

Determination of Occlusal plane parallelism with Ala-tragus line and Retromolar pad in Class I, Class II and Class III individuals

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ABSTRACT

Aim: The aim of the study was to determine accurately which part of the tragus used to form the ala-tragal line shows parallelism with the occlusal plane and which portion of retromolar pad corresponds to the occlusal plane in class I, II and III individuals.

Materials and methods: 90 dentate subjects of 18-25 years were taken for the study. Digital photographs are taken and using Auto-Cad, different angles between Eye-Ear plane and occlusal plane, Eye-Ear plane and the ala-superior border of the tragus, ala-middle border of the tragus and ala-inferior border of tragus were calculated. The closest angle formed between Eye-Ear plane and the occlusal plane was used to determine the occlusal plane of orientation. The parallelism with the retromolar pad was also checked.

Results and Conclusion: The mean angle was found to be close to ala-middle border of tragus in class I subjects and with ala-lower border in class II and class III subjects. The results in relation to retromolar pad showed that the lower third of retro-molar pad coincides with occlusal plane in class I subjects and with middle third of retro-molar pad in II and class III subjects.

Keywords: Frankfort-horizontal plane, Ala-tragal line, Camper's line, Retromolar pad, AUTO-CAD.

INTRODUCTION

The occlusal plane determination is one of the most important clinical procedure in prosthodontic rehabilitation. The glossary of prosthodontic terms defines an occlusal plane as "the average plane established by the incisal and occlusal surfaces of the teeth"¹. This Occlusal plane represents the planar mean of the curvature of these surfaces. 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. The junction of the upper and middle thirds of the retromolar pads are the usual posterior landmark². The four fundamental requirements that the complete denture should fulfill are esthetics, phonetics, mastication, and comfort. These requirements are achieved by applying proper techniques in complete denture construction. Thus, the correct determinations of the artificial occlusal plane in the occlusal rim during jaw registration procedures play an important role.³.

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The proper height of the occlusal plane is essential for the adequate buccolingual exchange and control of food, speech articulation contacts, tongue space, esthetics and buccal soft tissue support. If the occlusal table is too high, it will cause food collection in the sulci. If it is too low it will result in biting the cheek or tongue and instability of dentures⁴. The faulty orientation of the occlusal plane will jeopardize the interaction between tongue and buccinator muscle⁴. The occlusal plane should be oriented in such a way as to leave enough space for the tongue, as it plays a major role in speech. The posterior level of the occlusal plane is important for mandibular function and maintenance of the temporomandibular joint. There is a strong clinical indication that TMJ problems occur when the posterior position of the occlusal plane is farthest from the center of the ramus⁵. Boucher states that the teeth must be placed in exactly the same position as the natural teeth, which they are to replace. Some dentists position the occlusal plane parallel to and mid way between the residual ridges^{6,7}. Still other dentists recommend placing the occlusal plane so that it terminates posteriorly at the medial 2/3 rd of the retromolar pad. A study was done by Shigli et al.,⁸ showed results that were in co-ordination with the present study, but the studies were done in only class I subjects. There is not much published data for studies that were done in class II and class III subjects.

So, the main purpose of the present study is to determine accurately which portion of the tragus in ala-tragal line is more nearer or parallel to the occlusal plane and which portion of the retromolar pad is more nearer to occlusal plane in class I, class II and class III individuals.

MATERIALS AND METHODS

The study was carried out in 90 subjects who were out patients and students belonging to GITAM dental college within the age range of 18-25 years. In this study photography was used to determine the occlusal plane in dentulous patients and for checking the occlusal plane parallelism with retromolar pad impressions were made and casts were poured. Landmarks used for this study are described briefly below:

- Orbitale (O): the lowest point on the inferior border of bony orbit.
- Tragon(T1): The superior margin of tragus.
- T 2: The middle of tragus.
- T 3: The inferior margin of tragus
- Ala: The lowest point of the ala of the nose.
- Eye-ear plane(EEP/ OT1): The plane passing through the orbital points and the tragon; comparable to the Frankfort plane.
- Occlusal plane (OP): a plane through the incisal edges of the upper first incisors and the cusps of the upper first molars
- Retromolar pad

