Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

Jaw relations in completely edentulous patient

A Project Submitted to

College of Dentistry, University of Baghdad, Department of Prosthodontics

In Partial Fulfillment of the requirements for Bachelor degree in Dental Surgery

By

Omar Mohammed Akram

Supervised by:

Lecturer Dr. Hasanain Kahtan

B.D.S, M.Sc, Ph.D. Prosthodontics

2023 A.D.

1444 A.H.

Certification of the Supervisor

I certify that this project entitled "**Jaw relations in completely edentulous patient**" was prepared by **Omar Mohammed Akram** under my supervision at the College of Dentistry / University of Baghdad in partial fulfillment of graduation requirements for the Bachelor Degree in Dental Surgery

Signature

Lecturer Dr. Hasanain Kahtan

B.D.S, M.Sc, Ph.D. Prosthodontics

Dedication

To my family who have always believed in me and supported me throughout my life

Acknowledgment

First of all, I thank God Almighty, who blessed me with wisdom, patience, and willpower to reach this level in my life.

I would like to thank **Professor Dr. Raghad Al Hashimi**, the dean of the College of Dentistry, University of Baghdad for providing me the opportunity to complete my work.

I would like to thank **Prof. Dr. Abdulbasit Ahmed**, the chairman of the prosthodontic department for his support.

My sincere appreciation is to my supervisor **lecturer Dr.Hasanain Kahtan Alalwan** , for his thoughtful guidance, suggestion, invaluable help and advice planning and conducting this research.

List of contents

List of Figures

List of abbreviations

Abbreviation	Word
RVD	Rest vertical dimension
OVD	Occlusal vertical dimension
VD	Vertical dimension
CR	Centric relation
TMJ	Tempro-mandibular joint

Introduction

The relationship of the mandible to the maxilla and their orientation to the cranium is a very important consideration in prosthodontics. This is more so in completely edentulous individuals where there are no teeth to provide any reference. The maxillomandibular relationship is recorded following the fabrication and contouring of occlusal rims. The mandible moves to perform various functions like chewing, swallowing and speech. The constructed complete denture should function in harmony with the various mandibular movements. This will ensure a great deal of comfort and confidence to the denture wearer. The mandible moves as dictated by the movement of its condyle in the glenoid fossa and by the guidance of teeth. In a completely edentulous situation, the teeth should be arranged such that they do not interfere with the smooth, coordinated movement of the mandible during function. Hence, an understanding of the temporomandibular joint (TMJ) and mandibular movements is essential for understanding and recording maxillomandibular relations. The recorded jaw relations are then transferred to an articulator which can simulate these movements and assist in arranging the artificial teeth accordingly (**Rangarajan and Padmanabhan, 2017)**.

Aim of the review

This review attempts to have a comprehensive overview on the maxillo-mandibular jaw relations of completely edentulous patients and different methods and devices to record them

Chapter one

Review of the literature

1.1 Introduction

Maxillomandibular relationship record: A registration of any positional relationship of the mandible relative to the maxilla **(GPT, 2017).**

Establishing the correct maxillomandibular relationships can be one of the most perplexing aspects of prosthodontics, especially when treating the complete denture patient. The accurate determination, recording, and transfer of jaw relation records from the edentulous patient to the articulator is essential for the restoration of function, facial appearance, and the maintenance of the patient's health.

The clinical procedure of recording the jaw relationship enables the clinician to provide the dental technician with the following information:

- An appropriate vertical and horizontal relationship of the mandible to the maxilla.
- The required shape of the dentures.

This information is given to the dental technician in the form of wax record rims, which have been adjusted by the clinician, to enable the casts to be mounted on an articulator. The shape of the record rims provides the dental technician with a blueprint on which to base the design of the trial dentures **(Hassaballa, 2010).**

Maxillo-mandibular relations can be classified as:

1.2 Orientation relations

The jaw relation when the mandible is kept in its most posterior position, it can rotate in the sagittal plane around an imaginary transverse axis passing through or near the condyles **(GPT, 2017)**

This record gives the angulation of the maxilla in relation to the base of the skull. The plane of the maxilla may be tilted in some patients, in such cases, the plane of the mandible will not be altered because it articulates with the base of the skull.

Hence, a maxillary tilt will alter the relationship of the maxilla to mandible during different movements (Figure 1.1) (**Rangarajan and Padmanabhan, 2017)**. It will also

affect the level of the plane of occlusion of the denture. It is necessary to do orientation jaw relation before carrying out other jaw relations. Orientation jaw relation can be recorded with a face-bow.

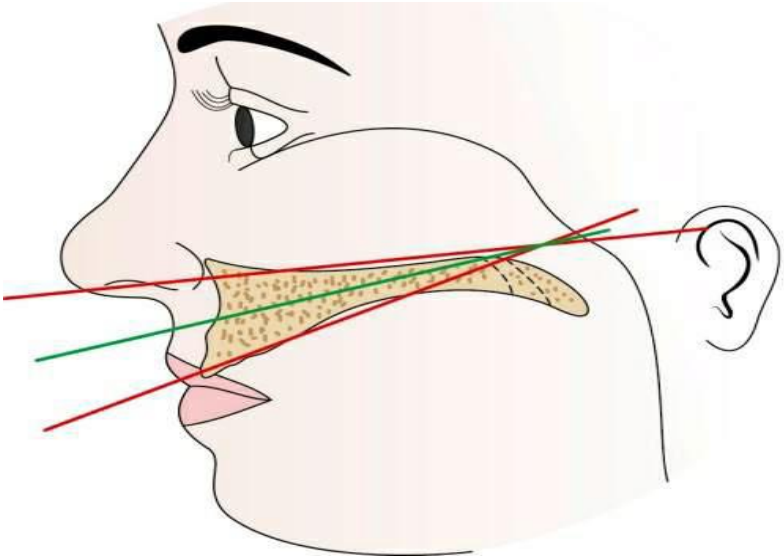

Figure 1.1: Tilt of maxilla – red lines show the existing tilt/inclination of the maxilla in relation to the cranium.

