

A Review on Occlusal Plane Analysis in Edentulous Patients

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Abstract

Aim: The Purpose of the present review was to determine the occlusal plane in edentulous patients.

Objective : Occlusal plane orientation is an important factor in the construction of a complete denture. Occlusal plane could be oriented using landmarks in the maxillary arch as well as the mandibular arch . Many methods have been used to establish the occlusal plane in complete dentures , but no method seems to be fully acceptable. So it is always challenging for the prosthodontist to restore the existing occlusal condition with a suitable prosthesis.

Materials and Methods : An electronic search engine without time/ language restrictions was taken from Google Scholar .

Conclusion: This article reviews different techniques to determine and correct occlusal plane. HIP was parallel to the occlusal plane , Ala-tragal line passing through lower part of the ala of the nose to inferior position of the tragus was relatively parallel to maxillary residual ridge. Therefore, this may be a viable reference in complete denture prosthodontics.

Key words : Plane of Occlusion , Camper's plane, Curve of Spee , Occlusal plane analyser , Ala tragus.

Introduction

Complete denture prosthodontics is a challenge for the dentist for rehabilitation of edentulous patients with conventional complete dentures. Occlusal plane orientation is one of the most important clinical procedures in edentulous patients. It may be tissue supported or implant supported, has to be done by considering various biological and mechanical factors to restore functions and health of the stomatognathic system¹. Developing an occlusion that is compatible with functional movements of the stomatognathic system is one of the key factors in determining the prognosis of the completely edentulous patients. One of the important factors that help us in the establishment of

ideal occlusion is the orientation of the occlusal plane.

A further description by Dr. Peter Dawson in 1780, said that the “The plane of occlusion refers to an imaginary surface that theoretically touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth.” The glossary of Prosthodontic term (2005) defines occlusal plane as “the average plane established by the incisal and occlusal surfaces of the teeth.” A plane is determined by at least three reference points that are not in a straight line. The occlusal plane is determined anteriorly by the maxillary incisor teeth and posteriorly by the retromolar pads.

When we relate to a plane we initially think of a flat surface, however, it is not a plane but represents the planar mean of the curvature of the surfaces. Using an occlusion rim, the clinician determines the incisal edge position by evaluating speech, lip support, and esthetics and then typically uses anatomical landmarks such as the retromolar pad and relative parallelism of the ridges to determine the position of the posterior teeth. The

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connection of these anterior and posterior landmarks establishes the occlusal plane².

The orientation of the occlusal plane is lost in patients rendered edentulous and should be re-located if complete dentures are to be esthetic and to function satisfactorily. For example, if the occlusal plane is placed too high, the tongue cannot rest on the lingual cusps of the mandibular denture and prevents the denture's displacement. There is also a tendency for accumulation of food in the buccal and lingual sulci. On the other hand, if the occlusal plane is placed too low, it could lead to tongue and cheek biting. Complete dentures are constructed to function in the mouth as an integral part of the masticatory system; therefore, they should be designed to conform to the patient's physiologic jaw relations.

The use of anatomical landmarks as guides has been suggested by many authors. Anatomical landmarks suggested to clinically determine the position of the occlusal plane are the upper lip, corner of the mouth, lateral margins of the tongue, two-thirds of the height of the retromolar pad, parallel to the ala-tragus (Camper's plane) and interpupillary lines, parallel to the hamular notch-incisive papilla plane, and 3.3 mm below the parotid papilla. A common concept is that the occlusal plane should be parallel to a line drawn from the lowest point of the ala of the nose to the external auditory meatus or tragus of the ear.