Selection criteria

1. 30 patients with Straight or orthognathic molar relationship, 30 patients with class II molar relationship and 30 patients with class III molar relationship
2. No previous history of orthodontic treatment
3. No congenitally missing or extracted teeth.
4. Subjects had complete dentition without crowns, fixed or removable partial dentures or supernumerary teeth or retained teeth.
5. No deciduous teeth
6. Absence of advanced periodontal diseases and associated tooth mobility.
7. Exclusion of TMJ disorder if any.
8. Absence of third molars

In this study, a Nikon digital camera with 3× optical zoom was used which stores the photographs digitally that can be later transferred to the computer. The camera was placed on a standard adjustable tripod stand. An adhesive strip, was placed horizontally on the face, with its mesial end coinciding with the right orbital point. A Trubyte occlusal plane plate (Fox plane) was placed in the mouth in such a position that it touched the incisal edges of the first upper incisors, and the cusps of the left and right upper first molar. The outer wings of the plate indicate the position of the occlusal plane which can be seen in the photograph. The dots on superior, middle and inferior margins of the right tragus and lower point of ala of nose were directly placed on the photo in computer. Each subject was asked to stand one meter away from the

mirror. Before making photographs the subjects were asked to stand with the head in natural head position. Walking slightly on the spot and tilting the head backward and forward before standing still, helped the subject assume the natural head position. A plumb line was suspended in front of the subject, which was used to "bisect" the facial reflection and to minimize lateral head rotations. The perpendicular distance between the subject's sagittal plane and camera was 1.5 meters. Lateral digital photographs of the face with fox bite plane in mouth and adhesive strip with mesial end on right orbital point and patient holding the fox plane in position by pressure from the opposing teeth was taken.(fig 1)



Fig 1: Placement of fox plane for lateral photographs

The following points were then digitized on all the photographs on the computer

- The superior margin of the Tragus (T 1)
- The middle margin of the Tragus (T 2)
- The lower margin of the Tragus (T 3)
- Lowest part of the ala (A) of nose.

The following lines were then digitized on all photographs

- The Eye-Ear plane (EEP) connecting the orbital point (O) to Tragus ie, superior

margin of the tragus (T1) i.e. OT 1 which is comparable to the Frankfort plane.

- Camper's plane or the ala-tragus line is a line drawn from the lowest part of the ala (A) to the tragus.
- Ala (A) to upper margin of tragus (T 1) i.e. AT 1
- Ala (A) to middle margin of tragus (T 2) i.e. AT 2
- Ala (A) to lower margin of tragus (T 3) i.e. AT 3 .

A line is drawn extending from the outer wing of fox plane, which is comparable to occlusal plane i.e.OP. Angles measured were between eye-ear plane(OT 1) and occlusal plane (OP) i.e. OT 1 -OP, between eye-ear plane(OT 1) and ala-upper border of tragus (AT1) i.e.OT1-AT1., between eye-ear plane(OT1) and ala - middle border of tragus (AT 2) i.e. OT 1 -AT 2, between eye-ear plane(OT 1) and ala lower border of tragus (AT 3) i.e. OT1 -AT 3. Of the three angles formed by the eye-ear plane (OT1) and the ala-tragal lines, the one closest to the angle formed between Eye-Ear plane (OT 1) and Occlusal plane (OP) was used to determine the occlusal plane of orientation. The computer software, AutoCAD, was used to calculate the angles.(fig 2)



Fig 2: Measurement of angles using AUTO-CAD software.

Comparison among the groups was done by ANOVA (analysis of variance). P-value was used to find out level of statistically significance where $P < .05$.

significant, and $P < .001$ -very highly significant. These were done using SPSS software.

Relationship of the occlusal plane to the retromolar pad

The location of the retromolar pad in relation to the plane of occlusion was determined by placing a 19 gauge straight (the straightness of the wire was determined by rolling it on a glass slab) stainless steel wire, 6 inches in length, on the tip of the mandibular cuspid and by posteriorly extending the wire to the distolingual cusp tip of the mandibular 2nd molar. The relationship of the plane of occlusion to the retromolar pad was determined by the intersection of the wire and the retromolar pad. The vertical height of the pad was divided into 3 parts (lower, middle and upper 1/3rd). This procedure was carried extraorally on the cast. (fig3) The distolingual cusp tip of the mandibular distal most molar was used as the distal reference as it has a closer anatomic relationship to the retromolar pad than does the distobuccal cusp.



Fig 3: Checking the parallelism of occlusal plane with retromolar pad.

