Lateral Cephalometric Radiographs: An Adjunct in Positioning the Occlusal Plane in Natural and Artificial Dentitions as Related to other Craniofacial Planes

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ABSTRACT

Occlusal plane orientation is one of the most important and vital clinical step in complete denture patients. The fundamental basis of locating occlusal plane differs among various countries, however, the most reliable one is the ala-tragus line which is a horizontal line drawn through the lower part of the nose and the orifice of the ear. Since, there is a lot of controversy regarding which part of the tragus should be used to orient the occlusal plane, cephalometry can be used as an adjunct to position the occlusal plane as related to other craniofacial landmarks.

Keywords: Occlusion, Cephalometric, Plane, Orientation.

INTRODUCTION

Orientation of the occlusal plane is one of the most important clinical step in removable prosthodontic treatment for edentulous patients, as it is a vital and important basis for tooth arrangement. It is considered to be the primary link between function and esthetics. In completely edentulous patients the occlusal plane orientation is lost and should be relocated 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 bite.1

Complete dentures are fabricated 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 occlusal plane in complete dentures has often been oriented anteriorly to fulfill esthetics and posteriorly parallel to Camper’s line, which is a horizontal line drawn through the lower part of the nose and the orifice of the ear.2

According to surveys,3,5 occlusal plane orientation differs considerably among various countries, however, the most widely used method in determining the plane of occlusion was the ala-tragus line method. Zarb et al6 suggested that the occlusal plane should be parallel to the hamular notch-incisive papilla plane, whereas other researchers have reported a close relationship between the ala-tragus line and occlusal plane.5

The use of a number of anatomical landmarks as guides from life or biometric guides for artificial tooth position has been suggested by many authors.7,9 Anatomical landmarks suggested to clinically determine the position of the occlusal plane are the upper lip, corner of the mouth,9 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,5,6 parallel to the hamular notch-incisive papilla plane and 3.3 mm below the parotid papilla.10

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 meatus or tragus of the ear. There are differences in the literature concerning which part of the tragus to use, since some researchers believe in using the lower border of the tragus, others believe in using the middle part of the tragus, and still others believe in using the upper part.5,6

The occlusal plane of dentures must be oriented as closely as possible to the occlusal plane that existed in the natural dentition. By doing so, the tongue and cheeks will be more effective during deglutition and mastication, and speech and esthetics will be improved. On the other hand other researchers believe that reproducing the natural occlusal plane in complete denture is not necessary due to conditions in natural dentitions differing from those of artificial dentures. They feel reproducing the natural occlusal plane offers no advantages for the extra care involved. Therefore, what is considered normal arrangement of teeth could be modified to suit edentulous needs; however, it would seem reasonable that dentures should not depart too radically from what they are replacing.
Since 1931, cephalometric analysis has served as a valuable adjunct to dental research and diagnosis, although its clinical application has been directed largely toward orthodontics. Cephalometry is of special value to prosthodontics, in that it can be used to reestablish the correct position of lost structures, such as the teeth. This can be achieved by identifying a predictable relationship between the teeth and other cranial landmarks not subjected to postextraction changes.

In this review, cephalometric analysis has been discussed to investigate the relationship between the natural occlusal plane and anatomical structure in the skull.\textsuperscript{11}

**CEPHALOMETRIC ANALYSIS OF OCCLUSAL PLANE AND CAMPER’S PLANE**\textsuperscript{12}

This analysis was aimed at determining the most reliable ala-tragus line as a guide for the orientation of the occlusal plane in complete dentures and the use of cephalometric landmarks to predict the occlusal plane orientation in edentulous patients. The analysis included 47 fully dentate subjects (21-34 years) with Angle’s class I occlusion. The criteria for selection of these patients were the presence of 28 to 32 natural teeth in an ideal arch alignment, with Angle’s class I molar relationship, a pleasing profile and no history of orthodontic treatment.