According to the Glossary of Prosthodontic terms, the occlusal plane is defined as "the average plane established by the incisal and occlusal surfaces of the teeth." Generally, it is not a plane but represents the planar mean of the curvature of these surfaces. These are as follows,

Curve of Spee + Curve of Wilson + Curve of Incisal Edges = Curve of Occlusion

Curve of Occlusion + Its relationship to the Cranium = Plane of Occlusion

The occlusal plane position is the foundation of clinical treatment and one of the most important criteria used to judge the degree of treatment success. It is an important factor which harmonizes morphology and function of stomatognathic system. Various authors have defined the occlusal plane in many different ways.

1. "An imaginary surface that touches the incisal edges of incisors and tips of the occluding surface of the posterior teeth".

2. "A line bisecting the molar and incisor overbite".

3. "A line extending from mesio incisal angle of upper central incisor to the mesiopalatal cusp of first maxillary molars".

4. It represents the functional table of occlusion in the first permanent molar, second premolar and the first premolar area.

5. The average plane established by the incisal and occlusal surfaces of the teeth.

Generally, it is not a plane but,

a. Represents the planar mean of the curvature of these surfaces.

b. The surface of wax occlusion rims contoured to guide in the arrangement of denture teeth.

c. A flat metallic plate used in arranging denture teeth - compensate to curve of occlusion

OCCLUSAL PLANE SIGNIFICANCE

The correct orientation of the occlusal plane plays a vital role in optimal esthetic achievement. In the natural smile, the incisal tips follow the curve of the lower lip. This effect is an expression of a correctly oriented occlusal plane; if the occlusal plane hangs posteriorly, the lip-line viewed from the front will appear straight and contribute more than any other factor to the so-called 'denture look'. The plane of occlusion forms an essential part of the concept of mechanically balanced articulation. The position of occlusal plane in denture wearers should be as close as possible to the plane, which was previously occupied by the natural teeth. Such position of the occlusal plane provides normal function of the tongue and cheek muscles, thus enhancing the denture stability.

It is believed that teeth oriented on an occlusal plane in harmony with the individuals physiognomy is responsible, in part, all conditions being equal, for stable, retentive full dentures. Faulty orientation of the occlusal plane will jeopardize interaction between tongue and

buccinators muscles. Where the occlusal plane is too high, the tongue cannot rest on the lingual cusps of the lower denture and prevent its displacement. Also it forces the tongue into a new position that is higher than its normal position. This higher position of the tongue causes the floor of the mouth to raise and create undue pressure on the border of the lingual flange and results in partial loss of border seal. There is also tendency for accumulation of food in the buccal and lingual sulci. An occlusal plane that is too low could lead to tongue and cheek biting. Correct orientation of the plane of occlusion in all three dimensions after loss of natural teeth is a demanding task. The optimal position/orientation of the occlusal plane is essential for successful prosthodontic treatment of completely edentulous patients.

OCCLUSAL PLANE ORIENTATION

Considering the importance of the accurate establishment of the location and inclination of occlusal plane on function, esthetics and speech, a method to conform it to the occlusal plane that existed in the natural teeth seems necessary. The question which arises in clinical practice is how to discover which position was occupied by the “natural occlusal plane” after the loss of natural teeth and exactly, how can the optimal position of the occlusal plane be found in every edentulous patient. The occlusal plane in anterior and posterior regions may vary and therefore, these should be evaluated separately. It is generally agreed that in the anterior region the vertical height of the occlusal plane is governed by esthetic requirements and less frequently by functional demands. Orientation of the occlusal plane is lost in patients rendered edentulous and should be relocated if complete dentures are to be esthetic and functional. It is difficult to find the optimal position of occlusal plane in every edentulous patient using the reported soft tissue landmarks. Improper use of these landmarks may compromise the functional and esthetic result of the intended prosthetic rehabilitation.