RESULTS

The results in terms of mean angles comparison using t-test and ANOVA test shows that OT1-OP angles for class I is 7.20, OT1-AT1 is 10.90, OT1-AT2 is 6.65 and OT1-AT3 is 6.65 which indicates that OT1-OP angles are nearer to middle border of tragus in class I subjects.

Table 1: Comparison of Class I, Class II and Class 3 with respect to angles (in degree) in four groups (OT1-OP, OT1-AT1, OT1-AT2 OT1-AT3) by unpaired t test

Group	Class	n	Mean	SD	t-value	P-value
OT1-OP	Class I	30	7.20	2.42	1.8091	0.0784
	Class II	30	6.00	1.72		
	Class III	30	6.0	1.72		
OT1-AT1	Class I	30	10.90	1.74	-1.0681	0.2922
	Class II	30	11.45	1.50		
	Class III	30	10.0	1.69		
OT1-AT2	Class I	30	6.65	2.54	-2.0034	0.0523
	Class II	30	8.00	1.62		
	Class III	30	3.4	2.10		
OT1-AT3	Class I	30	3.25	2.71	-1.1119	0.2732
	Class II	30	4.05	1.73		
	Class III	30	5.8	1.69		

Table 1 shows comparison of occlusal plane with all the three portions of the ala-tragal line which shows that occlusal plane is parallel to middle portion of tragus in class 1 subjects and it is parallel to lower border of tragus in class II and class III subjects. As seen in the table the p-value OT1-OP is 0.0784, OT1-AT1 is 0.2922, OT1-AT2 is

0.0523, OT1-AT3 is 0.2732 which shows no statistically significant difference in p-values. On comparison of OT1-OP values with that of OT1-AT2 and OT1-AT3 shows that the mean angles of OT1OP values are nearer to lower border of tragus in class II and class III subjects.

Table 2: Relationship of the mandibular occlusal plane to the retromolar pad in 90 subjects, 30 each for class I, class II and class III individuals

Part of retromolar pad	Left arch	%	Right arch	%
Lower part	24	80.00	21	70.00
Middle part	6	20.00	9	30.00
Upper part	0	0.00	0	0.00

Part of retromolar pad	Left arch	%	Right arch	%
Lower part	9	30.00	6	20.00
Middle part	21	70.00	24	80.00
Upper part	0	0.00	0	0.00

Part of retromolar pad	Left arch	%	Right arch	%
Lower part	12	40.00	6	20.00
Middle part	18	60.00	24	80.00
Upper part	0	0.00	0	0.00

Table 2 shows comparison of occlusal plane with retromolar pad in class I subjects which shows that lower 1/3 of retromolar pad is nearer to occlusal plane in 80% of the subjects and on comparison of occlusal plane with retromolar pad in class II subjects shows that middle 1/3 of retromolar pad is nearer to occlusal plane in 60% of the subjects and on comparison of Occlusal plane with retromolar pad in class III subjects shows that middle 1/3 of retromolar pad is nearer to occlusal plane in 60% of the subjects

DISCUSSION

This study is a photographic evaluation done to check which border of the tragus used to form ala-tragal line is parallel to occlusal plane in class I ,II and III dentate subjects. In this study parallelism of occlusal plane with occlusal plane was checked. The photographic technique used in this study is non-invasive and simple and the entire technique was standardized. The subject-to-camera

distance was set at approximately 10 times the maximum breadth of the subject reduces photographic distortion to less than 1%. In this study 3 types of errors may occur namely; errors of projection, mechanical errors in drawing lines between points and errors of land mark location. Projection error is reduced by the use of angular measurements because the values of angular measurement remain constant regardless of the enlargement factor. Errors introduced in drawing and measuring lengths and angles by hand can easily be eliminated by machine computation, as done in this study, provided that the reproducibility of digitization of individual points is high. Precise positioning of the subject, especially with no external device is very difficult, resulting in a situation in which the true anatomic mid-sagittal plane coincides with the nominal mid sagittal plane at the focusing plane. To minimize this error, in the study, a plumb line was suspended in front of the mirror that was used to bisect the facial reflection