As the mouth opens and closes in centric relation (CR), the movement of the condyles in the initial stages (up to about 12 mm) of opening and final stages of closing is a rotational movement in the horizontal axis, following an arc of a circle. The axis of the rotation or arc passes through the center of both the condyles. The condyles are centered in the glenoid fossa during this rotational movement. If the center of condylar rotation can be determined, it will correspond to the two posterior reference points necessary to form a plane for the maxilla, as the glenoid fossa is located just above the center. This is a repeatable border position and can be located consistently. A third reference point located anteriorly in the maxilla – infraorbital notch or nasion – will complete the plane (Figure 1.2)

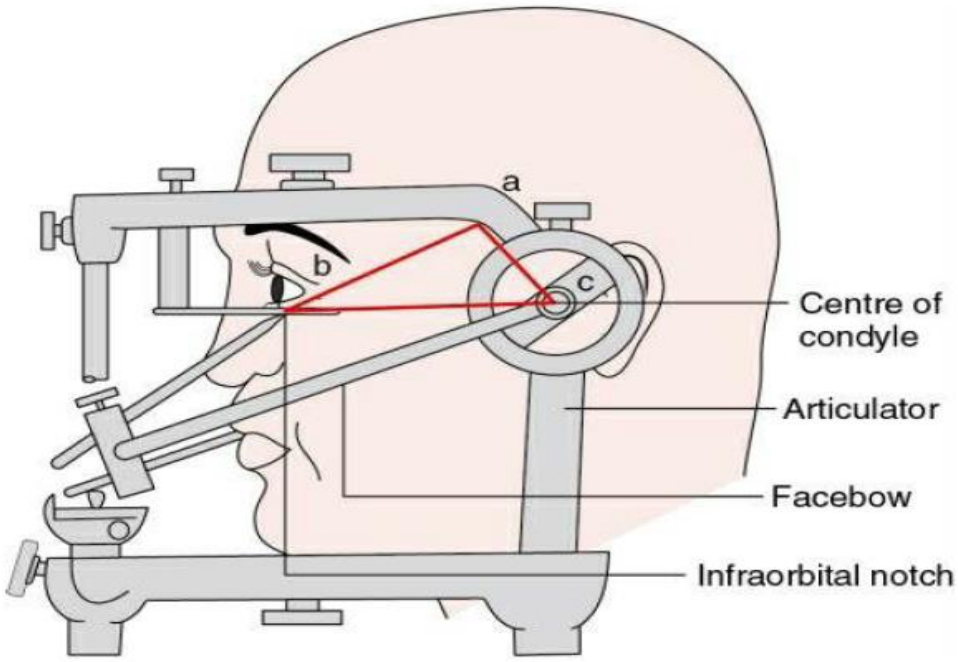

Figure 1.2: Facebow is used to determine the inclination of maxilla by forming a plane (a–c) using the centre of the two condyles (a and c) as posterior references and infraorbital
notch (b) as anterior reference. Hence, the centre of condylar rotation is also determined and the same is transferred to the articulator. Once the maxilla is oriented, the mandible is oriented with the maxilla using centric and eccentric records. (**Rangarajan and Padmanabhan, 2017)**.

1.2.1 Occlusal registration

The occlusal registration stage records the information required to produce the trial dentures. There are five essential recordings made: occlusal plane, centre line, lip support, vertical dimension and centric relation.

Further information indicating tooth position may also be recorded, such as smile lines and canine lines or helpful techniques such as neutral zone recording.

Anatomical relationships may be recorded to correctly position models on the articulator
using a facebow registration, and gothic arch tracing may be used to ascertain centric relation **(Johnson, 2012).**

1.2.2 Design of registration rims

Although the baseplate and wax rim together replace the teeth and any resorbed alveolar bone, registration rims are often constructed without specific aim or method and with little consideration for anatomical features.

Production of rims on primary models is not advocated. It is rare for rims produced on a primary model to fit working casts accurately. The anatomical features recorded on the secondary impression, such as the sulcus width and depth, should be used to design the registration rim.

A well-designed registration rim is quick and easy to construct and saves time during both the clinical registration stage and the production of the trial dentures **(Johnson, 2012).**

1.2.3 Contouring of the Occlusion Rims

The objective of this procedure is to shape the record bases and occlusion rim so that they will replace, in size and position, the teeth and supporting structures that have been lost. Correctly formed occlusion rims serve as excellent guides in the initial placement of artificial teeth (Figure 1.3).

Before the initial placement of the record base into the patient's mouth, the record base must be carefully inspected for sharp or rough surfaces or flanges. Once any irregularities are corrected, the record base should be comfortable for the patient. If the patient experiences discomfort, it may be necessary to use pressure disclosing paste to locate areas that may be causing the discomfort. Do not proceed if the patient is not comfortable.

A slightly loose-fitting record base should be expected because most undercuts on the master cast were blocked out prior to record base fabrication. However, patients should be assured that these record bases are not the final denture, and that the completed denture will fit the ridges and soft tissues much better.

The retention of slightly loose record bases may be improved by using a denture adhesive. However, extremely loose-fitting record bases should be evaluated for the cause **(Rahn et al., 2009).**

Figure 1.3: The record base will simulate the proper position of the teeth and establish the occlusal plane when contoured correctly.

1.2.4 Labial/Buccal contour

Wax is usually removed rather than added to the buccal and labial aspects of the maxillary occlusion rim to achieve adequate lip support from an esthetic and phonetic perspective.

Because the laboratory technician probably had to block out labial undercuts prior to fabricating the maxillary record base, the upper lip may have the appearance of being oversupported.

Thinning or shortening the base may not fully correct the problem at this time.

If it cannot be corrected, the patient must again be assured that this problem will not exist at denture insertion. The buccal surface of the rim almost always inclines labially from the border of the record base at about 15 degree angle and is approximately 8–9mm labially from the center of the incisive papilla. A photograph of the patient when he or she had natural teeth could help in this determination. A comparison of the lip support with that from an existing denture, if one exists, is also helpful in making this determination.

In the posterior, wax should be added or removed to achieve a bilateral "buccal corridor" space for esthetic purposes. This space is created by sloping the maxillary occlusion rim inward in the posterior area. There should be pleasant amount of space on both sides of the occlusion rim, which reproduces the space seen between the buccal surfaces of the premolars and cheeks/lips in dentate patients. Obliterating this space is a common mistake when setting the width of the maxillary denture **(Rahn et al., 2009).**

1.2.5 Occlusal plane and lip support

The occlusal plane is the plane at which the upper and lower teeth occlude. It passes through the incisal edge of the central incisors and curves upwards as it travels towards the molars (curve of Spee).

The occlusal plane is significant in providing suitable aesthetics, phonetics and function for the dentures. The incisal edge of the central incisors is the primary determinant for establishing the occlusal plane in edentulous cases. The labial surfaces of the anterior teeth or rim also provide support for the lips. Wax added to the labial surface of a mandibular block to support the lips can be used to achieve the correct labial contour to the face. Either adding or removing wax from the labial surface of the rim until the angle between the columella of the nose, and the upper lip approximates a right angle can achieve this **(Johnson, 2012).**

1.2.6 Forming the Plane of Occlusion

The Trubyte Fox occlusal plane plate will be used to establish the anterior plane parallel to an interpupillary line, and the anterior-posterior plane parallel with Camper's plane (ala-tragus line).

