measurements in all patients. Secondly, these measurements are not easy to obtain, as there are no precise measurable fixed points. Soft tissue landmarks can vary. In persons with thick bushy eyebrows, it is difficult to measure, than in one who has a very thin eyebrow. It is also difficult to fix the exact point on the chin to measure this distance. Further, such measurements place the human race in one group, which is generally not acceptable.

Willis bite gauge can also be used as a reference for pre-extraction record. By placing one arm below the base of nose and the other at the chin, the distance in OVD is measured with this instrument before extraction of teeth and is used as a pre-extraction record during registration of vertical dimension in the edentulous subject.

It is not possible to get precise measurements with Willis gauge. Dakometer, pointed steel dividers and precision callipers give a more accurate measurement.

WRIGHTS METHOD

There is yet another method recommended by Wright[35] (1939), which is similar to Willis method. The premise of this method is based on obtaining a recent good full-face undistorted photograph of the patient when he had natural teeth. Wright believed that in nature a ratio existed between the interpupillary distance and brow to chin distance. He based it on the assumption that brow to chin distance in photograph, is the distance when the mandible is in rest position.

The interpupillary distance (IPD) and the brow to chin distance (BCD) of the photograph were measured. He then measured the interpupillary distance of subject to obtain the brow to chin distance of the subject by the following equation.

IPD on photo	IPD in patient		BCD on photograph	BCD in patient
X	X_1	::	Y	Y_1

For example, if IPD in photo was 10mm , IPD on patient was 60mm and BCD on photo was 20 mm. Then BCD of the patient is calculated as :

$$Y_1 = X_1 \times \frac{Y}{X} \qquad \frac{60 \text{ mm} \times 20 \text{ mm}}{10 \text{ mm}} = 120 \text{ mm}$$

The BCD thus obtained is an indication of the facial height between the two fixed points when the mandible is in rest position. The OVD is subsequently arrived by reducing freeway space distance.

It is difficult to find edentulous patients who have good pre-extraction photographs where measurements of the interpupillary distance and brow to chin distance can be measured accurately. The preciseness of this method is very doubtful.

It is not always possible to have pre-extraction records, as very often the patient is not seen before he presents himself as an edentulous person. Therefore, other methods have been devised to obtain vertical dimension in complete dentures. The following are some of the methods that have been developed over the past years:

DIVISION OF FACE INTO THIRDS

This method is based on the division of the vertical proportions of face into three equal parts. The distance from hair line to eyebrow, eyebrow to base of the nose, and base of the nose to the chin are same. To measure these proportions, Willis bite gauge is used. The base of nose to chin distance in an edentulous subject is obtained by recording the measurement between the hairline to eyebrow or the eyebrow to the base of the nose.

OTHER FACIAL LANDMARKS

Eye-ear distance, pupil rima oris distance, distance between the angle of the mouth, glabella- subnasion distances are some of the facial measurements which are related to chin nose distance (nasion - subnasion) to record vertical dimension of occlusion[4,13,19,21,27,33,34,35].

Intra-oral tatoo marks at the mid-maxillary and mid-mandibular labial frena or between specific points at the maxillary and mandibular labial mucosa and radiopaque paste in vestibular fornix of the upper and lower muco-labial reflection are also useful references to obtain cephalometric pre-extraction records.

PARALLELISM OF RIDGES:

Victor Sears[21] suggested a method based on the theory that in occlusal vertical dimension, both upper and lower edentulous ridges are parallel to each other when viewed in a sagittal plane. This means that, if the patients mouth is opened wide and then closed until the ridges become parallel to each other, then this is the occlusal vertical dimension. Occasionally, the ridges have a marked curvature when parallelism between ridges would be impossible. Further, it is difficult to visualise whether the ridges are parallel to each other inside the mouth. This method however, can be used to check the articulated edentulous casts, to verify the vertical dimension obtained by other methods.