The anterior maxillary occlusal plane may be determined by lip relationships at rest and when smiling. Speech also provides for positional accuracy. When viewed from the front, the occlusal plane should be parallel to the inter-pupillary line. With regard to the orientation of the occlusal plane in the posterior region, however, there are contrasting views. Various authors

have postulated various landmarks for determining the occlusal plane. The commonly used method is based on anatomical landmarks which advises the positioning of occlusal plane parallel to the plane between the corner of mouth and the junction of middle and upper third of the retromolar pad. However, all the authors agree that ideal location for the occlusal plane is in the same position as it was when the natural teeth were present. Theoretically, plane established by Broadrick occlusal plane analyzer method has been considered as ideal occlusal plane for dentulous and partially edentulous individuals.

In case of edentulous individual, after anterior teeth were set, which is guided by phonetics and esthetics; tip of the canine and condylar element of the articulator can be taken as anterior and posterior survey points, respectively, for Broadrick occlusal plane analyzer method. The plane established by Broadrick occlusal plane analyzer method can be important guide for establishing plane in complete denture cases if anatomically established plane and plane established by Broadrick occlusal plane analyzer method coincide to each other. Precise establishment and orientation of the plane of occlusion is very important during rehabilitation of the completely edentulous subjects and is one of the important factors, which determines the prognosis of the case. It is desirable that the occlusal plane lost in edentulous patients should be relocated in prosthesis to conform to natural occlusal plane of the patient. Faulty orientation of occlusal plane in the prosthesis will jeopardize the interaction between tongue and buccinator muscle in placement of food bolus on the occlusal table. If the plane is too high, it would cause collection of food in the sulcus, and if it is too low, it would result in biting of cheek or tongue. Occlusal plane is an important factor of stability, critical in mounting on articulators, has a bearing on health and function of temporomandibular joint and is also of vital importance for articulate speech in a complete denture patient.

Different schools of thought exist regarding the method of orienting the occlusal plane based on intraoral and extra oral landmarks during complete denture fabrication. These include ala-tragus line, anterior nasal spine and hamular notch, lateral border of tongue, buccinator grooves, and commissure of lips and positioning the occlusal plane midway between the ridges. Lingual frenum has also been related to occlusal

plane. Various authors have advocated different methods for the orientation of the occlusal plane. Most important and accurate of these is pre-extraction record, eg: profile photographs, lead wire, acrylic face mask, dentulous casts etc

INSTRUMENTS TO EVALUATE OCCLUSAL PLANE:

1. Occlusal Plane Analyzer: This instrument was custom made to check for parallelism of ala-tragus line to the occlusal plane and occlusal plane to inter-pupillary line.

2. Digital Vernier Callipers: Digital Vernier calipers, with an accuracy of .001mm, were used

to check the distance between the two arrowheads on two parallel plates.

3. Buccinator Groove Relator: It was custom made to compare the level of the buccinator

groove (linea alba buccalis) with the occlusal plane.

4. Level Analyzer: An u-shaped plate was made to check the level of buccinator groove

with the occlusal plane on the impression taken. While fabricating, care was taken to

make sure both the prongs of the U were at the same level and parallel to each other.

5. Metallic Scale: A thin 6" stainless steel scale was used to relate the occlusal plane to the

retromolar pad

2. METHODS TO DETERMINE OCCLUSAL PLANE :

DIAGNOSTIC TRIAD FOR OCCLUSAL PLANE ANALYSIS

I. Clinical examination & evaluation

II. Cephalometric analysis

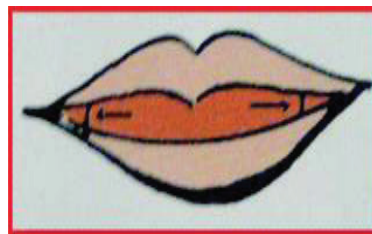
III. Mounted diagnostic casts

I. CLINICAL EXAMINATION & EVALUATION

:

1) PROTHERO'S METHOD:

Occlusal plane position should be 1-3 mm below the resting upper lip line anteriorly while it should be parallel to the ala-tragus line posteriorly.



