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Original article

A comparative evaluation of the parallelism of the occlusal plane with different levels of the tragus forming the ala-tragal line in Indore-Malwa dentate population – A Photographic study

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ABSTRACT

Aims: To determine the parallelism of the occlusal plane and the effect of age and sex on the three most commonly used reference points on the tragus in a sample Indore-Malwa (Madhya Pradesh, India) population. **Objective:** To evaluate the best posterior reference point of the ala-tragus line for orientation of the plane of occlusion in a sample Central India Dentate Population. **Methods and Material:** A total of 200 subjects (Male-100, Female – 100) in the age group of 18-50 years with complete dentition were selected for the present study. They were grouped as-Group A: 18-30 y, Group B: 31-50 y. Right lateral profile photographs were obtained with subjects having fox plane placed intraorally parallel to occlusal plane. Reference points corresponding to inferior, middle or superior border of tragus and inferior border of ala of nose were marked and were joined. Images were analyzed photometrically. The most parallel relationship was determined. **Results:** The occlusal plane was found to be more parallel to Ala-tragus line when inferior border of tragus was considered as posterior reference point. There was non-significant correlation found between age ($p>0.05$) and sex ($p>0.05$) in both the age groups with the level of Ala-Tragus line. **Conclusions:** Inferior tragal line is the most common posterior tragal reference point for orientation of plane of occlusion in 76.7% of the subjects in a sample Indore-Malwa population and there was no effect of age and sex on the level of ala tragus line. **Clinical Implications:** To find out the best posterior reference for orientation of the occlusion plane for the complete denture prostheses.

Introduction

The proper orientation of the occlusal plane plays a very essential role in achieving optimal esthetics and function in complete denture therapy.(1) An improper orientation of the occlusal plane jeopardizes the harmony between various components of the Oro-Facial Articulatory Complex.(2) Review of literature showed considerable debate regarding the posterior tragal landmark (3), Spratley (4) mentioned the ala-tragus line as the line running from centre of the ala to the centre of the tragus whereas, Ismail and Bowman(4) defined it as a line passes from ala of the nose to the centre of the external auditory meatus. Various other references have also been cited for the same like resting upper lip line, commissure of the lips, lateral tongue borders, inter-ridge relations, buccinator grooves etc (4) .

Thus as per present literature, no single tragal reference could safely be considered as a posterior landmark.(5) The effect of demographic or ethnic

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variation over the parallelism of ala-tragal lines may also play an important role in determining the correct occlusal plane. Richard K et al (5) performed a study on radiographic interpretation of cranio-facial reference lines in relation to prosthodontic plane orientation in Chinese and Scandinavian (Caucasian) population, but till date there is no proper demographic data regarding the best suitable posterior landmark in Indore-Malwa (Indian) population. Hence, the following study was planned to evaluate the best posterior reference of the ala-tragal line for orientation of the plane of occlusion in the sample Indore-Malwa (Madhya Pradesh, India) dentate population.

Materials and Methods:

This cross sectional study was carried out between the time period of June-Aug 2015 on 200 subjects which included dental students as well as the patients of College of Dental Science & Hospital, Rau, Indore within the age group of 18-50 years (Group A - 18-30 years, Group B - 31-50 years. On the basis of following formula:

$$\text{Sample size} = \frac{Z_{1-a/2}{}^2 \, SD^2}{d2}$$

$Z_{1-a/2}$ -Standard normal variate (at 5% type one error ($P<0.05$) it is 1.96), SD- standard deviation of variation based on previous studies and, d- absolute error or precision (0.05), each group should contain atleast 70 subjects, so the following samples size was selected containing Male -100 , Female -100 subjects.

Inclusion criteria:

1. Subjects belonging to Indore-Malwa region who were atleast domiciled for four previous generations.
2. Subjects with an apparent straight facial profile on visual examination.
3. Subjects having a full complement of permanent natural teeth (excluding third molars) were selected for the study.