PHONETICS

It is believed that vertical dimension could be most readily determined by means of phonetics[19,23]. When the patient pronounces certain key words, the occlusal surfaces of upper and lower teeth have a relatively constant relationship to each other and this would greatly aid in determining vertical dimension. For example, during fricative sounds mandible is in rest position. When a patient is able to say sibilant sounds such as "six-sixteen" without clicking the teeth or contacting the occlusal rims together one can be sure that the bite is not "opened". This does not however give any indication whether the bite is over closed.

Phonetic method certainly indicates the limit of vertical dimension and also serves as a check to verify dimension obtained by other methods and to judge extent of the available free way space. Some examples are :

1. *F* and *V*, fine, value –Pronunciation of these require an adequate freeway space. Inability to pronounce these words probably indicates the possibility of an incorrect vertical dimension.
2. When a patient is asked to pronounce the words thick- thin, alternatively, the tongue usually fills into the gap between the upper and lower occlusal surface. This is again useful to judge the adequacy of free way space.
3. During pronunciation of mm., Mississippi, fifty-five – the observer can visualise the appropriate free way space. If teeth click each other during pronunciation of these sounds, it suggests that vertical space is over opened. If these are pronounced as Sh, or with a whistling sound, it indicates that vertical dimension is reduced.

SILVERMAN'S CLOSEST SPEAKING SPACE METHOD

Closest speaking space is based on functional speech movement of the mandible. It is in contrast to the techniques based on rest position of the mandible, which is static, non-functional and inconsistent.

Meyer Silverman[23] (1953) suggested the use of the closest speaking method to record vertical dimension. This method is useful.:-

i. as a pre-extraction record
ii. as one of the methods for the determination of vertical dimension
iii. to verify the available interocclusal space in trial dentures.

i. <u>As a pre-extraction record</u>: The closest speaking space is measured before extraction of teeth and the same is reproduced in complete dentures.

Procedure: Patient is seated in an upright position, and is made to close in centric occlusion. A line is drawn with a sharp pencil on the lower anterior teeth at the horizontal level of the incisal edges of the opposing upper anterior teeth. This line is referred to as *centric occlusion line*. Patient now pronounces words containing an end sibilant such as yes, Miss, buzz. While these sibilants are pronounced, mandible is in its closest speaking relation to maxilla. A horizontal line is now drawn on the same lower anterior teeth at a level corresponding to the upper incisal edges. This line is referred to as *closest speaking line*. The distance between the centric occlusion line, and the closest speaking line is the *closest speaking space* between upper and lower teeth. The closest speaking space is usually about 2-3 mm. It is measured in natural dentition before extraction of teeth as a pre-extraction data and it is reproduced in complete dentures.

ii. When pre-extraction closest speaking record is not available, Silverman also indicates this closest speaking space method for recording vertical dimension during jaw relation procedure.

Procedure: Occlusal rims are placed in the mouth and the vertical height of occlusal rims is

adjusted until a minimum of 2 mm of closest speaking space exists when the patient pronounces the letter S or other sibilants.

iii. Closest speaking space method is also useful during wax trial of dentures to ascertain the adequacy of interocclusal space and the acceptability of vertical dimension of occlusion.

Finally, this method can also be applied to verify the occlusal vertical dimension obtained with other methods.

The limitations of this method are :

1. It requires a fair degree of dexterity and judgement in obtaining the closest speaking line and the assessment of 2mm closest speaking space.
2. During the jaw relation record, patient's speech and pronunciation are strained due to the presence of occlusal rims and therefore it may fail to indicate the correct closest speaking space.
3. This technique is applicable mostly in Class I jaw relationship.

Closest speaking space is different from freeway space

Note : The concept of closest speaking space and freeway space are diametrically opposed to each other. Yet, both have been found beneficial in recording vertical dimension of occlusion. Closest speaking space measures the vertical dimension when mandible and muscles are in phonetic activity, whereas freeway space measures the vertical dimension when the mandible and the involved muscles are at rest.

