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# **Evaluation of the Posterior Reference Point of Ala Tragus Line in Relation to Occlusal Plane and Frankfort Horizontal Plane Through Cephalometry in Sangareddy (Telangana) Population**

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**Abstract**---The Occlusal plane (OP) inclination is determined by paralleling the ala- tragus line to the occlusal plane. The location of the ala-tragus line is unclear because the exact location of the posterior reference tragal point is controversial. Additionally, morphological variations are observed between different ethnic groups. Therefore, evaluation of the exact reference point on the tragus is important. The study aimed to determine the most reliable

posterior reference point on the ala-tragus line that forms the most parallel line with the natural OP among the dentate Sangareddy volunteers from Telangana. Prosthodontically related craniofacial reference lines and angles of lateral cephalometric radiographs were analyzed for 25 dentate volunteers. Stainless steel balls were attached to the ala of the nose (A) and three points corresponding to the inferior (I), middle (M), and superior (S) points on the tragus. The angle formed by each line (IA, MA, and SA planes) with the OP and Frankfort horizontal (FH) plane were measured on cephalometric tracings. The mean angular value of IFH (angle between the FH and IA planes) was nearest to the cant of the OP, and the mean angular value of IOP (angle between the OP and IA plane) was lower than those of SOP (angle between the OP and SA plane) and MOP (angle between the OP and MA plane). The inferior point marked on the tragus with superior and middle points is the most appropriate point for marking the ala-tragus line among Sangareddy volunteers from Telangana with Angle's Class I maxillomandibular relationship.

**Keywords**---Occlusal plane, craniofacial, maxillomandibular, tragal points.

## Introduction

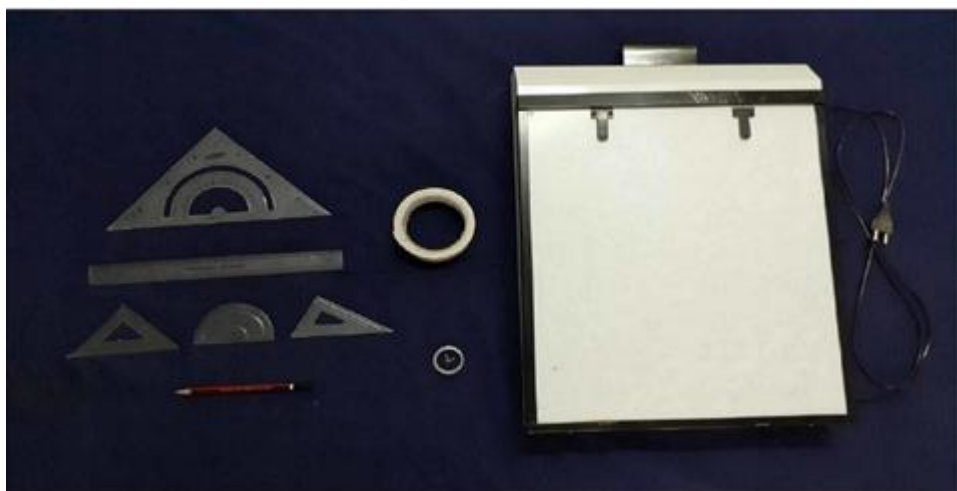
The prosthodontist is responsible for fabricating complete dentures, rehabilitating the natural form and function, and establishing an occlusion that is most compatible with the craniofacial structures and neuromuscular mechanism. Accurate establishment of the lost occlusal plane (OP) is a major challenge in the prosthetic rehabilitation of an edentulous patient. The location of the OP in complete denture fabrication is very subjective and is widely variable due to the uncertainty of reference landmarks and individual judgment.<sup>1</sup> The OP is considered the primary link between function and esthetics and should not be placed too high or too low.<sup>2</sup> The OP is defined as the common plane established by the incisal and occlusal surfaces of the teeth (GPT-8)<sup>3</sup>

