A cephalometric analysis to establish a correlation of different ridge relations to three levels of camper’s line in edentulous patients: An in vivo study

DRV Kumar, Shrikar Sandeep Mehta, Sumit Deshpande\textsuperscript{1}, Arun Gupta, Manish Chadha, Chetna Kumar\textsuperscript{2}
Departments of Prosthodontics and Crown and Bridge and \textsuperscript{2}Orthodontics, Pacific Dental College and Hospital, Udaipur, Rajasthan, \textsuperscript{1}Department of Prosthodontics and Crown and Bridge, Pandit Deendiayal Upadhyay Dental College, Solapur, Maharashtra, India

**INTRODUCTION**

The placement of the occlusal plane in the fabrication of complete denture forms the basic platform for ideal teeth arrangement to fulfill necessary mechanical, esthetic, and phonetic requirements, and also aid in proper respiration and deglutition.\cite{1} Hence, the occlusal plane should be established as identical as possible.

**Keywords:** Ala-tragus line, camper’s line, cephalometric analysis, complete denture, occlusal plane, yen angle
The orientation of occlusal plane anteriorly is governed by the esthetic and less frequently by functional requirements. However, there are contrasting views with regard to the orientation of occlusal plane in the posterior region. The most commonly used reference to establish the occlusal plane posteriorly is the Camper’s Line, which was originally postulated in 1780, by Petrus Camper, passes through the anterior nasal spine and center of the external auditory meatus.\[^{[2]}\] However, changes have been made such that the line passes through the superior part of the tragus of the ear. Some dentists position the occlusal plane parallel to and mid-way between the residual ridges while some recommend placing the occlusal plane terminating posteriorly at the anterior two-third of the retromolar pad.\[^{[3,4]}\] Hence, dilemma prevails whether to consider maxillary or mandibular landmarks to establish the occlusal plane. Although predecessor considered mandibular landmarks as criteria to establish occlusal plane, the successors gradually shifted to maxillary landmarks for the establishment of occlusal plane considering esthetics as useful criteria.

Literature shows the consideration of superior, middle, and inferior points of tragus as posterior reference points. However, there is no scientific evidence as to which point of tragus should be considered in reference to ridge relation. Hence, this study was designed to establish a relationship between normognathic (Class I), retrognathic (Class II), and prognathic (Class III) ridge relations with superior, middle, and inferior levels of ala-tragus line in edentulous individuals, by utilizing arbitrary methods and cephalometric landmarks.

**METHODOLOGY**

Ninety edentulous male patients in the age group of 45–70 years, visiting the Department of Prosthodontics, Pacific Dental College and Hospital, Udaipur, Rajasthan, having high well-rounded ridge configuration (Atwood’s Order III) were selected for the study after obtaining the ethical clearance from the Institutional Research and Review Board. Participants with anatomical deformity of external ear and nose, ridge deformity, and suffering from oral diseases such as oral submucous fibrosis, temporomandibular disorders, systemic diseases such as neuromuscular disorders, and osteoporosis were excluded from the study.

**Fabrication of permanent denture base and occlusal rims**

Denture fabrication procedure for each patient was initiated as per the standard clinical protocols. The fabrication of permanent denture base for maxillary and mandibular master casts was carried out using heat-cured acrylic resin using compression molding technique. Two radiopaque ball bearings of 3.175-mm diameter were fixed in the incisive papilla region of maxillary denture base and central incisor region of mandibular denture base, respectively [Figure 1]. Wax rims were made on maxillary and mandibular permanent denture bases according to ideal dimensions.

**Recording of maxillomandibular relationship**

The mandibular occlusal rim was adjusted intraorally using the stable intraoral landmarks such as the corner of the mouth anteriorly and the anterior two-third of the retromolar pad area posteriorly at the level of the lateral border of the tongue.\[^{[5,6]}\] The maxillary occlusal plane was adjusted to the established mandibular occlusal plane. Tentative jaw relations were established using Niswonger’s method and Silverman’s closest speaking space. The facebow transfer was made, and the maxillary cast was oriented to semi-adjustable articulator. The mandibular cast was oriented to maxillary cast in centric relation. Based on the recorded maxillomandibular relations, the patients were categorized into three groups as follows:

a. Normognathic (Class I)
b. Retrognathic (Class II)
c. Prognathic (Class III).