BOOS BIMETER:

A relatively scientific development in vertical dimension was brought forth by Ralph Boos[3] (1940) who described the power point. He stated that if one could find the power point of mandibular closure, then vertical dimension could be related to it and he designed an instrument capable of registering muscle force at different vertical heights. It had a mechanism for determining the power point using a simple spring loaded device, which was set into the lower occlusal rim while a plate was fixed to the upper occlusal rim.

The patient forcibly bit on this plate against the spring, and a dial in front of the spring showed the biting force in pounds, which the patient could develop. Patients were allowed to exert biting force at various degrees of jaw separation. Vertical height was now adjusted by altering occlusal rims, till the patient achieved a maximum force while closing. This was referred as the power point. Boos assumed that the power point represented the occlusal vertical dimension.

Sometime later, it was reported that this did not represent an occlusal position, but rather represented rest position. Since then it has been shown that vertical dimension has no definite relationship to the power point, neither the occlusal nor rest position does necessarily coincide with the power point. Therefore, the use of power point as a reference in vertical dimension is not always accurate.

ELECTROMYOGRAPHY:

A review of the various methods to record vertical dimension shows that there is no scientific method of obtaining vertical dimension except probably one method which uses electromyographic tracings of the masticatory muscles. Moyers, Hickey, Shpuntoff, believed that the rest position can be determined by means of an electromyograph which would record the minimal activities of the masticatory opening and closing muscles. They found that these muscles show the least activity, when the jaw is at rest.

Electrical leads are placed on the skin over the muscles to record their electrical potential. Their electrical potential is increased when the muscle is in action. By means of electromyographic tracings it is possible to find the rest position of mandible, when all the muscles are relatively at rest and thus record the rest position of the mandible.

This may appear simple, however it is not a practical method. Electromyographic recorders are very expensive, and it requires trained personnel. It is not an equipment that every one can learn to use in the mouth. It is a cumbersome procedure, and it may not be practical to install an electromyogram in the dentist office for the purpose of recording vertical dimension. Inability of the patient to relax, co-operate and understand instructions are the other difficulties which should also be considered.

Ramfjord's[8] EMG study indicated a resting range for the muscles rather than a position. Further, the clinically determined rest position does not often agree with minimal muscle activity as determined electromyographically.

Significance of physiological rest position of the mandible to vertical dimension of jaws

The physiological rest position of the mandible can be defined as that position the mandible assumes as a result of the most comfortable state of equilibrium and minimal activity of the muscles attached to it. It is a physiological postural position assumed by the mandible when the opening and closing muscles (flexors and extensors) of the mandible are in equal tonicity. It is one of the many positions assumed by the mandible, most of the time arrived unconsciously, at the end of any functional activity, mandible returns back to its rest position.

This position is of great significance to the Prosthodontist , since it is a reproducible position, and therefore a guide to record the vertical dimension of occlusion in edentulous individuals. Niswonger[16] in 1934 was the first to recognise the importance of rest position and relate it to obtaining occlusal vertical dimension in edentulous patients. He observed that a variable extent of space exists between lower and upper teeth when the mandible is in its physiological rest position. Based on this premise, he recommended a method to record vertical

dimension of occlusion for edentulous patients by determining the vertical dimension of rest position and then deducting an appropriate free way space from this distance.

In natural dentition, prior to the loss of teeth, the vertical height between the jaws in centric occlusion and the rest position of the mandible had an intimate relation to one another. When the mandible assumes its physiological rest position, teeth disocclude from centric occlusion and a space of 2-3 mm (Thompson[31]), 2-5mm (Sicher[22]), 3 mm. (Niswonger[16]), 3 mm (Pleasure[20]) is seen between the occlusal surfaces of upper and lower teeth. This inter-occlusal space is generally referred to as "freeway space" or " inter-occlusal rest space". These recommended values of freeway space is a guide to obtain VDO from VDR.