Left lateral cephalograms were taken by a standard technique with the mandible closed in maximum intercuspation. Barium sulfate creamy mix was applied to the teeth, one drop on the incisal edge of the left maxillary central incisor, and another drop painted to cover the mesiopalatal cusp of the left maxillary first molar. Another creamy mix of barium sulfate was painted on the skin on the left side of each patient’s face in the shape of a triangle to mark required landmarks to be shown in the final radiograph. The apex of the triangle superiorly pointed to the lower border of the ala of the nose, and the other one was applied to mark the whole tragus of the ear. The apex of the painted triangle of the tragus pointed posteriorly to the tragus so that the lowest angle between occlusal plane and ala-tragus line at the superior, middle and inferior border of the tragus could be identified. The cephalometric points used were the following:

- **Ala (point A):** The lowest point of the left ala of the nose represented by the superior apex of the triangular barium sulfate applied to the skin of the left side of the face.
- **Tragus (point T):** The whole tragus of the left ear represented by the triangular barium sulfate applied to the skin of the face of the dentate and edentate subjects.

The cephalometric planes used were the following:

- **Ala-tragus line (Camper’s plane):** The line joining point A with point T.
- **Occlusal plane:** The line connecting the lowest point of the incisal edge of the left maxillary central incisor with the lowest point of the mesiopalatal cusp of the left maxillary first molar.

The angular measurements were recorded to the nearest degree. The angles to be studied were as follows:

- **Camp I-OP:** Angle between Camper’s I (superior border of tragus) and occlusal plane.
- **Camp II-OP:** Angle between Camper’s II (middle border of tragus) and occlusal plane.
- **Camp III-OP:** Angle between Camper’s III (inferior border of tragus) and occlusal plane.

Occlusal plane angle formed between the occlusal plane and Camper’s plane had the lowest mean value in the angle formed with Camper’s I, which represents the measure taken from the superior border of tragus of the ear with a score of 2.1°. The highest was measured in the angle formed with Camper’s III, with score of 6.1°, while the mean angle formed with Camper’s II was 3.2°. The differences between the three planes in relation to the occlusal plane were found to be significant (p < 0.001).

**DISCUSSION**

An analysis of cephalometric lines and angles can provide useful information on the craniofacial skeleton and the orientation of the occlusal plane in dentulous and edentulous subjects. The plane of occlusion has been recognized as an essential functional part of the craniofacial skeleton.\textsuperscript{13-15}

Angular variables can be used to illustrate variations in artificial occlusal plane (AOP) orientation in relation to other craniofacial planes and to determine the validity of the use of the ala-tragus line as a reference point for occlusal plane orientation. Complete dentures are constructed to function in the mouth in harmony with the masticatory system; therefore, the complete dentures should be designed in accordance with all jaw movements and relations. Part of designing the complete denture is orienting the occlusal plane in the most acceptable cant for esthetics and function. Investigators have suggested various concepts and methods for the orientation of the occlusal plane in complete dentures based on morphologic studies on natural and artificial dentitions and on clinical experience.\textsuperscript{5,16-18}

Historically, the assessment of a patient’s occlusal line has been performed by comparing its inclination with selected craniofacial reference lines. The ala-tragus line was the most commonly used and widely taught method for the orientation of the plane of occlusion.\textsuperscript{3}

In the literature, there is controversy in defining Camper’s plane, which is considered the most popular plane used to orient the occlusal plane in edentulous patients. Definition of the Camper’s line causes confusion, because the exact reference points are controversial. For example, the glossary of prosthodontic terms\textsuperscript{19} states that the Camper’s line runs from the inferior border of the ala of the nose to the superior border of the tragus, while for Spratley it runs from the center of the ala to the center of the tragus. Among seven of the most famous prosthodontic textbooks, only Boucher’s provide a definition.\textsuperscript{2}
Two textbooks recommend the concept without defining it, while Basker et al, Grant and Johnson, and Neill and Naim provide only pictorial representation, illustrating Camper’s line as extending to a point, not at the superior border, but at the center of the tragus of the ear, corresponding to the definition of Ismail and Bowman,17 which predates Boucher’s definition. However, investigations into the clinical reliability of Camper’s line serve only to compound the confusion, as Ismail and Bowman17 compared the use of an ala-tragus line oriented to the middle of the tragus with the occlusal plane of natural teeth, and concluded that dentures constructed accordingly would have an occlusal plane set far too low posteriorly. This is contradicted by Abrahams and Carey,20 who concluded that the occlusal plane of complete dentures conforms to a line oriented to the superior border of the tragus results in the occlusal plane being leveled far too high posteriorly.