2) RETROMOLAR PAD:

The occlusal plane, as determined by a line from the mandibular cuspid tip to the distolingual cusp tip of the distal mandibular molar, terminated in the area of the lower half of the retromolar pad in 75% of the subjects.

In the other 25%, the plane terminated in the area of the upper half of the retromolar pad.

Most frequently, Mandibular occlusal plane coincides with lower 1/3 of retromolar pad. It is always inferior to upper 1/3 of retromolar pad



3) RELATIONSHIP OF THE OCCLUSAL PLANE TO THE PAROTID PAPILLA, COMMISSURE OF LIPS AND THE BUCCINATOR GROOVE:

The average superior distance of the parotid papilla from the maxillary molar cusp tip was 4.2 mm.

- Vertically, the embrasures formed due to commissure of lips were within a range of 1 to 3 mm

- The mean distance of the parotid papilla was 2.56 mm above the maxillary occlusal plane.

- The commissure of lip was inferior to the mandibular occlusal plane by 1.37 mm.

- The buccinator was 0.94 mm below the mandibular occlusal plane.

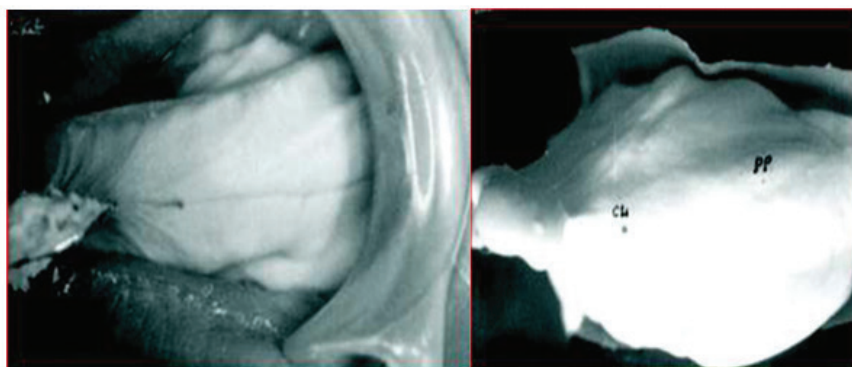


Fig. 3 Vestibular impression showing marking of commissure of lip and buccinator groove

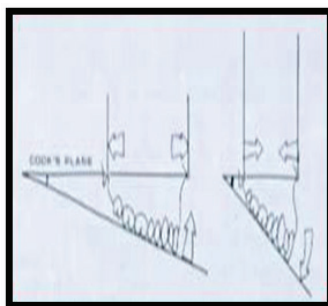
Fig. 4: Vestibular impression showing commissure of lip (CL), buccinator groove and parotid papilla (PP) placed on casts in centric occlusion.

4) COOK'S PLANE:

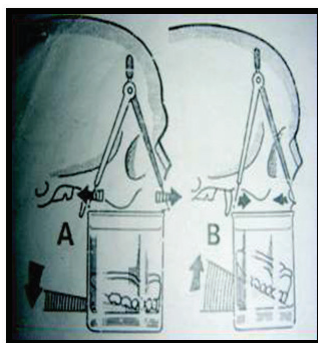
Sloane and Cook showed that the plane of occlusion is related to the length of a line connecting the anterior nasal spine (ANS) to the hamular notch on dry skulls.

- This line, called Cook's plane forms an angle with the occlusal plane that varies inversely with the distance separating the two reference points.
- Thus, the greater the distance between ANS and the hamular notch, the more acute the angulations of the occlusal plane, and conversely, the smaller the distance, the more obtuse the angle will be.

This tendency has been confirmed by the cephalometric studies of L'Estrange and Vig and represents a phenomenon that may be explained by the "denture glass effect".