NISWONGER'S METHOD

This is based on Niswonger's concepts that mandible moves 1/8" inch (3 mm) upward from rest position to the centric occlusion position. As mentioned earlier, this amount of space exists between upper and lower jaws when the mandible is in its physiological rest position. Today, this concept is very commonly used to record vertical dimension in edentulous patients. It is preferred to other methods mainly because of its simplicity and functional accuracy.

Procedure: The patient is seated so that the Camper's plane is parallel to the floor. Two precise dot marks are made. one at the base of the nose on the philtrum, and another on the chin. Patient is then made to swallow and relax. The distance between the two points is measured. This procedure is repeated again to recheck the measurement until two measurements coincide. This is the rest vertical dimension. The occlusal rims are then adjusted such that when they occlude in the mouth, the distance between these points is less by 1/8 " inch than the first measurement to allow the desired freeway space between rims.

Rest vertical height with and without dentures

Edentulous rest position is influenced by the presence of dentures in the mouth. It has been conclusively shown that the rest position of the mandible increases upto 3 mm with the presence of dentures from its edentulous state[7,10,18,24,28].

During jaw relation procedure, vertical dimension is measured extra-orally on facial landmarks, either without occlusion rims in the edentulous state, with upper occlusion rim or with both the occlusion rims in the mouth. Gattazi[7] suggested that the rest vertical dimension should be determined with occlusion rims in the mouth to simulate the presence of dentures to minimise the discrepancy. Solomon and Julion[24] compared rest vertical height with upper occlusion rims alone, and with upper and lower occlusion rims, to the rest vertical height after insertion of dentures in the same mouth. Least discrepancy in vertical height was observed when both occlusion rims where placed in the mouth during measurement of rest vertical height.

In view of this finding, measurement of rest vertical height should be done with both occlusion rims in the mouth, to minimise the discrepancy which is likely to occur after insertion of complete dentures.

Historical Background

Hunter[9] was probably the first to recognise the rest position of the mandible. In 1771, he mentioned that "in the lower jaw as in all the joints of the body, when motion is carried to its greatest extent in any direction, the muscles and ligaments are strained which make the person uneasy. The state therefore into which every joint naturally falls especially when asleep is nearly in the middle between the extremes of motion, by which means all the muscles and ligaments are equally relaxed. The teeth of the jaws are not in contact, nor are the condyles of the lower jaw so far back in the cavities as they can go". Walisch[7] was one of the first to define physiological rest position of the mandible. In 1906, Wallisch described mandibular rest position as that position of the mandible, wherein all the muscle action is eliminated and the mandible is passively suspended. He further stated that in this position the opposing teeth do not contact.

Constancy concept of the rest position of the mandible

Niswonger [16] (1934) was perhaps the first to study extensively the rest position of the mandible by recording measurements on patients. He referred the rest position as the "Neutral position" of the mandible, since the opening and closing muscles are in a state of equilibrium, and the mandible is suspended in this position with the aid of the masticatory elevator and depressor muscles. This resting position may be assumed voluntarily and is constantly assumed subconsciously. He designed an instrument "Jaw relator" to measure the distance between the jaws from rest position to centric occlusion. Niswongers work was the beginning of the dictum that the rest position remains constant throughout the life.

Brodie[2] in 1941, was the first to utilize the cephalometer introduced by Broadbent to study vertical dimension of jaws. With cephalometric tracing, the error of soft tissue measurement in Niswongers method was reduced and permanent records were available, which could be analysed and compared at any future time. He contended that the rest position persists perhaps throughout the life.

Thompson [29,30] (1941, 1943) believed that the rest position is determined by a balance of tension in the musculature, which suspends the mandible and the rest position is not affected by the presence or absence of teeth. In 1946 Thompson[31] unequivocally concluded that "the mandible assumes the positional relationship to the head by the third month of life and thereafter does not change". Sicher[22] (1951) agreed with Thompson[30] and Brodie[2], when he felt that rest position was completely dependent on the tonicity of the muscles which is fairly constant for each individual, and thus mandibular rest position was a fairly constant position.