Exclusion criteria:

1. Presence of obvious of facial asymmetry or craniofacial anomaly either congenital or acquired.
2. Previous history of orthodontic or orthognathic treatment.
3. Presence of advanced periodontal diseases and associated tooth mobility.
4. Presence of extensive restorations that alter the occlusal plane, i.e. Long span bridges in the posterior segment of the maxillary or mandibular arch.

The objective of the study was explained to each subject and written informed consents were obtained from them. The study protocols were approved by the Institutional Ethical Committee, College of Dental Science & Hospital, Rau, Indore, which was in accordance with Helsinki declaration.

In the present study, lateral facial profilometric photographs were recorded using a Canon DSLR camera model No. 1200d with 25-55 & 55-250X optical zoom. The camera had a resolution of 20 Mega pixels which may be considered to be more than adequate for computer analysis. The camera was fixed on a standard adjustable tripod stand, so that it can become parallel to the horizontal plane. A Fox plane was placed in the mouth of the subject and positioned such that it touched the incisal edges of the maxillary central incisors and the cusps of the maxillary first molars. The plane was thus located in a position equivalent to the plane of orientation that is established during complete denture fabrication. The fox plane was stabilized in position with the help of pressure

Groups	18-30y		31-40 y	
	Mean	±SD	Mean	±SD
Female				
ST	8.40	4.13	9.60	4.46
MT	5.23	3.34	6.53	3.12
IT	2.80	2.76	3.83	2.48
Male				
ST	6.63	3.52	8.43	3.93
MT	4.60	3.05	5.03	3.15
IT	3.67	2.77	3.27	2.66

SD= standard deviation, ST - superior tragal line, MT- middle tragal line, IT- inferior tragal line

[Table 1] : Mean of deviation from parallelism of the Occlusal Plane to the Ala-Tragal lines (ST, MT, IT)

Group	18-30 years	31-40 years	't' value	P value*
Female				
ST	8.40	9.60	1.08	0.284
MT	5.23	6.53	1.55	0.124
IT	2.80	3.83	1.52	0.132
Male				
ST	6.63	8.43	1.86	0.066
MT	4.60	5.03	0.78	0.439
IT	3.66	3.27	0.56	0.570

*A P value < 0.05 was considered to be statistically significant (Student t test); ST- Superior tragal line; MT- Middle tragal line; IT- Inferior tragal line.

[Table 2] : Showing influence of Age on the parallelism of the Occlusal Plane to the Ala-Tragus line.

generated by the teeth of opposing arch. The outer wings of the fox plane represented the position of the occlusal plane and could be readily seen in the photograph. The photographs obtained were then transferred to the computer. Dots were marked on the superior, inferior and middle margins of the right tragus of each subject directly on the photo in the computer.

Each subject was made to sit upright 1.5m away from the camera. A grid was placed behind each subject. The grid ensured that there was no tilt of the head or lateral head rotation of the subject during photography. The perpendicular distance between each subject's sagital plane and the photographic film was fixed at 1.5m. A right lateral digital photograph of the face with the fox plane positioned in the mouth was thus taken.

The following points were then digitized on the computer:

The superior margin of the tragus (ST)

- The middle margin of the tragus (MT)
- The inferior margin of the tragus (IT)
- The lowest part of the ala of the nose (A)

The following lines were then digitized on all the photographs:

- Camper's line or the ala-tragus line which is a line drawn from the lowest part of the ala of the nose (A) to the tragus. Three points on the tragus were then marked and three lines were then drawn accordingly:

  From ala (A) to the superior margin of the tragus (ST)

  From ala (A) to the middle margin of the tragus (MT)

  From ala (A) to the inferior margin of the tragus (IT)

- The images thus obtained were analyzed using AdobeTM software to determine the most parallel relationship between the arms of the fox plane (i.e. the occlusal plane) and the three different levels of the ala-tragal line (ST,MT,IT) [Fig1].