Cook's Plane



Denture glass effect

6) CAMPER'S PLANE:

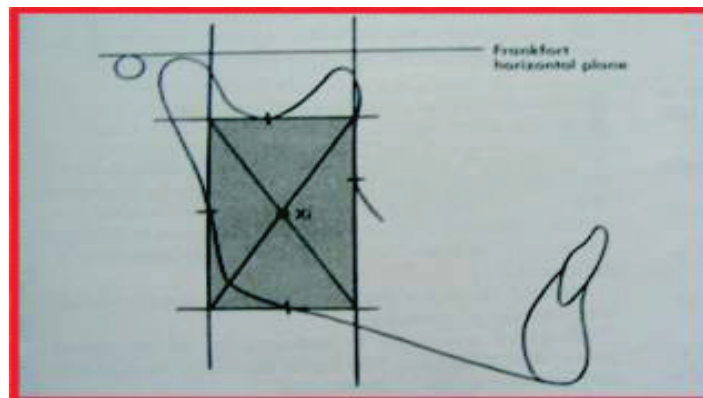
It is a plane passing from the acanthion to the center of each bony external auditory meatus.

Plane of occlusion should be parallel to the Ala-Tragus line (Camper's plane) .

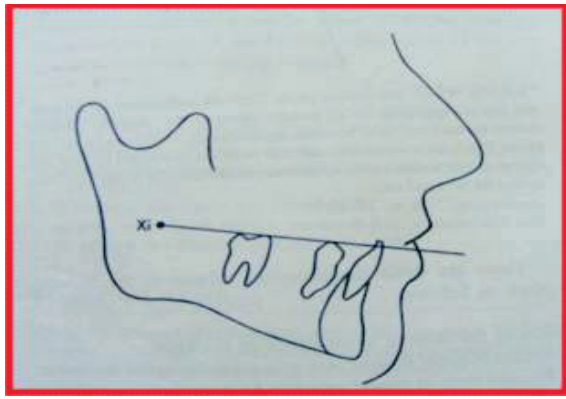


II. CEPHALOMETRICS:

- The functional occlusal plane is a plane that relates to the occlusal surfaces of the molars and premolars.
- The purpose of analyzing the occlusal plane cephalometrically is to determine its correct vertical position in both the anterior and posterior segments.
- An esthetically pleasing occlusal plane is close to the centre of the ramus (Xi point) at the posterior and slightly below the lip embrassure at the anterior.
- The lower incisal edges are normally slightly above the level of the functional occlusal plane.
- The posterior level of the occlusal plane should approach the level of Xi point.



Xi point. A rectangle is formed with the top and bottom parallel to the Frankfort horizontal plane and the sides perpendicular. The Xi point is located at the intersection of diagonals and represents the geometric centre of the ramus



The functional occlusal plane relates to the occlusal surfaces of molars and premolars. It does not bisect the incisors. It is close to the Xi point in the back and aligns slightly below the lip embrasure in the front.

III. MOUNTED DIAGNOSTIC CASTS :

- i) Broadrick's Occlusal plane analyzer (BOPA) and
- ii) Simplified Occlusal plane analyzer (SOPA)

The use of Broadrick flag or SOPA is not applicable for non-restorative cases; however, so occlusal plane analysis does have real value for orthodontic and surgical analysis if it is used with clinical evaluation.

1. BROADRICK'S OCCLUSAL PLANE ANALYZER

This instrument was devised by Dr. Lawson K. Broadrick. It is used for analyzing the curve of Spee & developing an acceptable curve of occlusion.