Oslen[18] (1951) studied roentgenographically edentulous patients with and without dentures and his findings suggested that rest position was not rigidly stable. Thompson[32] later in 1954 refuted his earlier statement of the immutability of the mandibular rest position.

One of the most extensively documented studies in rest position was done by Atwood [1] during the period 1956 – 1958 . He studied before and after teeth extraction and demonstrated the variability in a sitting, between sittings and also between readings with and without dentures. A decrease in vertical dimension of rest position was clearly shown following the removal of opposing occlusal contacts. Tallgren[28] in 1957 studied the changes in adult face by cephalometric radiographic technique. Her findings were similar to Atwood and Oslen showing the mutability of rest position after extraction of teeth.

CONCLUSIONS

1. An accurate vertical limit of occlusion with provision for a desirable freeway space in complete denture is of paramount importance; because of the consequences of too little or too much occlusal vertical height on the esthetic well being of denture wearer, and also on its detrimental influence on the supporting tissues and the temporomandibular joint.
2. Although, several methods have been described to obtain vertical dimension of the edentulous jaws, no one particular method has proved to be completely reliable by itself. A knowledge of most of them, combined with clinical judgement, gives a reasonable degree of accuracy and satisfaction.
3. Among the various methods, Niswongers' concept of recording rest vertical height to obtain the occlusal vertical height of jaws based on rest position of the mandible has been clinically evaluated for over six decades. This method has stood the test of time in comparison to the other methods based on cephalometric radiography, neuro-muscular perception, face measurements, swallowing guidance and phonetics. However, it should be pointed out that this method is not infallible. Dependence on Niswongers method alone cannot give a satisfactory result. This method requires to be checked and verified with other methods to obtain a clinically satisfactory vertical dimension suitable to the patient.
4. Visual check up of the vertical dimension by facial appearance, phonetics and swallowing should be given consideration regardless of any particular method, the operator prefers to choose to record vertical dimension in edentulous subjects.
5. The reduction in rest vertical dimension subsequent to extraction of teeth and a differential increase in rest vertical height from edentulous state to the presence of occlusal rims and insertion of dentures should be considered.
6. Vertical limit of occlusion is an appropriate term to denote the vertical threshold of occlusion necessary in complete dentures in preference to the other commonly used terms such as VDO, VHO, OVD, VCO and OVH.

Abstract

Introduction to Acupuncture - P. Rostid

Acupuncture originated in China more than 3000 years ago and involves insertion of needles into various parts of the body with the intention of curing disease. An introduction to the practical application of acupuncture in dentistry is presented in the light of recent research. It is concluded that acupuncture could supplement conventional treatment modalities. Its value in the treatment of temporomandibular dysfunction syndrome & facial pain has been well documented and supported by randomised controlled trials. Although it may be useful in the control of post operative pain, its use as sole analgesia for operative care is questionable. The mode of action of acupuncture can be explained with reference to modern neurophysiology. A short training course can allow the technique to be an effective tool in every dentist's hand. Acupuncture is not a miracle cure and is not going to replace the drill. However, the technique can be a supplement to conventional treatments in TMD's, facial pain, pain management, Sjogren's syndrome, and in phobias & anxiety.

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Rest vertical height of the jaws with and without occlusion rims

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ABSTRACT

The influence of occlusion rims on the rest vertical dimension was studied and compared with the rest vertical dimension after the insertion of complete dentures by clinical and cephalometric methods. It was shown that the rest vertical height recorded with the upper or both occlusion rims was not the same after the insertion of dentures.

INTRODUCTION

For nearly seven decades, the criteria of establishing vertical dimension based on the reference of physiological rest position of the mandible to occlusal vertical dimension has remained unchanged. It is therefore imperative, that the rest vertical dimension is determined accurately to achieve a precise vertical dimension of occlusion and to provide an optimum interocclusal space between the upper and lower dentures.