A common concept is that the OP should be parallel to an imaginary line drawn from the ala of the nose to the external auditory meatus or tragus of the ear; however, opinions differ among authors regarding the posterior reference point of the tragus. Many guides have been utilized for OP orientation, although no single alternate method is completely accepted. In modern dentistry, the first effort in OP determination was performed by orienting to the Camper's plane.<sup>4</sup>

Several studies have related the OP to anatomic reference planes. Some authors have used the Camper's plane, whereas few others have utilized the Frankfort horizontal (FH) plane as a guide to correctly orient the OP. It is easier for less experienced dentists to use the ala-tragus line.<sup>5</sup> Radiographic cephalometry was introduced to dentistry by Broadbent in 1931. It was initially established as a tool to study cranio-facial growth and development and was then gradually used for the assessment and treatment planning for individual patients.

## Materials and Methods

The materials used in the study were a cephalostat, Vernier calipers, stainless steel ball bearings, set squares, a scale, double adhesive tape, plumb line, Natraj pencil, and an X-ray viewer. (Figure 1)



**Figure 1: Materials used in the study**

In this study, cephalometry was used to determine the OP in dentulous patients. Various cephalometric analyses have evolved to easily and precisely define the skeletal characteristics of an ideal face and occlusion. Hence, different anatomical reference points are used for OP determination. Cephalometric landmarks predict the OP orientation in edentulous patients. A total of 25 dentulous volunteers (11 female and 14 male) were selected from the Outpatient department of the Prosthodontics Department, MNR Dental College and Hospital, Sangareddy.

Patients of both sexes in the age group of 18-30 years with 28 – 32 teeth and an Angles Class-I, Maxillomandibular relationship residing in Sangareddy were enrolled in the study. Patients with skeletal or ear abnormalities; missing or replaced teeth; previous orthodontic or prosthodontic treatment; history of any esthetic surgery, facial asymmetry, and craniofacial anomaly; and overjet and overbite over 2mm were excluded.

The tragal length extending from the superior-most point of the tragus up to the lower border or the intertragic notch of the external ear was measured using Vernier calipers (SSU Silver Calipers). Three points were marked equidistantly along the double adhesive tape corresponding to the superior (S), middle (M), and inferior (I) points on the measured length of the tragus.

2 mm diameter stainless steel balls were attached to these points on the tragus. Another stainless-steel ball was attached with the help of a 1 cm × 1 cm double adhesive tape to the inferior margin of the ala (A) of the nose (Figure 2). By using bilateral adjustable ear rods in each auditory meatus, digital lateral cephalograms were obtained after the patient stood in the cephalostat (OrthophosXG, Sirona).



**Figure 2: Placement of stainless-steel balls using double adhesive tape on the participant**

Figure 3: Depicts the participant standing in the cephalostat machine with the (FH) plane parallel to the floor. A plumb line was suspended in front of the participant to obtain a true vertical. The participant was instructed to look straight and maintain a relaxed posture with teeth in centric occlusion and lips relaxed during the procedure. The central ray coincided with the ear rod of the cephalostat. The tube voltage was 73 kVp, current 15 mA, absorbed radiation dose 0.2dGYcm, and exposure time 9.4 s. The cephalograms (Figure 2) were traced on the X-ray viewer on the tracer film using an HB lead pencil. (Natraj bonded lead, HB, Hindustan Pvt. Ltd., India).



**Figure 3: A participant standing in front of the cephalostat**

The S, M, and I points of the tragus were joined with the A of the nose to form three ala-tragus lines, namely the SA, MA, and IA lines. The line joining the porion (Po) and orbitale (Or) gave the FH plane. According to Downs' analysis, the OP is the line bisecting the overlapping cusps of the first molars and premolars. The true horizontal line (NL) was drawn through the bony nasion. The true vertical line (PL) was drawn passing through the center of the silver chain (plumb line) and was perpendicular to the NL standardizing the lateral cephalogram. The lines were drawn using a scale (Natraj) and set squares (Natraj).



**Figure 4: The true vertical line (PL) passing through the center of the silver chain in the lateral cephalogram**

The following angles were measured using a protractor (Natraj).