The occlusal plane of most natural posterior teeth is approximately parallel with these landmarks. This plane ideally would be parallel to the interpupillary line, equally split the distance between the opposing ridges, be at the level of the middle to upper third of the retromolar pad, be parallel to the remaining ridges, and be just below the corners of the mouth when the patient smiles. (Figure 1.4 and 1.5) **(Rahn et al., 2009).**

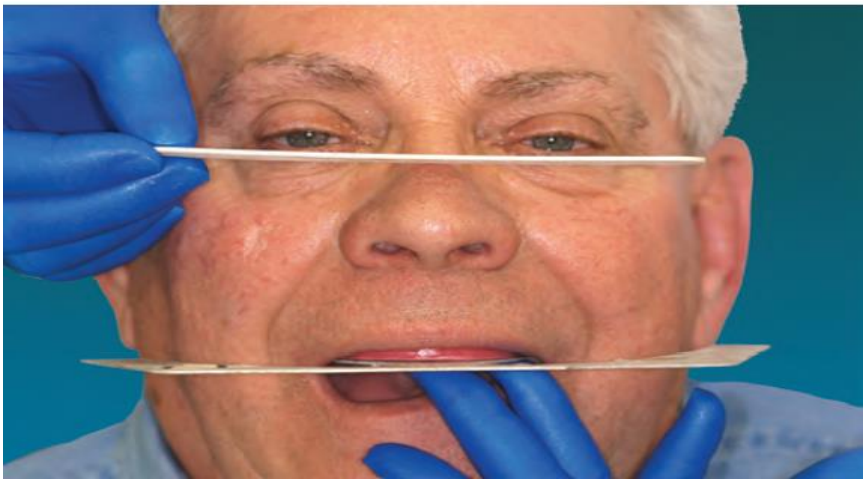

Figure 1.4: When the Fox plane guide rests on the occlusion rim, it should be parallel to the interpupillary line.

Figure 1.5: When the Fox plane guide rests on the occlusion rim, it should be parallel to the Ala-Tragus line (Camper's Plane).

Esthetics and function are certainly significant concerns for making the final determination. This initial estimate of the plane of occlusion is, therefore, tentative and may require adjustment during the setting of the teeth or at the trial insertion appointment.

1.3 Facebow

Is a caliper - like device that is used to record the relationship of the jaw to the temporomandibular joints or the opening axis of the jaws and to orient the casts in this same relationship to the opening axis of the articulator . The face - bow is also a convenient instrument for supporting the casts while they are being attached to the articulator. **(Hassaballa, 2010).** It is placed on the face, with the condyle rods located approximately in the region of the hinge axis, which will be near the condyles **(Zarb et al., 2013)** (Figure 1.6).

Figure 1.6: The face bow placed on the face with condyle rods near the condyles Adopted from **(Klineberg *et al*., 2015)**

The purpose of an ideal facebow is to transfer both functional and esthetic components from the patient to the articulator, specifically, the 3D location of the maxillary arch in relation to the cranial base and the mandibular transverse horizontal axis.

Most facebows were designed to transfer the maxillary arch relationship primarily to a repeatable mandibular axis **(Nagy & Goldstein, 2018)**.

1.3.1 Bite fork

"U" shaped plate, which is attached to the occlusal rims, is used while recording the orientation relation. It is attached to the frame with the help of a rod called the stem. The bite fork should be inserted about 3mm below the occlusal surface within the occlusal rim **(George, 2006).** (Figure 1.7)

Figure 1.7: Bite Fork. Adopted from **(George, 2006).**

1.3.2 Classification of facebow

Traditional facebows can be classified into two basic types:

1.3.2.1 Kinematic facebow

Kinematic facebows can be configured to locate and transfer the mandibular transverse horizontal axis points (determined axis) to an articulator **(Preston, 1979).**
However, the axis of rotation belongs to the movable mandible and not to the fixed cranial base, and many rotational centers are possible **(Shanahan, 2004)**

1.3.2.2 Arbitrary Facebow

It is the most commonly used facebow and is preferred for complete denture construction (**Rangarajan and Padmanabhan, 2017)**. This type of facebow generally located the true Hinge axis within a range of 5 mm. It uses arbitrary or approximate points on the face as the posterior points and condylar rods are positioned on these points. It is further classified as fascia and ear piece type of facebow **(Nallaswamy, 2003).**

Arbitrary facebows are classified as:

1. **Earpiece type (ear bow):** is an arbitrary face - bow that utilizes the external auditory canals as posterior reference points . The relationship of the external auditory canals to the horizontal axis is assumed to be relatively constant . When transferring the ear - bow to the articulator , the earpieces are seated on the auditory pins of the centric locks . The auditory pins are located approximately 6 mm . posteriorly from the actual transverse axis of the articulator to compensate for the location of the ear posts in the external auditory meatus , which are roughly the same distance posteriorly from the mandibular transverse hinge axis of the articulator. **(Nallaswamy, 2003).** The ear - bow is a simple instrument to use, does not require measurements or marks on the face , consumes less time for its use **(Hassaballa, 2010).**
2. **Facia type:** The fascia type of face bow utilizes approximate points on the skin over the TMJ as the posterior reference points. These reference points are located by measuring certain anatomical landmarks on the face. While using the facia facebow, the center of the condyle is arbitrarily located on the side of the face 11-13 mm anterior to the tragus on a line connecting the superior border of the tragus

and the outer canthus of the eye. It has a disadvantage that it is placed on the skin which is movable and so there is a tendency for the condylar rods to displace. It also requires an assistant to hold the face bow in place **(Elsayed et al., 2018).**

1.4 Articulators

A mechanical device which represents the temporomandibular joints and the jaw members to which maxillary and mandibular casts may be attached to simulate jaw movements **(GPT, 2017).**

Articulators attempt to reproduce the range of movement of the jaws. Maxillary and mandibular casts can be attached to the articulator, so that the functional and parafunctional contact relations between the teeth can be studied. Diagnosis of teeth and jaw relation, the arrangement of the artificial teeth, and the development of the occlusal surfaces of both removable and fixed restorations commonly employ articulators in clinical practice **(Zarb and Hobkirk, 2012).**

1.4.1 Advantages of articulators

1. Providing a better view of the patient's occlusion, especially lingual side.
2. Refinement of complete denture occlusion is extremely difficult intraorally, because of movement of denture base and resiliency of supporting tissues. These problems are eliminated with articulators.
3. Patient cooperation is not a factor once casts are mounted on articulator with appropriate records.
4. Chairside time for the dentist and appointment time for the patient is decreased.
5. Some procedures can be delegated to technicians if an articulator is used.
6. Patient's tongue, saliva and cheeks are not factors of hindrance while using an articulator. **(Rangarajan and Padmanabhan, 2017)**

1.4.2 Classification of articulators

Articulators are most commonly classified according to how closely they mimic centric and eccentric mandibular movements.

1. Simple hinge or plane - line articulators

2 Fixed condylar path (mean - value) articulators

3. Adjustable articulators which may be either

a. Semi - adjustable

b. Fully – adjustable

1. Simple hinge articulator (Class I)

Simple hinge articulators are the least adjustable, because they have very limited capabilities for simulating eccentric mandibular positions and records only the occlusal position (centric occlusion) allowing only opening and closing movement about the hinge. **(Hassaballa, 2010)** (Figure 1.8).