PROCEDURE:

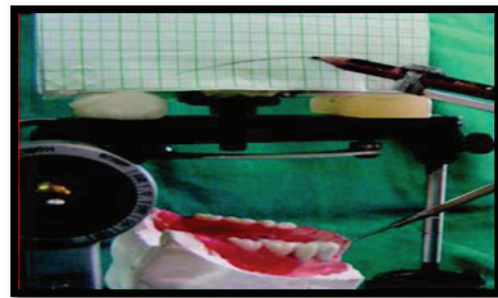
- The maxillary cast is first mounted to the articulator by a face bow transfer and the mandibular cast is then mounted in centric relation.
- The articulator is then adjusted in compliance with the articulator technique. Then the maxillary cast is removed from the articulator during the survey.
- A stud of card index is inserted into the hole in the upper member of articulator. Small arcs of 3 3/4", 4" and 5" radii can be drawn over the functional occlusal surfaces on the lower posterior teeth.
- An average of 4" radius may be used in majority of surveyed cases. Variation is only necessary when a pronounced curve of Spee may require a 3 3/4" radius or

a flat curve of Spee requiring a selection of up to a 5" radius.

- Now, the Bow Compass is adjusted to the radius selected (most commonly 4"). The centre of the Bow Compass which is set at 4" radius is positioned on the anterior survey point (A.S.P.) which is usually the disto-incisal of the cuspid.

- If cuspid is worn flat, the A.S.P. may be at the incisal edge. With the centre point of Bow Compass positioned on the A.S.P., a long arc (about 3") on the plastic record card is drawn.

- The occlusal plane survey centre will ultimately be located on some point of this arc. (Figure 11).



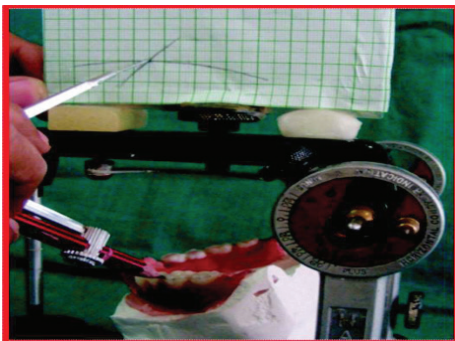
Anterior survey point

- The posterior survey point (PSP) is located on distobuccal cusp of the last mandibular molar.
- The centre of Bow Compass is positioned on the P.S.P. and an arc is applied to intersect the arc from A.S.P.
- The centre point of the bow compass is placed, adjusted to 4" radius, on the intersection of arcs on the plastic record card (Figure 12).
- Alternate to the molar P.S.P. is a position on the condylar element of articulator at the anterior intersection with the condylar shaft.
- The center point of bow compass is positioned on this condylar posterior survey point (C.P.S.P.) and an arc is applied to intersect the arc formed from the A.S.P.



Condylar element used as the Posterior survey point

- The needle point is swept over the occlusal surfaces of the lower posterior teeth to see how the arc conforms to the existing occlusal plane.
- This occlusal plane survey centre (O.P.S.C.) can be shifted on the A.S.P. line, until the most acceptable line and plane of occlusion is found.
- By trial and retrial, the ideal survey centre forming the most acceptable line and plane of occlusion will be located.
- The centre point of the Bow Compass is now pierced into this ideal O.P.S.C. Point of compass is placed at the survey center of the flag. 4-inch radius is drawn through the buccal surfaces of mandibular teeth .



Acceptable plane of occlusion

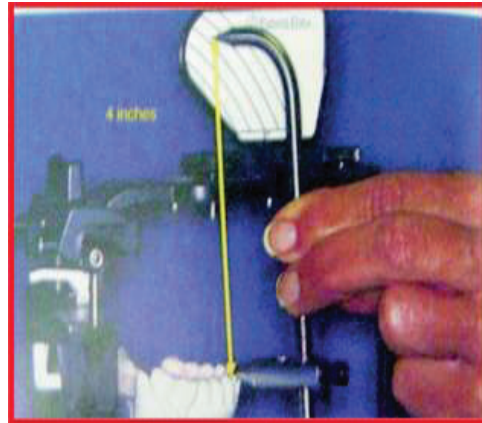
2)SIMPLIFIED OCCLUSAL PLANE ANALYZER (S.O.P.A.):

- This simplified method reduces the time required for occlusal plane analysis because the analysis point for surveying the occlusal plane is already related to the condylar axis.
- A SOPA is preset at 4" from the condylar axis

and it works with Denar articulators.