SFH: angle between the FH and SA planes

MFH: angle between the FH and MA planes

IFH: angle between the FH and IA planes

SOP: angle between the OP and SA planes

MOP: angle between the OP and SA planes

IOP: angle between the OP and IA planes

Cant of OP: COP

## Results

The obtained data were subjected to statistical analysis. The mean, median, standard deviation, and Karl Pearson coefficient of correlations of the various angular measurements were derived.

	MEAN	Standard Error of Mean	MEDIAN	Std. Deviation
SFH	9.3200	0.9587	10.0000	4.7934
MFH	6.6400	0.6580	6.0000	3.2899
IFH	4.7200	0.4709	4.0000	2.3544
SOP	8.1200	0.9369	9.0000	4.6844
MOP	5.1600	0.6725	5.0000	3.3625
IOP	4.6800	0.6897	3.0000	3.4487
COP	4.8000	0.5416	4.0000	2.7080

**Table 1: Mean, standard Error of mean (SEM), median and standard deviations of the measured angles**

Table 1 depicts that the mean angular value of IFH was closer to that of the COP than to that of SFH and MFH. Whereas IOP had the least mean value.

Correlation between	Pearson-correlation	Significant if $P < 0.05$ (two-tailed)
COP and SFH	0.400	0.048 S
COP and MFH	0.492	0.012 S
COP and IFH	0.762	0.000 S
COP and SOP	-0.537	0.006 S
COP and MOP	-0.426	0.034 S
COP and IOP	-0.467	0.019 S

**Table 2: Karl Pearson correlation coefficient (r) and probability (P)**

The correlation was considered significant (two-tailed).

Table 2 depicts a maximum positive and highly statistically significant correlation between COP and IFH ( $P < 0.01$ ). Further, the correlation between COP and IOP was positive and highly statistically significant ( $P < 0.01$ ).

Close to COP	n %	
SFH	3	12.00
MFH	7	28.00
IFH	15	60.00
Total	25	100.00

**Table 3: Percentages of SFH, MFH, and IFH.**

Table 3 depicts that the IFH had the closest angular measurement to COP in 60% individuals

### Discussion

The OP design is acknowledged as one of nature's most beautiful expressions of dynamic harmony<sup>6</sup>. It is the oldest, simplest, and most commonly used to re-establish occlusion in edentulous patients according to a study conducted by Levin and Sauer<sup>7</sup>. The OP should be as close as possible to the plane previously occupied by the natural teeth to harmonize with the normal functions of the tongue and cheek muscles.<sup>8,9</sup>

Some concepts state that the OP is related to the Camper's line in edentulous patients. Thus, it is desirable to locate it accurately and propagate its use while stabilizing the OP. The definition of the ala- tragus line is confusing because the exact points of references on the tragus and ala are not categorically specified. Data analysis for OP is specific to the ethnic group from which they are obtained and may be misleading when applied to other ethnic groups as different racial groups have different facial characteristics. Therefore, the norms found in standard text books should be applied carefully to non- Caucasians.

Downs analysis was used as a base- line for comparing variations in the facial relationship. The results indicated that the COP, the angular relation between the OP and the FH plane, ranged from 1.5 to 14 with a mean value of 9.3<sup>10</sup> A different ethnic group must be treated according to its own individual characteristics.<sup>11,12</sup> The FH plane was used as a skeletal guideline in this study

for locating the OP posteriorly. This is because the FH plane is a fixed anatomical craniometric landmark, is not affected by the loss of teeth, and can be easily located using a lateral cephalogram.

Projection errors can be reduced using angular measurements because these values remain constant regardless of the enlargement factors. Precise positioning of the subject, with no external device is very difficult, resulting in only a rare coincidence of the true anatomic mid- sagittal plane with the nominal mid sagittal plane at the focussing plane.