Figure 1.8: Nonadjustable articulator. It is capable of simulating only hinge movements. Adopted from **(Nallaswamy, 2017).**

2. Mean value articulator (Class II)

Has its condylar angle fixed at 30°. It has an adjustable incisal guidance without provision for condylar side shift adjustment. It has 3 degrees of freedom. But its limitation is significant in practice since the condyles' angles are fixed. The average

value articulator produces an approximation of condyles' movements and balanced occlusion **(Klineberg *et* al., 2007).**

3. Semi adjustable articulators (Class III)

All semi - adjustable articulators have adjustable horizontal condylar paths , adjustable lateral condylar paths , and adjustable incisal guide tables.(Figure 1.9) Occasionally an intercondylar adjustment , and a face - bow to relate the casts to the hinge axis . **(Hassaballa, 2010)**

For most routine prostheses, the use of a semiadjustable articulator is a practical approach to providing the necessary diagnostic information while minimizing the need for the clinical adjustment during treatment **(Rosenstiel et al., 2016).**

Figure 1.9: Semi-adjustable articulator. Adopted from **(Nallaswamy, 2017).**

Nonarcon articulators: Any articulator design in which the condylar element (analogue) is not part of the lower member of the articulator and may be used to simulate the three-dimensional motions of the left and right condylar compartments **(GPT8).** (Figure 1.10)

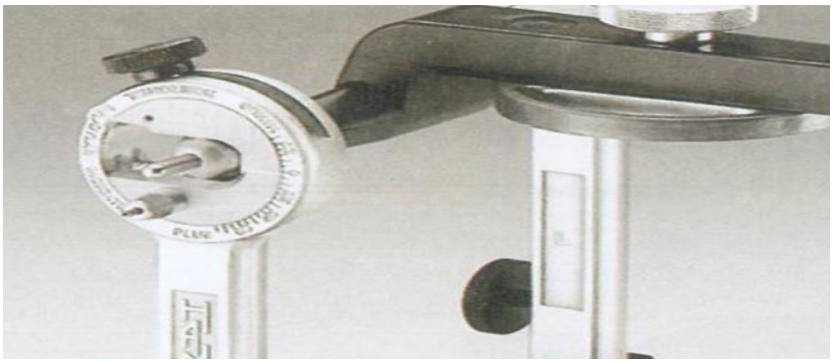

Figure 1.10: Nonarcon articulator. Adopted from **(Nallaswamy, 2017).**

Arcon articulators:

An Arcon articulator refers to that category of semi-adjustable articulators in which the design is anatomically normal. These articulators resemble the temporomandibular joint. The condyle elements are attached to the lower member, while the condylar guidance is attached to the upper member. The face-bow transfer, occlusal plane and the relationship of the opposing casts are preserved when the articulator is opened and closed. (Figure 1.11)

Example, Whip Mix Articulator **(Barbenel *et* al., 2010).**

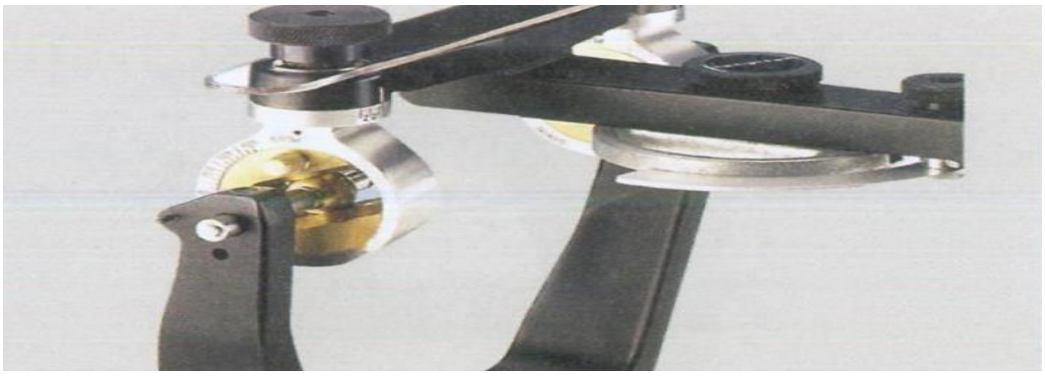

Figure 1.11: Arcon articulator. Adopted from **(Nallaswamy, 2017).**

4. Fully adjustable articulators (Class IV)

Fully - adjustable articulators are arcon instruments with adjustable intercondylar distances . The condylar housings can be adjusted in the horizontal , sagittal , and

frontal planes . Each has a Bennett guide adjustment . They all accept arbitrary or hinge -axis face bow transfers **(Hassaballa, 2010)** (Figure 1.12)

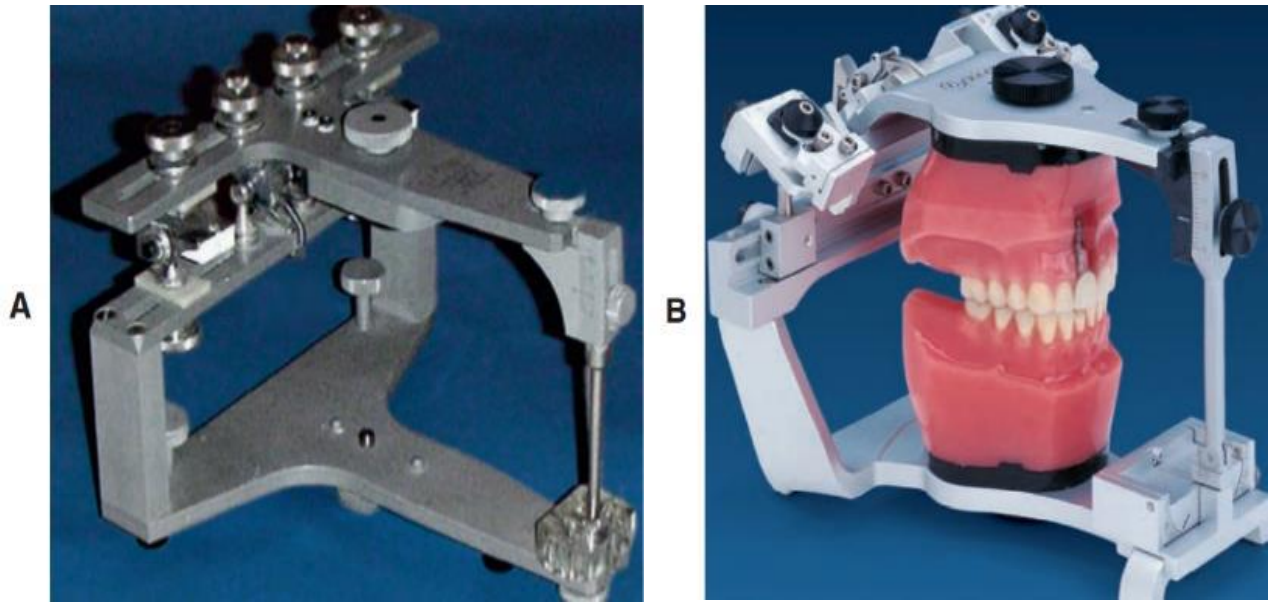

Figure 1.12: Fully adjustable articulators. A. The Stuart articulator. B. The Denar D5A articulator. Adopted from **(Rosenstiel et al., 2016).**