After the establishment of maxillomandibular relationship, a 3 cm long orthodontic wire of 21G was adapted on the right side of the maxillary occlusal rim depicting the established occlusal plane [Figure 2].

**Preparation of the subject for lateral cephalogram**

Three radiopaque ball bearings of 3.175-mm diameter were attached on the superior, middle, and inferior parts of tragus, and one ball bearing at inferior border of ala of the nose using an adhesive tape [Figure 3]. The maxillary and mandibular occlusal rims were placed intraorally, and the patient’s mandible was guided in centric relation.

**Lateral cephalograms**

Kodak 8000 c machine was used for taking lateral cephalograms [Figure 4], and films were exposed at 70 kVp and 30 mA. Similar to this, 90 lateral cephalometric radiographs, 1 for each participant [Figure 5] were obtained.

**Tracing of lateral cephalogram**

Cephalometric tracings were carried out by an orthodontist using 0.35-mm lead pencil on acetate paper over an illuminated light box for all cephalograms [Figure 6]. Natural head position (NHP) (formed at an angle of
7° from sella (Se)-nasion (N) line when the Frankfort horizontal plane is parallel to floor) was taken as the reference plane for measuring all the angles. The following points and planes were constructed on the tracings:

1. Ala of the nose
2. Superior tragus point (T1)
3. Middle tragus point (T2)
4. Inferior tragus point (T3)
5. Occlusal plane (OP)

6. Ala-Superior Tragus (AT1)
7. Ala-Middle Tragus (AT2)
8. Ala-Inferior Tragus (AT3).
Taking NHP as the reference, a perpendicular line was dropped down to OP from sella. This perpendicular line forms an angle with OP which is denoted as NHP-OP angle. The same perpendicular line also forms angles with three levels of ala-tragal lines (NHP-AT1, NHP-AT2, and NHP-AT3 angles). These angles were measured and compared to NHP-OP angle. Out of the three NHP-AT (Ala-Tragus) angles, the angle which is near to NHP-OP angle is considered as the optimum reference plane to establish the occlusal plane.

The skeletal relationship between the maxilla and mandible was assessed using the Yen angle.[7] It is created by drawing a line from sella to the midpoint of maxillary ridge up to the midpoint of mandible on cephalogram. If this angle is in the range of 117°–123°, it is Class I (Normognathic). Similarly, for Class II and Class III, the Yen Angle is <117° and more than 123°, respectively. The correlation between the different ala-tragus lines and profile is depicted in the following tables.

RESULTS

The values obtained in the methodology were subjected to statistical analysis using SPSS version 16 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program to compare and correlate the values.

ANOVA test was used for quantitative data within three groups for each method. Tables 1 and 2 shows ANOVA analysis for visual and cephalometric methods, respectively, which reveals proximity of mean values OP angle to AT3 (ala-inferior tragus) for Class I and Class III participants, OP-AT2 (ala-middle tragus) for Class II participants with a P < 0.001. This suggests a significant difference between all the parameters in each class.

Multiple comparisons [Tables 3 and 4] were carried out using the Bonferroni test for both visual and cephalometric methods. Table 3 shows the statistical insignificance between the occlusal plane and AT3 in Class I, occlusal plane and AT2 in Class II, and occlusal plane and AT3 in Class III with the P = 1, 0.165, and 0.492, respectively. Furthermore, Table 4 shows the statistical insignificance between the occlusal plane and AT3 in Class I, occlusal plane and AT2 in Class II, and occlusal plane and AT3 in Class III with the P = 0.362, 1, and 0.817, respectively.

The interoperator variability was analyzed using the Kappa statistical analysis. Table 5 shows the Kappa statistical correlation between visual analysis and Yen angle which reveals that for visual analysis Class I, out of 30 participants, 28 participants are coinciding with cephalometric studies except two participants which were categorized into Class II and Class III.