To minimize this error in the study, a plumb line was suspended in front of the mirror to bisect the facial reflection and to minimize lateral head rotations. This also served to standardize the mid - sagittal plane to further distances. In the current study, a digital lateral cephalogram, a popular and contemporary tool, was used for diagnosis because radiographic studies can examine the relation between various cranial reference lines.<sup>13</sup>

The cephalometric analysis involves use of angular measurements that are relatively stable with respect to age and time<sup>14</sup> and could provide useful information on OP orientation in dentulous and edentulous subjects as they can re-establish the spatial position of lost structures such as teeth.<sup>15</sup>

The FH plane was considered as a standard reference plane, and lateral cephalogram standardization in all the three planes was performed to minimize errors. The FH plane was kept horizontal to the floor. A plumb line was hung from the cephalostat to indicate the true vertical. Both ear rods of the cephalostat machine ensured stability of the transverse plane, and the nasion holder of the cephalostat stabilized the head in the vertical plane.<sup>16</sup> Angular measurements were used instead of linear measurements in the current cephalometric analysis because they are practical, simple and independent of age and sexual dimorphism.<sup>14</sup>

For ease of comparison of the angulations, only orthognathic subjects were selected in this study. The selected subjects were aged 18-30 years because by 18 years, growth of the face ceases, and the relationship of the Camper's plane to the OP remains stable. The upper age limit was restricted to 30 years because at this age, the dentition is usually normal without being subjected to age-related changes such as tooth loss and excessive attrition.<sup>12</sup>

Results of the current study are concurrent with those of studies by van Niekerk et al,<sup>5</sup> Karkazis and Polyzois<sup>9</sup>, Kumar et al<sup>12</sup> Chaturvedi and Thombare<sup>10</sup>, Hindocha et al<sup>17</sup> Nayar et al<sup>18</sup>, and Hartono<sup>19</sup>, whereas they are contradictory to the results of studies by Al Quran et al<sup>3</sup>, Augsburg<sup>20</sup>, Jayachandran et al<sup>21</sup>, Sadr and sadr<sup>22</sup>, Shigli et al<sup>23</sup>, and Nissan et al<sup>24</sup> which concluded that the lines passing through superior border or middle border of the tragus were parallel to the OP. This variation may be due to race and ethnic variations.<sup>15</sup>

Kumar et al<sup>1</sup> reported a relative consistency in the angle between the OP and FH plane in dentulous subjects with Angle's Class I jaw relationship. This finding aid in establishing an accurate method for OP determination in orthognathic,

completely edentulous individuals for complete denture fabrication. The present study infers that IFH has a maximum correlation with the COP ( $r = 0.765$ ,  $P < 0.01$ ), confirming that the inferior point on the tragus gives the closest value of IFH ( $4.72^\circ$ ) that correlates to the COP ( $4.8^\circ$ ) in Angle's Class I jaw relationship. Thus, the ala-tragus line passing through the I is the most suitable plane to orient the OP in the orthognathic, completely edentulous population of Sangareddy.

This study has few limitations - Only dentulous subjects were selected for the study because of which age changes in the ala-tragus line in edentulous patients were not considered, angular relationship variation based on gender differences has to be investigated in the Telangana population and Results of this study can be applied only to Class I or orthognathic profile patients limiting its use in Class II and Class III profile patients. The OP, as established by the teeth arrangement, should be located according to the mechanical requirement for the stability of the denture and preservation of supporting structures.

## Conclusion

Positioning of the OP depends on mature clinical judgment and must ultimately satisfy esthetics, function, and denture stability. If the OP is placed too high, the tongue cannot rest on the lingual cusps of the mandibular denture, resulting in denture displacement and a propensity for the accumulation of food in the buccal and lingual sulci. Conversely, if the OP is placed too low, it could lead to tongue and cheek biting.

The inferior border of the tragus can be considered the posterior reference point when drawing the ala- tragus line, as 60% of the volunteers in the present study had an ala- tragus line passing through the inferior border of the tragus. Thus, it can be used as a guideline for OP orientation among the Angle's Class I Sangareddy population from Telangana.

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