Virtual Articulators

Virtual Articulators are also called as "software articulators" as they are not concrete but exist only as a computer program. They comprise of virtual condylar and incisal guide planes. Guide planes can be measured precisely using jaw motion analyser or average values are set in the program like average value articulator. The Virtual Articulators are able to design prostheses kinematically. They are capable of simulating human mandibular movements, by moving digitalized occlusal surfaces against each other and enabling correction of digitalized occlusal surfaces to produce smooth and collision-free movements **(Padmaja, 2015 and Shadakshari, 2012).**

1.5 Vertical relation

Vertical dimension: the distance between two selected anatomic or marked points (usually one on the tip of the nose and the other on the chin), one on a fixed and one on a movable member. **(GPT-2017)**

• The correct vertical dimension should be established before recording horizontal relations as increasing or decreasing the vertical dimension can have deleterious effects.

• The vertical dimension is maintained by the occlusion of teeth or the mandibular musculature.

1.5.1 Interocclusal distance

The distance between the occluding surfaces of the maxillary and mandibular teeth when the mandible is in a specified position **(GPT9).**

It is generally considered that the teeth should not be in contact when the jaws are at the vertical dimension of rest position. The 2 to 4mm distance between the upper and lower teeth when the mandible is at physiologic rest position is called interocclusal distance (IOD) frequently referred to as the " free way space " (figure 1.13) **(Basker et al., 2011).**

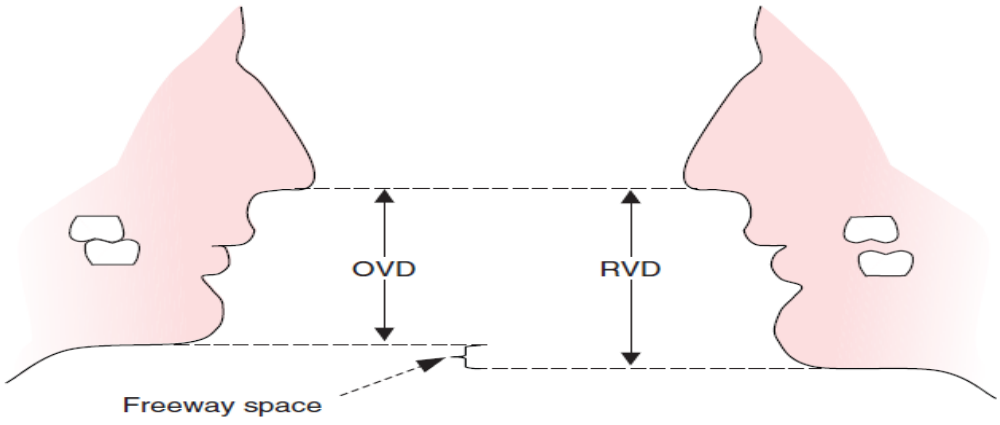

Figure 1.13: Freeway space

Classification:

1.5.2 Vertical dimension at rest

The length of the face when the mandible is in rest position (GPT).

1.5.2.1 Determination of rest vertical dimension

The rest position is established by muscles and it is influenced by the position of the head . The clinically recorded rest position is quite variable during different conditions and therefore the R.V.D. is not a reliable basis for the determination of the occlusal vertical dimension (O.V.D.), and it should be accompanied with other evaluations such as patient comfort, esthetic, appearance and phonetics.

Other concept to measure the rest vertical dimension is dividing the face into thirds with patient standing and instructed to relax leaving the mandible to hang loose with the lips lightly touching.

The measurement is then made to determine if the distance from below the chin to the bottom of nose is equal to the distance from the bottom of the nose to the eyebrows. It can be verified by having the patient lick the lips, swallow and then relax **(Jameson , 2004).**

1.5.3 Factors influence the rest position

1. **The posture of the patient**: The rest position is affected by postural changes. The patient should be sitting upright or standing with the head erect and looking straight ahead, when the rest position is determined.

2. **A relaxed patient**: When a patient is nervous, tense, irritable or tired, the rest position may be inaccurate. It should be determined when the patient is relaxed.

3. **Neuromuscular disturbance**: It will be difficult to determine the rest position in patients with such problems. The dentist should be more considerate, patient and spend more time to establish the rest position in such individuals.

4. **Duration**: As it is a position in space, the patient cannot maintain the rest position for long periods. The dentist should make the measurement without delay when the patient assumes this position.

5. **Use of several methods**: Although the rest position is measurable and repeatable, there is no single scientific method of establishing the same. A combination of various methods is used to verify the position. **(Rangarajan and Padmanabhan, 2017)**

1.5.4 Occlusal vertical dimension:

The distance between two selected anatomic or marked points (usually one on the tip of the nose and the other on the chin) when in maximal intercuspal position **(GPT, 2017)**

1.5.5 Determination of occlusal vertical dimention

O.V.D. is achieved when the mandible is in an intercuspal position, and it is reached by an upwards and slightly forward movement from the rest position and the distance traveled by the mandible in this movement is between 2-4mm.

He also reported that the O.V.D. is reached by simultaneous contact between both arches from rest position and at this level the closing muscles are in optimal contraction. **(Kim, 1995)**

The other concept of determination is appear that suggest the O.V.D. is established by muscular placement of the mandible. They also stated that even through the O.V.D. occur when the teeth are fully articulated, teeth are not the determinants of

vertical dimension (V.D.) rather their position is determined by the V.D. of the space available between the fixed maxilla and the muscle positioned mandible.

They also indicated that the optimum length of contraction for the closing muscles repeatedly positions the mandible when the muscles go through their maximum power cycle , the teeth erupt until they are met by their contra - posed teeth at the point of optimum muscle contraction , and they suggested that the O.V.D. is maintained at a constant dimension throughout life unless teeth have been lost .

(Dawson , 1989)

Other method to determine vertical dimension is by phonetics, this uses phonetics to determine the vertical dimension. Phonetic vertical dimension: The distance measured between two selected points when the occluding members are in their closest proximity during speech **(GPT, 2005).**

Phonetic tests of the vertical dimension consist more of listening to speech production than of observing the relationships of teeth during speech. As the teeth are being arranged , it is not the speech sound itself that is critical but rather the inter relationships of the tongue , teeth , denture base , and lips **(Carlson , 1997).**

Closest speaking space: The space between the anterior teeth that should not be more or less than 1–2 mm of clearance between the incisal edges of the teeth when the patient is unconsciously repeating the letter ‘s’.