- The pencil point is simply positioned at the desired height for the lower canine and the point of the compass is placed on the center line of the SOPA.

- Compass pencil is then arced back to show the occlusal plane that would correctly relate to the condyles. By setting the caliper scribe at 4 inches & aligning the marking point at the tip of canine, an occlusal plane can be scribed on the lower cast that will go through the condylar axis in one simple step.



Occlusal plane scribed on the lower cast that will go through the condylar axis in one simple step

Discussion

The ultimate goal of any type of prosthodontic rehabilitation is to restore the missing structures in a way that they were present. To achieve this goal majority prosthodontic concepts have been derived from the observation made in healthy subjects. The concepts derived in this way will make successful rehabilitation possible in majority of the patients. The concept for occlusal plane orientation is one such concept. In literature several authors have proposed their method for establishing occlusal plane, for both partially and completely edentate patients.

In case of complete denture patients the methods proposed are:

1. Parallel to ala-tragus line
2. Locating occlusal plane parallel to and midway between the residual ridges.
3. Positioning occlusal plane at the level of lateral

border of the tongue

4. Locating occlusal plane posteriorly at the middle or upper third of the retromolar pad

5. Orienting occlusal plane with the buccinators groove and commissures of the lips.

6. Establishing occlusal plane in relation to parotid papilla

7. Use of certain cephalometric criteria for establishing occlusal plane

During complete denture construction the occlusal plane should be established as close to the natural dentition as possible. This statement is logical since the musculature of the tongue and cheeks was trained to function normally in that environment and will again function appropriately when they are called upon to stabilize the bolus at the same vertical position of the occlusal table as formerly existed. For partially edentulous patient, the Broadrick occlusal plane analyzer method for occlusal plane orientation is widely accepted. The plane obtained by this method will have curvature as observed in sagittal plane, known as curve of Spee. For complete denture cases, still the opinion of the authors differs. In complete denture cases, as per the established occlusal plane, teeth setting will be done; following principles of the teeth setting. At this time the teeth set in trial denture will show curvature in sagittal plane. The curve, anteroposterior compensatory curve, established in this way will help to achieve balanced occlusion for better stability of the dentures. If the compensatory curve also has geometry similar to the curve of Spee of natural dentition, than the same method used for natural dentition may have potential to be used in complete denture fabrication also³.

Summary & Conclusion

· The line joining from ala to the lower border of the tragus was parallel to the occlusal plane in 53.3% of the subjects. In 26% occlusal plane was parallel to the ala to middle border of tragus and in 20.7% occlusal plane was parallel to the ala to upper border of tragus.

· There was no influence of the sex on the level of occlusal plane i.e. both males and females showed the occlusal plane parallel to the line joining the ala to the

lower border of tragus.

· In subjects with small tragus either middle or lower border of the tragus may be used to determine the level of occlusal plane

· Alatragal line passing through lower part of the ala of the nose to inferior position of the tragus was relatively parallel to maxillary residual ridge.

· Alatragal line passing through lower part of the ala of the nose to middle position of the tragus was relatively parallel to mandibular residual ridge.

· In the rest position Maxillary and mandibular residual ridges were not parallel to each other. They formed an angle with a mean difference of 4.20 degrees.

· The HIP plane is parallel to the natural occlusal plane⁴.

· The HIP plane can be used as a reference plane to re-establish the occlusal plane in edentulous patients.

· In most of the individuals, the occlusal plane correlated with the lower 1/3rd of the retromolar pad.

· No significant difference was found between males and females regarding the association of occlusal plane with level of retromolar pad.

· Retromolar pad can serve as a stable intraoral landmark to reestablish the lost occlusal plane orientation in edentulous subjects.

Ethical Clearance – Not required since it is a review article

Source of Funding – Nil

Conflict of Interest – Nil

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