Several studies[1,6,10,18,28] have shown that the edentulous rest position of the mandible is altered with the presence of dentures in the mouth. Since the rest vertical dimension is the basis for determining the vertical dimension of the occlusion, this variability in RVD with and without dentures should be considered while establishing vertical dimension in an edentulous person.

While these studies have positively shown that the presence of denture changes the rest vertical dimension from the edentulous state, it is not certain whether the presence of occlusion rims in edentulous mouth would give the same rest vertical height when dentures are finally inserted in the mouth.

Commonly, rest vertical dimension is recorded by measurements between two fixed points situated in the maxillary and mandibular region of the face, either with the upper occlusal rim (GPT-7 occlusion rim), with both occlusal rims or without the occlusal rims. It is important to know if there is any significant change in rest vertical height between these criteria and the rest vertical dimension after the insertion of complete dentures in the mouth.

So far, it is not known whether the presence of upper occlusion rim alone or both the rims in the mouth give similar rest vertical height values after the insertion of dentures. If it is not so, then it is necessary to find out the discrepancy between them, and which of the two conditions gives a rest vertical height closer to rest vertical height after the insertion of dentures. The differences, which occur, must be anticipated during jaw relation procedure and should be suitably compensated.

Key words: Vertical dimension - Rest vertical height - Variables in registration.

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METHOD

Thirty edentulous subjects between 40-70 years with Class I - jaw relation without any previous denture wearing experiences having a passive lip contact in postural rest position were selected. Besides an upper and lower complete denture, one set of upper and lower occlusion rims was made for each subject. The occlusion rims were adjusted to the same occlusal vertical height of complete dentures. The rest vertical height with dentures, with and without occlusion rims was recorded clinically with the head gear fixture and by cephalometric method at the time of delivery of dentures (Fig. 1 & 2).

The rest vertical height was recorded for each of these subjects on a tracing plate attached to a stationary headgear with an extra oral tracer fixed to the chin for the following four conditions.

Condition A : In edentulous state - *Basic rest level*
Condition B : With upper occlusion rim
Condition C : With upper and lower occlusion rim
Condition D : With upper and lower denture - *Control group*

The subject was trained for the postural rest position in the edentulous state by swallowing method and later told to say 'mm' and then remain in a passive lip contact. While he remained relaxed in this position, the vertical rod with the tracing plate was gently moved by loosening the clamp at the head gear to make contact with the tip of the tracing stylus Fig.1. It was then withdrawn to its original position. The dot mark on the tracing plate was designated as "A". This indicated the "Basic rest level".

The mean rest vertical levels with upper occlusion rim, upper and lower occlusion rim and upper and lower dentures were recorded and these were designated as "B", "C", "D" rest levels. The tracing plate was later mounted on a travelling microscope to measure the distance between AD and BD and CD to the tenth of a millimeter. Mean measurements between two fixed skeletal points viz. nasion to menton and anterior nasal spine to menton were also obtained in lateral cephalometric tracings for each subject (Fig.2 and 3) for all the four conditions. This was