The production of ‘ch’ and ‘j’ sounds also brings the anterior teeth close together. When correctly placed, the lower incisors should move forward to a position nearly directly under and almost touching the upper central incisors. (figure 1.14) (**Rangarajan and Padmanabhan, 2017)**.

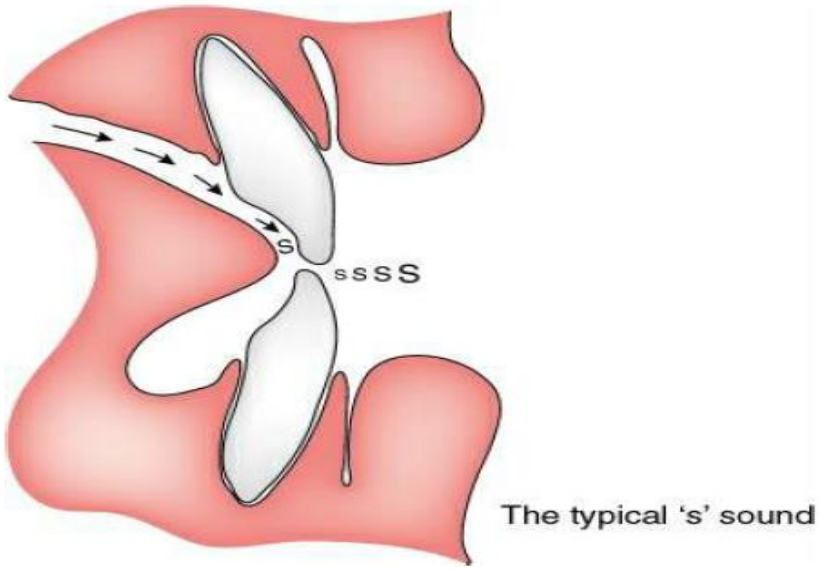

Figure 1.14: Closest speaking space

1.5.6 Pre-extraction records

These records can be prepared prior to the extraction of teeth and can be used as a guide to verify the vertical dimension of occlusion during the fabrication of complete dentures.

1. **Profile photographs:** Photographs are made of the facial profile when the teeth were present, in occlusion. These are enlarged to a life size and similar photographs are made during recording of jaw relations with the rims in occlusion. Distance between similar anatomic landmarks on the photographs taken when the teeth were present and during jaw relation is compared. This allows verification of occlusal vertical dimension.

2. **Radiographs:** Cephalometric radiographs and radiographs of condyles in fossa have been used similar to previous methods before extraction and during recording jaw relations to verify the vertical dimension. Because of radiation hazards and inaccuracies, they are now avoided.

3. **Articulated cast:** Casts are mounted before extraction and following

the recording of the edentulous jaw relation in CR. The interarch distance is compared between the two casts to verify accuracy of vertical dimension.

4. Facial measurements: Facial measurements had been suggested as a mean of recording the O.V.D. prior to the loss of the natural teeth. Various instruments for making facial measurements have been used in many different forms**.**

A method had been described based upon the length of the upper lip and the amount of the central incisor that is exposed when the lips are parted in reposed and he used a Labiometer device to measure the length of the upper lip. While, another research group used Sorenson profile scale as a pre - extraction record (**Rangarajan and Padmanabhan, 2017)**.

The nasion locator of the instrument was placed in the depression of the bridge of the nose , the chin seat raised until it highly contact the most inferior border of the chin . In addition, he used a plastic ruler and tongue depressor to measure the distance from the base of the nasal septum to the inferior border of the chin (Figure 1.15) **(Kaya, 2018)**.

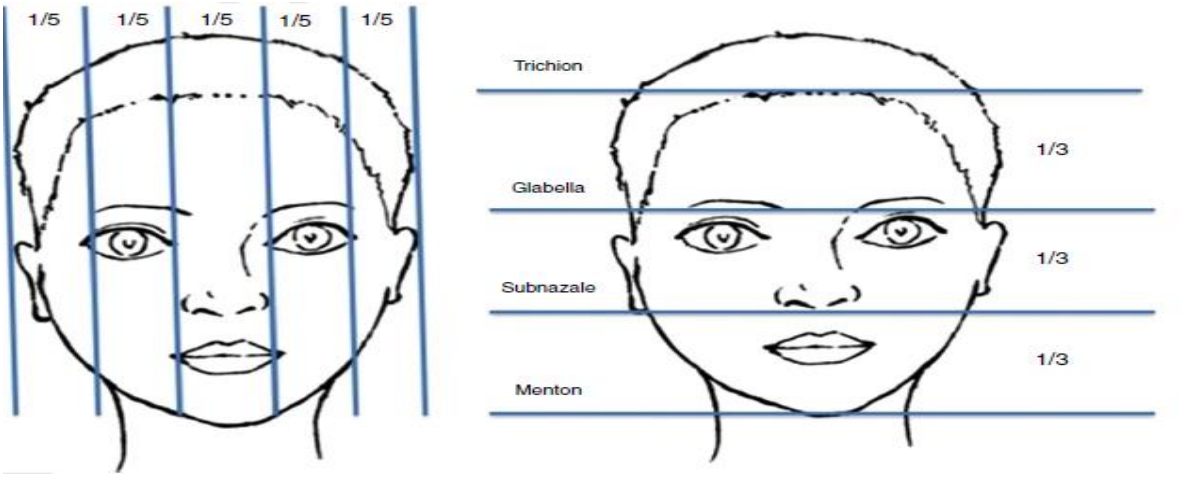

Figure 1.15: Height and width ratios of a face. A face is divided into five equal parts in the vertical plane and three equal parts in the horizontal plane.

1.5.7 Effects of increase in vertical dimension

1. **Discomfor**t: Chewing is a muscular mandibular movement, acquired over a period of many years, which the patient performs automatically and unconsciously. Increasing the vertical dimension alters the environment in which these unconscious movements take place and until the original condition is restored, discomfort will result. The jarring effect of teeth coming into contact sooner than expected also causes discomfort.

2. **Trauma**: The sudden and frequent contacting of teeth causes trauma to the denture-bearing area, especially under the lower denture, where the area to resist pressure is less. Correcting the fitting surface of the denture will typically not solve the problem.

3. **Tempro-mandibular** (**TMJ) problem**: The constant tooth contact will also affect the TMJ causing soreness and pain.

4. **Bone resorption**: The increased vertical height does not allow the muscles that close the mouth to complete their contraction. They will continue to exert force to overcome this obstruction and this will lead to resorption of supporting tissues.

5. **Muscular fatigue**: Due to the constant effort of the muscles to close the mouth, muscular fatigue will also occur.

6. **Clicking of teeth**: The premature contact of teeth sooner than what the individual is used to, will cause clicking of teeth.

7. **Facial distortion**: There will be an inability to close the lips, which will produce a strained expression and elongation of face.

8. **Difficulty in swallowing and speech**: The inability to close the lips will also cause difficulty in swallowing and speech. (**Rangarajan and Padmanabhan, 2017)**.