and to minimize lateral head rotations. This also served to standardize the mid-sagittal plane to film distance.¹⁰ Photographs were taken with the subjects positioned in the natural head posture (NHP). NHP is a logical orientation adopted for assessing facial profile as it relates to the patient's head posture in daily life. The natural head position can be achieved by asking the patient to relax, so that the FH plane is parallel to floor. The Eye-Ear plane (EEP) i.e. OT 1 which is comparable to Frankfort horizontal plane (FH plane) is taken as a standard reference plane as it is (FH plane) stable and is not affected by tooth loss. Also it is universally accepted as a fixed cranial plane.¹¹ The subjects were selected between the age group of 18-25 years. By 18 years growth of the face ceases and there is no change in the relationship of camper's plane to the occlusal plane. The upper age limit was restricted to 25 years as at this age a dentition can be expected to remain normal without tooth loss and excessive attrition. The angulation of the occlusal plane to the FH plane (OT 1) is known as "cant of the occlusal plane" and was first enunciated by Downs¹². Table-I shows that mean angle of OT 1 -AT 2 is close to mean angle of OT1 -OP i.e. the angle formed between FH plane and occlusal plane is closer to the angle between FH plane and ala-middle border of the tragus in class 1 subjects and nearer to lower third in class 2 and class 3 subjects, this means that the occlusal plane is more parallel to the line drawn from the ala to the lower border of the tragus. In a similar study done by Shigli et al., found out that the occlusal plane is parallel to the line drawn from the lowest point of the ala of the nose to the middle border of the tragus. The occlusal plane, as established by tooth arrangement should be located according to mechanical requirement for stability of denture and preservation of the supporting structures. Occlusal plane should be perpendicular to the forces of mastication and should be developed parallel to the lower ridge. The occlusal plane placed high in relation to lower ridge result in additional leverage and denture instability. There are several other studies which have shown that line joining ala of nose to lower border of tragus is nearer to occlusal plane^(13, 14, 15, 16) in class I subjects, but in the present study ala-middle border of tragus is nearer to occlusal plane in class I subjects. This may be due to the length of the tragus. In the subjects with short tragus there was not much distance between lower

and middle border of the tragus thus making both the lower and middle borders almost parallel to occlusal plane. In this study it was found that in none of the subjects upper border of the tragus is parallel to the occlusal plane. This might be due to the antero-posterior dimensions of the maxillary base, which governs angulation of the occlusal plane. The greater the distance between ANS (anterior nasal spine) and the hamular notch i.e. wider anterior cranial base, the more acute the angulation of the occlusal plane and conversely, the smaller the distance the more obtuse the angle will be. This is given by Sloane and Cook.¹⁷ Cephalometric studies done by Rostamkhani et al.¹⁸ on individuals with Angle's Class III malocclusion and Sharifi et al.,¹⁹ on individuals with Angle's Class I jaw relation found out that the occlusal plane had a stronger tendency to be parallel to the line joining the ala of the nose and inferior border of the tragus.

The location of soft tissue landmarks are extremely difficult to accurately measure. However, a determined effort was made to reduce soft tissue distortion to a minimum. The retromolar pad is a pear shaped area that forms only after the removal of the most distal molar²⁰. Also it is a soft tissue area and at times its anterior and posterior borders cannot be demarcated accurately. Therefore relying only on this one landmark cannot guarantee complete validity to the occlusal plane orientation. However, when used as one of the guides for the occlusal plane orientation, the area in the lower third of the retromolar could be used. Lundquist and Luther²¹ determined the plane of occlusion in relation to the retromolar pad by placing a 16 gauge wire on the tip of the mandibular cuspid and by posteriorly extending the wire to the distolingual cusp tip of the second molar. distolingual cusp was used instead of distobuccal cusp as it has close anatomic relation to retromolar pad. The relationship of the occlusal plane to the retromolar pad was determined by intersection of the wire and the pad. A study done by Gupta et al²² used a metallic scale which passed along the cusp tip of cuspid to mandibular second or third molar and extended posteriorly to the retromolar pad. They concluded that in maximum number of cases the occlusal plane coincided with the middle third of the retromolar pad. The lower 1/3 rd of the retromolar pad was observed to be consistent with the mandibular occlusal plane in class 1 subjects and

middle 1/3rd for class 2 and class 3 subjects. It is a prominent and stable anatomical landmark which is easily accessible.

CONCLUSION

Within the limitations of the present study,

- Lower border of ala of the nose to the lower part of tragus of the ear showed more parallelism with the Eye-Ear plane (Frankfort horizontal plane) and occlusal plane in, class II and class III subjects and middle part of tragus showed more parallelism in class I subjects.
- Also lower third of retromolar pad coincides with occlusal plane in 75% of the class I subjects and with middle third of retromolar pad in 70% of class II and class III subjects.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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