The data thus obtained was then statistically analyzed. Mean, standard deviation and 'p' values were statistically evaluated by using commercially available program MSTATC. The parallelism of ala-tragus line

Group	18-30 years				31-40 years			
	Female	Male	't' value	'p' value	Female	Male	't' value	P value*
ST	8.40	6.63	1.78	0.079	9.60	8.43	1.07	0.286
MT	5.23	4.60	0.76	0.446	6.53	5.03	1.85	0.068
IT	2.80	3.67	1.21	0.229	3.83	3.26	0.85	0.397

*A P value < 0.05 was considered to be statistically significant (Student t test); ST- Superior tragal line; MT- Middle tragal line; IT- Inferior tragal line.

[Table 3] : Influence of Gender of the respective age groups on the parallelism of the Occlusal Plane to the Ala-Tragus line

with the occlusal plane with respect to different age groups and gender were tabulated and compared using student 't' test. The significant level was standardized at p= 0.05 for this analyses.

Results:

In the present study, total 200 subjects were selected between the age group of 18-50 years for comparing the best posterior Ala-tragal point. The statistical analysis of the data obtained revealed that the line joining ala to the lower border (IT) of the tragus was most parallel to the occlusal plane, i.e., in 76.7% of the total subjects, 15% of the study subjects demonstrated the occlusal plane to be parallel to the line joining the ala to the middle border (MT) of the tragus. Only 8.3% of the study subjects revealed occlusal plane to be parallel to line from the ala to the superior border of tragus (ST) [Fig2].

Table1 shows the mean values of deviation of parallelism of the differently oriented ala-tragal lines with the occlusal plane. The superior ala-tragal line showed the highest range of deviation from parallelism of the ala-tragal lines with occlusal plane [mean values: male – 4.83-6.63, female- 8.4-9.6], whereas the inferior ala-tragal line shows the lowest range of deviation from the parallelism [mean values : male- 3.27-3.67, female- 2.80-3.83] with the occlusal plane in both the age groups(18-30y, 31-50y) respectively, i.e., the inferior ala-tragal line is more parallel with the occlusal plane as compared to the superior and middle ala-tragal lines in both the age groups and gender of respective groups.

Statistical data obtained from the subjects of two different age groups [18-30y, 31-50y] were compared. The results revealed no significant difference (p>0.05) in the parallelism of the different ala-tragal lines with the occlusal plane i.e., superior tragal line (ST) [p=0.28], middle tragal line (MT)[p=0.22], inferior tragal line [p=0.13] between the two age groups. This shows that there is no significant influence of age on the parallelism of ala-tragal lines with the occlusal plane and the inferior tragal line is still most parallel with the occlusal plane in all the age groups [Table2].

The numerical data obtained from the genders (male & female) of different age groups (18-30y),(31-50y)

were found to be non- significant respectively($p>0.05$). The result obtained showed that there was no influence of gender on the parallelism of the ala-tragal lines on the occlusal plane. The values analyzed showed least deviation in the parallelism of inferior tragal line from the occlusal plane as compared to the superior and middle tragal lines [Table3].

Discussion:

A proper orientation of the plane of occlusion is an essential parameter in the process of fabrication of complete dentures .(3) It ensures proper bucco-lingual exchange and control of the food bolus, maintains proper speech-articulation contacts, prevents the encroachment of tongue space and helps in the establishment of satisfactory esthetics by ensuring proper labio-buccal soft tissue support .(3) The ala-tragus line or Camper's line as a guideline remains one of the most popular and accepted anatomical landmark for the establishment of the plane of occlusion. This may be attributed to its easy visualization and universal acceptance.

In the present study photographic evaluation has been used to determine the most suitable posterior reference point of the ala-tragus line for orientation of the occlusal plane for complete denture fabrication in Indore-Malwa (Madhya Pradesh, India) population to compare the effect of demographic, racial /ethnic variation on the parallelism of ala-tragal lines from the occlusal plane.