1.5.8 Effects of decrease in vertical dimension

1**. Inefficiency**: The biting force exerted by the teeth in occlusion decreases which causes inefficient mastication.

2. **Cheek biting**: The loss of muscle tone and reduced vertical height

causes the flabby cheeks to become trapped during mastication.

3. **TMJ problem**: The patient has to often protrude the mandible to occlude the teeth and this causes pain and clicking in the TMJ.

4. Angular cheilitis: The corners of the mouth form deep folds, which are bathed in saliva. This becomes infected and sore

5. Facial distortion: The following effects are seen:

- Nose appears closer to the chin
- Loss of lip fullness
- Loss of tonicity of muscles of facial expression
- Face appears flabby
- Patient appears older (**Rangarajan and Padmanabhan, 2017)**.

1.6 Horizontal jaw relation

Following the orientation of maxilla and determination of vertical dimension, the final relation to be recorded is the horizontal relation. This is the anteroposterior relation of the mandible to the maxilla in the horizontal plane.

The horizontal relations can be classified as:

• Centric relation

• Eccentric relations – protrusive and lateral.

1.6.1 Centric jaw relation

A maxilla-mandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxilla-mandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position. **(GPT9)**

Centric Occlusion (CO): the occlusion of opposing teeth when the mandible is in centric relation; this may or may not coincide with the maximal intercuspal position **(GPT, 2017).**

1.6.2 Methods of mandible retruding

To record CR, the mandible must be retruded. The various methods of retruding the mandible can be classified as:

Passive methods

The mandible is retruded by the patients themselves, following the dentist's instructions without any physical participation by the dentist.

1. Swallowing or free closure" technique. This method used the technique of swallowing saliva for obtaining the occlusal vertical dimension and CR

2. A technique where the patient was asked to touch their palate with the tip of their tongue to achieve condylar seating in CR

(Kattadiyil et al., 2021)

Active methods

1. Technique to ensure seating the condyle in the most superior position of the glenoid fossa. The mandible is guided superiorly with the finger position of the clinician at the gonial angle while the thumb simultaneously applies a downward pressure at the chin.

(Kattadiyil et al., 2021)

2. Dentist palpates the temporal and masseter muscles to relax them.

3. Dawson's bimanual palpation – the dentist stands behind the patient and places all four fingers of both hands on the lower border of the mandible on either side. The thumbs are placed over the symphysis such that they contact in the midline. The patient is instructed to open the mouth and then close slowly. As the patient closes, dentist applies an upwards lifting force with the fingers on the inferior border and simultaneously applies a downward force with the thumbs (Figure 1.16) . This guides the patient to close in CR. **(Rangarajan and Padmanabhan, 2017).**

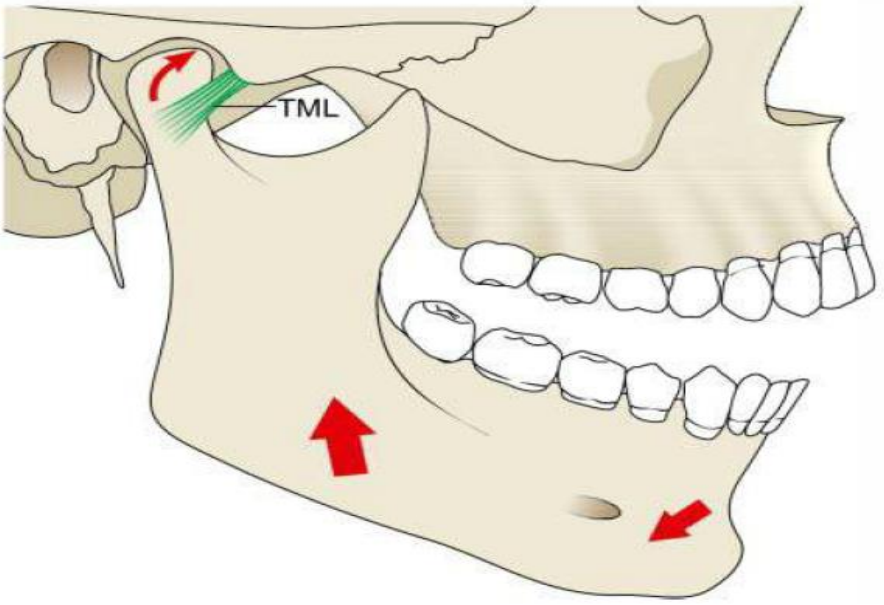

Figure 1.16: Dawson's bimanual palpation – direction of force application.
Adopted from **(Rangarajan and Padmanabhan, 2017).**

1.6.3 Recording the centric relation

After establishing the vertical dimension, the mandible is oriented to the maxilla in the horizontal relation using centric and eccentric records. The record is transferred to the articulator so that the artificial teeth can be arranged to harmonize with the patient's mandibular movements.

1.6.4 Requirements of CR record

1. To record correct horizontal relation of mandible to maxilla.
2. To exert equalized vertical pressure.
3. To remain undistorted till mounting on articulator.

1.6.5 Methods used to record CR

1. Interocclusal check record method

The interocclusal check record is the most commonly used method of recording centric relation because it requires less time and equipment , though the results are acceptable if care exercised during the recording . Some of the recording materials used in the interocclusal check record method are

1) waxes
2) dental plaster
3) zinc oxide eugenol paste .

The interocclusal check record or tactile method is referred to as a physiologic method. The normal functioning of the patient's proprioception , and tactile sense is essential in the making of an accurate record . The visual activity and the sense of touch of the dentist **(Hassaballa, 2010).**

2. Functional method or chew-in method

These methods utilize the functional movements of the jaws to record the CR. The patient is asked to perform border movements such as protrusive and lateral excursive movements in order to identify the most retruded position of the mandible. All these methods require a static CR record mounted on the articulator to prepare the recording devices. The new occlusal rims with the recording devices are fabricated with an increased vertical height so that the correct dimension is established as patient performs functional movements and grinds down the recording medium. Very stable record bases are required. The functional methods are not very popular as graphic methods may be more accurate.

The Needles-House technique and the Patterson technique are examples of the functional or chew - in method

- **Needle–House method:** Occlusal rims are fabricated from impression compound. Four metal balls or styli are embedded in the canine and molar areas of the maxillary occlusal rim. The occlusal rims are inserted and the patient is asked to perform various functional and excursive movements of the mandible with the styli contacting the lower rim. The vertical height is reduced as the styli cuts through the lower rim and the patient is stopped at the appropriate vertical dimension. The styli makes three-dimensional diamond-shaped tracings, which can be transferred to a suitable articulator to duplicate the movements. The most anterior point of the marking denotes CR and can be used to mount on any articulator. **(Rangarajan and Padmanabhan, 2017).**

- **Patterson method:** Wax occlusal rims are fabricated. A trench or trough is made in the mandibular occlusal rim which is filled with equal mixture of carborundum paste and plaster.
- The occlusal rims are inserted and the functional mandibular movements will produce compensating curves in the plaster lower rim. As the vertical height reaches the appropriate level, the patient is asked to retrude his jaw and the occlusal rims are joined together with metal staples **(Rangarajan and Padmanabhan, 2017)**.