Fig. 1 : Measurement of rest vertical height with a head gear fixture

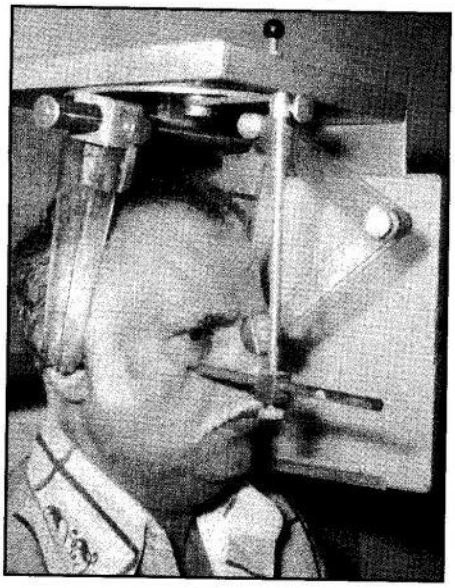


Fig. 2 : Cephalometric method of recording rest vertical height

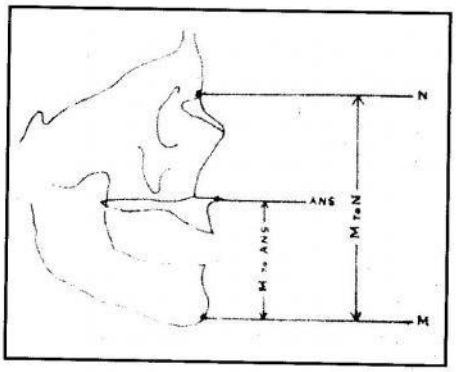


Fig. 3 : Reference points for measurement of rest vertical height on cephalometric tracing. M - Mention, ANS - Anterior nasal spine, N - Nasion

done to ascertain whether any discrepancy was seen between the measurements obtained from soft tissue landmarks and skeletal points.

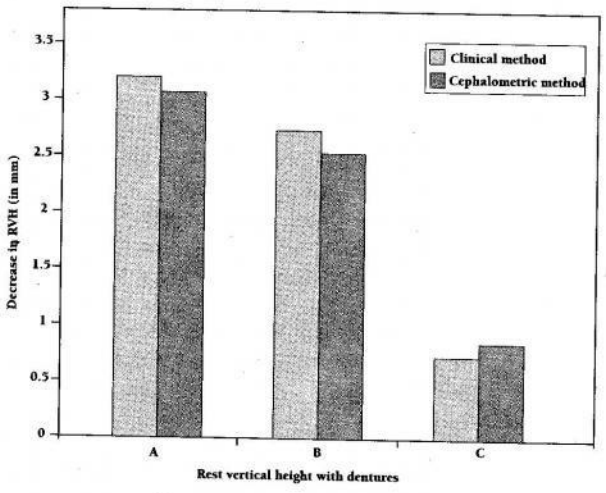
RESULTS

There was no significant difference between the results obtained by the clinical and cephalometric methods. The mean deviation in rest vertical height between the control group D and conditions A, B and C is shown in Table I and in the bar diagram.

It was seen that the vertical height after the insertion of dentures was not the same as in the edentulous state without occlusion rims or with either the upper or both the upper and lower occlusion rims. Insertion of dentures, resulted in an increase in the rest vertical height as compared to the rest vertical height in the edentulous condition or with the presence of occlusion rims in the mouth.

Table 1
The mean deviation of rest vertical height between control group D and condition A, B, C.

Condition	Method	Mean Deviation in mm	Significance in relation to rest vertical level with dentures
A.	Clinical	3.18	H.S. P>.01
	Cephalometric	3.03	H.S. P>.01
B.	Clinical	2.70	H.S. P>.01
	Cephalometric	2.54	H.S. P>.01
C.	Clinical	0.73	H.S.
	Cephalometric	0.83	H.S.



Graph 1 : Discrepancy between rest vertical height (RVH) with complete dentures (condition D) and the RVH in conditions A, B & C

DISCUSSION

The presence or absence of dentures, plays a significant role to alter the rest vertical height. Past studies have shown that presence of dentures in the mouth increases rest vertical height up to 3mm. The same observation was seen in this study (Table 1). If this is considered, then the rest vertical dimension measured in an edentulous state cannot serve as a reference to establish occlusal vertical dimension, since it is likely to increase freeway space after the dentures are inserted.

For example, if the RVD in edentulous state is 60mm, the RVD after the insertion of dentures would become 60 plus 3mm (63mm). When dentures are made with a FWS allowance of 3mm for a RVD of 60mm measured in edentulous state, the OVD then would be 57mm. However, with dentures the RVD now becomes 63mm whereas the OVD is maintained at 57 mm. Thus, the freeway space is no more 3mm, but becomes 6mm. This should be of concern. Fortunately, to an extent this discrepancy may not always be noticeable since the FWS is a range (rest vertical range) and is not a precise distance. This discrepancy can be corrected by keeping the free way space allowance to a minimum during jaw relation procedure, as a compensation for the anticipated increase in rest vertical height seen after the insertion of dentures.