The symmetric measures of Kappa[13] value are shown in Table 6. The value obtained is 0.8 which indicates excellent correlation and agreement between the two. Out of 90 participants, 78 participants are in total agreement with the classification.

To correlate the arbitrarily established and cephalometrically derived parameter by two different clinicians, the results were interpreted using the Kappa Statistics as shown in Table 5.

DISCUSSION

The use of the ala-tragus line (Camper’s line) as a guide to establish the occlusal plane has gained popularity as it is easily visualized. Even though controversies exist in selecting the posterior point of tragus (superior, middle, and inferior) to form the ala-tragus line. The occlusal plane is made parallel to this line to establish tentative jaw relation. While establishing the occlusal plane, the adjustment is done depending on the availability of height of maxillary occlusal rim and space for lower occlusal rim, the posterior point of tragus is decided which can vary in patients with different maxillo-mandibular skeletal relation. No study is available in literature which has correlated the relation between tragus points to a definite skeletal relation. Thus, an in-vivo study was designed for

| Class: Visual analysis | n     | Mean | Mean squares | F         | P          |
|-----------------------|-------|------|--------------|-----------|------------|
| Class I               |       |      |              |           |            |
| Occlusal plane angle  | 30    | 9.03 | 625.146      | 125.071   | <0.001*    |
| AT3 angle (inferior tragus) | 30 | 8.83 |
| Class II              |       |      |              |           |            |
| Occlusal plane angle  | 30    | 12.9 | 360.672      | 120.091   | <0.001*    |
| AT2 angle (middle tragus) | 30 | 13.8 |
| Class III             |       |      |              |           |            |
| Occlusal plane angle  | 30    | 10.5 | 596.615      | 76.205    | <0.001*    |
| AT3 angle (inferior tragus) | 30 | 9.1  |

*Significant difference

| Class: Yen angle | n     | Mean | Mean squares | F         | P          |
|-----------------|-------|------|--------------|-----------|------------|
| Class I         |       |      |              |           |            |
| Occlusal plane angle | 38 | 9.45 | 764.752      | 155.781   | <0.001*    |
| AT3 angle (inferior tragus) | 38 | 8.47 |
| Class II        |       |      |              |           |            |
| Occlusal plane angle | 21 | 14.1 | 278.713      | 69.136    | <0.001*    |
| AT2 angle (middle tragus) | 21 | 14.67 |
| Class III       |       |      |              |           |            |
| Occlusal plane angle | 31 | 10.26 | 625.598     | 77.516    | <0.001*    |
| AT3 angle (inferior tragus) | 31 | 9.06 |

*Significant difference
The present study considered a cephalometric indicator, Yen Angle to determine the maxillomandibular relationship. The second parameter of the study establishes the occlusal plane to the profile (ridge relation) of the patient using Yen angle (Class I: 117°–123°, Class II: <117°, and Class III: >123°). The result reveals coincidence of inferior part of the tragus in Class I and Class III ridge relations, and middle part of the tragus in Class II which is in accordance with the previous studies conducted by Clapp (1910), Dalby (1912), van Niekerk et al.,[9] Karkazis et al.,[10] and Hindocha et al.[11]

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Clinical implications
1. The profile of the patient infers approximate posterior reference point for the establishment of the occlusal plane rather than arbitrarily establishing posterior reference point.

Suggestions for future study
1. This study can be further improved by the inclusion of more number of participants and considering other cephalometric landmarks for comparison and evaluation of arbitrarily established the occlusal plane to cephalometrically derived angles.

CONCLUSION

Within the limitations of this study, the results obtained are as follows:
1. For normognathic (Class I) and prognathic (Class III) ridge relationship, the point to be considered is inferior part of tragus to establish the occlusal plane
2. For retrognathic (Class II) ridge relationship, ala‑tragus line formed by the ala of the nose and middle part of tragus is parallel to the established occlusal plane.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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