3. Graphic methods

The graphic methods record a tracing of mandibular movements in one plane, an arrow point tracing. A graphic tracing can record centric and eccentric relations of the mandible to the maxillae; however when it is used to record centric relation, it should be made at the predetermined vertical dimension of occlusion. The apex of a properly made tracing (sharp apex) presumably indicates the position of centric relation.

- Graphic methods are either intraoral or extraoral , depending upon the placement of the recording device
- Graphic methods are the most accurate visual means of making a centric relation record with mechanical instruments; however all graphic tracings are not necessarily accurate **(Hassaballa, 2010).**

1.6.6 Eccentric jaw relation

Any relationship of the mandible to the maxillae other than centric relation **(GPT-4)**

• Protrusive relations

• Lateral relations

These records are essential if a balanced occlusion is planned for the denture.

They are used to adjust the protrusive and lateral condylar inclinations of the articulator, which will help in reproducing the mandibular movements of the patient.

Protrusive records: As the condyles move downwards and forwards during protrusion, these records help determine the protrusive condylar inclination of the articulator and are similar to those described for recording CR

lateral records: Lateral records are used to adjust the lateral condylar inclination of the articulator. The same functional, graphic and interocclusal check methods can be used to make lateral records. The patient is instructed to move the jaw laterally instead of protrude, to make the record. Hanau derived a formula to determine the lateral condylar inclination, if the protrusive (horizontal) condylar inclination was available through protrusive records **(Rangarajan and Padmanabhan, 2017)**.

$L = (H/8) + 12$

Where L = lateral condylar inclination, H = horizontal condylar inclination

Chapter two

Conclusions

2.1 Conclusions

Recording of maxillo-mandibular relations is critical step in fabrication of prosthetic appliances and it will be of utmost significance when a completely edentulous patient is the target of prosthetic treatment plan. Therefore, various methods, devices and concepts in recording Jaw relations were discussed in the literature; in this review, we tried our best to characterize them simply and precisely**.**

References

(A)

AH Elsayed, H., I Fayad, M., & RZ Alkholy, M. (2018). ELECCTROMYOGRAPHIC EVALUATION OF CANINE GUIDANCE OCCLUSION AND BILATERAL BALANCED OCCLUSION IN THERMOPLASTIC COMPLETE DENTURES. *Al-Azhar Journal of Dental Science*, *21*(2), 93-98.

(B)

Barbenel, J. C., Paul, P. E., Khambay, B. S., Walker, F. S., Moos, K. F., & Ayoub, A. F. (2010). Errors in orthognathic surgery planning: the effect of inaccurate study model orientation. International journal of oral and maxillofacial surgery, 39(11), 1103-1108.

(C)

Carlson G.E. Boncher's prosthodonotic treatment for edentulous patient 11th edition 1997.

(D)

Dawson P.E. evaluation diagnosis and treatment of occlusal problem 2nd Ed 1989 .

(G)

George, B. (2006). *Textbook of complete denture prosthodontics*. New Delhi, India: Cbs Publishers & Distributors.

(H)

Hassaballa, King saud University, Academic Publishing & press. (2010). Clinical complete denture prosthodontics.

(J)

jameson, W. S. (2004). Combining fixed and removable restorations with linear occlusion to treat combination syndrome: a clinical report. *General Dentistry*, *52*(2), 135-141

(K)

Klineberg, I., & Eckert, S. (2015). Functional Occlusion in Restorative Dentistry and Prosthodontics. 1 st ed. Elsevier Health Sciences.

Kaya, K. S., Türk, B., Cankaya, M., Seyhun, N., & Coşkun, B. U. (2018). Assessment of facial analysis measurements by Golden Proportion. *Brazilian Journal of Otorhinolaryngology*, *85*(4), 494–501.

Kim, N. J., Lee, S. B., Choi, D. G., & Park, N. S. (1995). The study about the changes of masticatory system subsequent to randomly increasing the vertical dimension. *The Journal of Korean Academy of Prosthodontics*, *33*(4), 731-752.

Klineberg, I., Kingston, D., & Murray, G. (2007). The bases for using a particular occlusal design in tooth and implant-borne reconstructions and complete dentures. Clinical oral implants research, 18, 151-167.

Kattadiyil, M. T., Alzaid, A. A., & Campbell, S. D. (2021). The relationship between centric occlusion and the maximal intercuspal position and their use as treatment positions for complete mouth rehabilitation: best evidence consensus statement. *Journal of Prosthodontics*, *30*(S1), 26-33.

(N)

Nallaswamy, D. (2017). Textbook of prosthodontics. 2 nd ed. JP Medical Ltd.

Nagy, W. W., & Goldstein, G. R. (2018). Facebow use in clinical prosthodontic practice. Journal of Prosthodontics, 28(7), 772-774.

Nallaswamy, D., Ramalingam, K. and Bhat, V. (2003). Textbook of prosthodontics. 1 st ed. New Delhi: JP Medical Ltd.

(P)

Preston, J. D. (1979). A reassessment of the mandibular transverse horizontal axis therory. The Journal of prosthetic dentistry, 41(6), 605-613.

Padmaja, S. (2015). An insight into the future beckons of maxillofacial prosthodontics: Anaplastology. *Journal of Dental Research and Review*, *2*(2), 91.

(R)

Rangarajan, V., & Padmanabhan, T. V. (2017). *Textbook of prosthodontics- e book*. Elsevier India.

Rosenstiel, S. F., Land, M. F., & Fujimoto, J. (2016). Contemporary Fixed Prosthodontics. 5 th ed. St. Louis: Mosby, 70-74.

Rahn, Arthur O., John R. Ivanhoe, and Kevin D. Plummer. Textbook of complete dentures. PMPH-USA, 2009.

R. M. Basker, J. C. Davenport, J. M. Thomason. Wiley-Blackwell, prosthetic treatment of the edentulous patient, 2011

(S)

Shadakshari S, Nandeeshwar DB, Saritha MK. Virtual articulators: a future oriented technology. Asian J Med Cli Sci 2012;1(2):98-101.

Shanahan TE: Physiologic jaw relations and occlusion of complete dentures. J Prosthet Dent 2004;91:203-205

(T)

The glossary of prosthodontic terms. (2017). *The Journal of Prosthetic Dentistry*, *117*(5).

(W)

Wood, Duncan J. Techniques in complete denture technology. John Wiley & Sons, 2012.

(Z)

Zarb, G. A., Hobkirk, J., Eckert, S., & Jacob, R. (2013). Prosthodontic treatment for edentulous patients. 13 ed. Mobsy; 9-10