The photographic technique was preferred to cephalometric investigation which eliminated radiation exposure as well as avoided the inherent errors which may be caused due to image distortion. In this case, the subject-to-camera distance was set at 1.5m. This was thus approximately corresponding to 10 times the maximum breadth of the subject, the distance from the ear to the nose being approximately 15cm. (11) This helped in reducing the photographic distortion to less than 1% .(3) While recording angular measurements from a two-dimensional image of a three-dimensional object, the following errors may be caused: 1)Errors of projection, 2) Mechanical errors in drawing lines between points, and 3) Errors of landmark location. (3,11) In the present study, projection error was reduced by the use of angular measurements, because the values recorded by angular measurements remain constant and is independent of the enlargement factor. (11) The mechanical errors were eliminated by machine computation while ensuring that the reproducibility of the digitization of the individual points were high. (3) The errors of landmark location were minimized by precise positioning of the subject. (3,11) This was ensured by using a grid for stabilizing head position thus eliminating errors caused due to lateral head rotation.

The sample population of the present study was in the age group of 18-50 years. By 18 years there is cessation of facial growth and thus there is no change in the relationship of the occlusal plane to the Camper's plane. The upper age limit was restricted to 50 years so that the dentition could be expected to remain normal without tooth loss and excessive attrition.(3) For facilitating easy comparison of facial angulations, only orthognathic subjects were selected for the study. The fox plane was used in the study as it remains to date, it is the simplest, most widely used and less bulky than the other instruments used for determining the occlusal plane. Further it was more suitable for photography.

The results of present study revealed that the inferior tragal line (IT) presents the maximum parallelism or

the minimum deviation from the occlusal plane as compared to ST & MT which is in accordance with studies by Van Niekerk, (5,10) and others stated that the inferior border of the tragus be used for posterior reference.(5) A cephalometric study carried out by Karkazis,(5,10)and Polyzois,(5,10) also was in accordance with the findings of van Niekerk et al. (5,10). Clapp,(3,5,10)Dalby and Wilson,(3,5)also have suggested that the occlusion plane is parallel to a line drawn from the lowest point of the external auditory meatus (equivalent to the inferior border of the tragus) to the lowest point of the ala of the nose.(5)

Also no influence of age and gender was obtained on the parallelism of the ala-tragal line to the occlusal plane in a sample Indore-Malwa (Madhya Pradesh, India) dentate population, as previously postulated by Sandeep Kumar, Sandeep Garg and Seema Gupta.(3,5) The results obtained in the present study corroborated the findings of these studies.

Contradicting the results of present study, the findings of Solomon et al,(5,10) suggest that the ala-tragus line is parallel to the plane of occlusion when that tragal reference point was located between the superior border and the middle of the tragus. Similar results were obtained in the study conducted by Nissan et al, (5,10) Ismail and Bowman,(10) Spratley & Shigli et al ,(10) have also recommended the middle point of the tragus be used for posterior reference. These variations may be attributed to the effect of racial and ethnic variations.(4)

Within the subject population of the present study, it was found that the posterior tragal reference point was more toward the inferior border of the tragus. Hence, it can be assumed that the inferior border of the tragus may be used as a posterior reference point for the Indore-Malwa (Madhya Pradesh, India) population.

Conclusion:

From the present study, the following conclusions may be drawn:

1. For the total number of subjects (200), the most common posterior tragal reference point for orientation of the plane of occlusion was inferior tragus in 76.7% of the subjects followed by middle tragus in 15% of the subjects.
2. The least common posterior tragal reference point for orientation of the plane of occlusion was superior tragus in 8.3% of the subjects.
3. There was no influence of age and sex on the level of the occlusal plane.

The results of the present study which was performed on the Indore-Malwa dentate population using the photographic technique have helped in reducing manual errors and provided with more accurate results. However, further studies should be done involving larger sample size to further corroborate the finding of the present study.

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