In the cephalometric study,12 three Camper’s planes were used, based upon the superior, middle and inferior part of the tragus; as Camper’s plane I is the line extending from the inferior border of the nose to the superior border of the tragus of the ear, Camper’s plane II is the line extending from the inferior border of the ala of the nose to the middle border of the tragus of the ear, and Camper’s III is the line extending from the inferior border of the ala of the nose to the inferior border of the tragus of the ear. The lowest mean angle formed between Camper’s I and the natural occlusal plane was 2.1°, Camper’s II was 3.2°, and Camper’s III was 6.1°. Nissan et al,21 on the other hand, recorded the angle formed between occlusal plane and Camper’s line as 7.08°. Abrahams and Carey20 reported the angle formed between the natural occlusal plane and Camper’s plane to be 9.66°. Augsburger16 found the angle of the occlusal plane deviated from Camper’s plane by 3.2° to 7.85° in dentate patients of different facial types.

Van Niekerk et al5 recorded a 2.45° angle between the occlusal plane of the complete denture and the ala-tragus line. Karkazis and Polyzois11 did not find a correlation between Camper’s plane and the occlusal plane of natural teeth (average 2.84°) or artificial teeth (average 3.25°); however, the inclination of the occlusal plane on complete dentures was similar to the occlusal plane. The difference between the average angle (2.0°) made by the occlusal plane and Camper’s plane as found in the cephalometric study12 and that of other studies can be explained by the use of different points of measurement. Van Niekerk et al5 used the inferior border of the tragus as the posterior border of the ala-tragus line, whereas Karkazis and Polyzois11 used the center of the tragus as the posterior border of Camper’s plane.

According to the findings of cephalometric analysis,12 Camper’s I is the most suitable plane to orient the occlusal plane, forming a stop anteroposteriorly following the curve of the ramus of the mandible, and establishing a curve that would serve the artificial teeth to be set in a way to prevent any interferences that would dislodge the denture during protrusive movement, making the dentures more stable and ensuring satisfactory service. On the other hand, an investigation18 has been carried out that compared the occlusal plane orientation before extraction of natural teeth and when artificial teeth were arranged so that the AOP paralleled the ala-tragus line. The results indicated that the natural occlusal plane was higher posteriorly than the AOP, which disagrees with what had been shown by Wylie, Abrahams and Carey20 and Ow et al.15 One can see the controversy regarding the position of the natural occlusal plane in relation to the AOP (determined by the use of the ala-tragus line). Moreover, in actual practice, the determination of the AOP by the ala-tragus line is taken only as an approximation and as the mean of the angle formed between the two planes. The ala-tragus line has proved to be a useful reference line for the initial orientation of the occlusal plane in complete dentures. Therefore, the ala-tragus line may be modified to be extended from the inferior part of the ala of the nose to the superior part of the tragus of the ear, instead of the mid- or inferior-tragus points. The differences between Camper’s I, II and III were tested and revealed a significant statistical difference, which means that using Camper’s I to orient the occlusal plane would make a significant difference in the esthetics and comfort of the complete denture.

The results of cephalometric study12 found that the superior border of the tragus is the most acceptable point to orient the occlusal plane, which complies with Boucher,7 the glossary of prosthodontic terms19 and Trapozzano. On the other hand, cephalometric study12 does not agree with the findings of other studies. Van Niekerk has suggested the use of the inferior part of the tragus rather than middle or superior, while Ismail and Bowman18 suggested the use of the middle part of the tragus.

CONCLUSION

Within the limitations of cephalometric analysis, it can be concluded that the superior border of the tragus with the inferior border of the ala of the nose was most accurate in orienting the occlusal plane.

REFERENCES