This increase of nearly 3mm of RVH from the edentulous state to the insertion of dentures can perhaps be related to the influence of gravity in maintaining rest vertical height, the role of tongue and the proprioceptive impulses to change in environment.

Postural rest position of mandible[16,20,22,27,33] is attained by a delicate balance of forces and tonicity between the elevator and depressor muscles of the mandible, and the weight of mandible plays an important role in the maintenance of rest position. It is possible that the weight of lower denture influences these muscle groups to shift the rest position of the mandible downward.

This hypothesis can be supported from the fact that the rest vertical height is reduced when the mandible becomes edentulous after extraction of teeth. The edentulous mandible which is now without the weight of natural teeth and alveolar bone, offers less gravitational pull than the dentulous mandible. As a result, the supra mandibular elevator muscles take the mandible to an upward position. The influence of the weight of lower denture on the RVH can be substantiated if the RVH of edentulous jaw is recorded with several lower dentures of various weights.

The encroachment of tongue due to the presence of dentures, results in a change in tongue position within the denture space as compared to the edentulous state. This, as well as the altered proprioceptive response to the presence of lower denture could be the other factors which causes an increase in RVH after insertion of dentures.

The clinical implication of this finding of a 3mm difference in rest vertical height seen between the edentulous state and the presence of dentures cannot be underestimated. Freeway space that is calculated on the basis of edentulous rest vertical height exceeds its range of acceptance after the insertion of dentures. A further 3mm increase to the freeway space would be alarming. This should be averted during jaw relation procedure by increasing the occlusal vertical height up to 3mm as a compensation for the increase in free way space noticeable after insertion of dentures.

Considering the variability of RVH with and without dentures, Gattazi[6] empirically suggested that the rest vertical dimension should be determined with occlusion rims in the mouth to simulate a situation when dentures are present.

It is a common practice to place either the upper or upper and lower occlusion rims in the mouth during measurement of rest vertical height. There is no definite guidance to choose between the two to obtain a rest vertical height which will be similar or closer to the rest vertical height with dentures. It was shown in the present study that none of these two conditions compared favourably with the rest vertical height with the dentures in the mouth.

The results confirmed that edentulous RVH was not the same as the RVH after the insertion of occlusion rims or complete dentures. Also the RVH with upper occlusion rim or both the occlusion rims were different from RVH after denture insertion. There was a downward shift of the rest vertical dimension after insertion of dentures, except in a few subjects in the 72 age group who demonstrated an upward shift.

These findings defy the validity of recording the RVH in edentulous situation without occlusion rims or with the upper occlusion rim alone. Both these conditions showed differences ranging from 2.54 - 3.18 mm as compared to RVH after insertion of dentures. Least discrepancy of 0.73 to 0.83 mm was found when both the occlusion rims were kept in the mouth while recording RVH.

For this reason, it is recommended that the upper and lower occlusion rims should be kept in the mouth while recording the rest vertical height in complete denture subjects.

CONCLUSIONS

1. Presence of occlusion rims or complete dentures in the mouth demonstrated a significant downward shift in the rest vertical dimension from the edentulous state.
2. Among the three conditions studied, the presence of both upper and lower occlusion rims showed minimum discrepancy and it was nearest to the rest vertical dimension seen after insertion of dentures. A large discrepancy of 3.1 mm mean was seen when rest vertical height was measured without occlusion rims and a 2.62 mm mean shown with only the upper occlusion rim.
3. Recording rest vertical height in edentulous state without the occlusion rims or with the upper occlusion rim alone is not desirable, since the rest vertical height changes significantly after the

insertion of complete dentures.

4. To minimise the discrepancy in rest vertical dimension after denture insertion, it is suggested that both occlusion rims should be kept in the mouth while registering the rest vertical height.

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