

## A Cephalometric Study to Determine the Plane of Occlusion in Completely Edentulous Patients: Part I

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**Abstract** To determine the relationship between the plane of occlusion and the Camper's line (ala-tragus line). Lateral cephalograms of 105 edentulous subjects were obtained after outlining the tragus and the base of the ala of the nose with radiopaque markers. Tracings of the cephalograms were done and the relationship between the plane of occlusion and the Camper's line (ala-tragus line) was noted. The most common tragal reference as a posterior landmark for determination of plane of occlusion was found to be below inferior (in 30.48% of subjects), and inferior (in 24.76% of subjects). The least common tragal reference was found to be above superior (in 3.82% of subjects) followed by superior of tragus and the point between superior and middle of the tragus (in 6.66% of subjects). The tragal reference in this study population was more towards the inferior of the tragus, with most of the times being below the inferior border. Therefore, the orientation of the plane of occlusion using the superior of tragus as a posterior landmark (according to the widely accepted definition of Camper's line) may be considered to be questionable. Further, the use of the tragus as a posterior landmark for the orientation of the plane of occlusion may be questioned on the basis of the findings of this study.

**Keywords** Plane of occlusion · Edentulous · Ala-tragus · Camper's plane · Cephalogram

### Introduction

In both natural and artificial dentitions, the plane of occlusion plays an important role in fulfilling the important criteria of function and esthetics. During teeth arrangement, it is generally advised that the artificial teeth be placed in the positions previously occupied by the natural teeth [1–4]. Many methods have been used to establish the plane of occlusion in complete denture prosthodontics; posteriorly the tongue [5], retromolar pad [6], and Stenson's duct [7] are considered as anatomical landmarks. Some dentists bisect the space between the residual ridges [8].

The technique of using the ala-tragus line (Camper's line) to establish the plane of occlusion is well documented [9]. The Glossary of Prosthodontic Terms 8 [10] defines the 'ala-tragus line' as 'the line which runs from the inferior border of the ala of the nose to some point, usually the tip of the tragus of the ear'. The same glossary defines the 'Camper's line' as 'established by the inferior border of the ala of the nose and the superior border of the tragus of the ear'.

A review of literature reveals that debate exists within the prosthodontic community over the exact definition of the ala-tragus or Camper's line. Most of the controversy revolves around which tragal reference is to be considered as a posterior landmark during orientation of the plane of occlusion. For example, Spratley [9] describes the ala-tragus line as running from the centre of the ala to the centre of the tragus whereas Ismail and Bowman [6] define it as a line that passes from the ala of the nose to the centre of the external auditory meatus.

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The aim of this cephalometric study was therefore to determine the relationship between the plane of occlusion and the Camper's line on dentulous subjects.

## Materials and Methods

A total of 105 dentulous subjects (65 male and 40 female) were selected for the study. The main criterion for inclusion in the study was absence of derangement of the plane of occlusion due to long standing extraction of teeth. Lateral cephalograms of these subjects were obtained. Prior to exposure of the cephalograms, a lead wire was adapted according to the shape of the tragus and attached to the tragus with the help of adhesive tape. A paste of barium sulphate was prepared (by mixing barium sulphate powder with water) and a point was marked at the base of the ala of the nose with the help of a brush (Fig. 1). For sake of uniformity, the right side of the subject's face was chosen while applying the markings.

All the cephalometric films were exposed keeping a standard distance of five feet between the X-ray target and mid-sagittal plane of the head of the subject. The mid-sagittal plane to film distance was standardized at 15 cm. The cephalograms were taken with the subject closing in maximal intercuspation position (Fig. 2). The same cephalostat and X-ray technician were used for all the subjects. After developing, the cephalograms were mounted on an X-ray viewer and traced using acetate films.

The radiopaque markings of the tragus (made by the lead wire) and the base of the ala of the nose (made by barium sulphate) were marked on the cephalometric tracings. The plane of occlusion was then outlined extending from the mid-incisal point of the maxillary central incisors to the meso-palatal cusp of the maxillary first molar.

A line parallel to this outlined plane of occlusion was then drawn through the alar marking and passing



**Fig. 1** Adaptation of lead wire to the tragus and barium sulphate marking at the base of the ala of nose



**Fig. 2** Cephalogram of the subject

posteriorly through the tragal marking. The relationship of this ala-tragus line with the tragus was noted (Fig. 3) and the tragal reference obtained was noted.

## Observations and Results

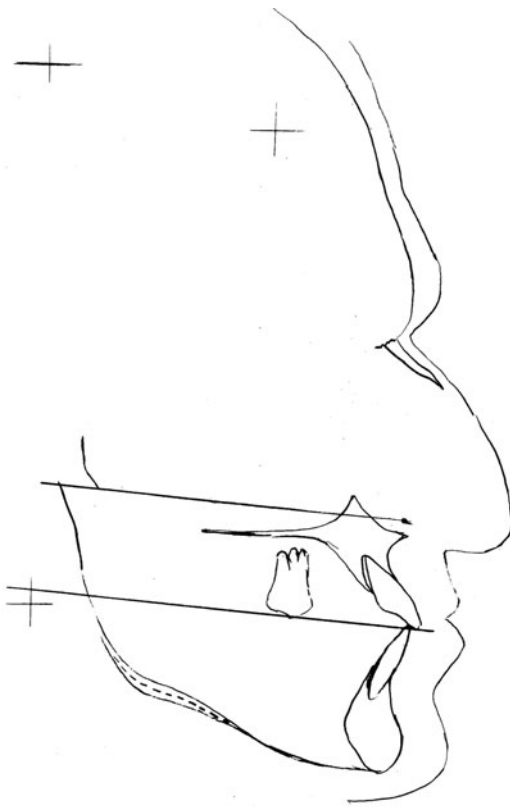
Table 1 shows the relationship of the tragus with the line passing through the base of the ala of the nose (ala-tragus line) and parallel to the plane of occlusion (in percentages). Seven tragal references were accordingly determined.

Figures 4, 5, and 6 show the distribution of number of patients according to the tragal reference obtained in male, female and total subjects, respectively.

From Table 1, it may be concluded that—in a majority of male subjects—the tragal reference was found to be below inferior (36.92%) followed by inferior (26.15%). The least common tragal references were superior (1.55%) and above superior (3.08%).

In the female subjects, the most common tragal reference was inferior (22.5%) followed by below inferior (20%) and middle (20%). The least common tragal reference was above superior (5%).

While considering the total subjects (male and female), the most common tragal reference was found to be below

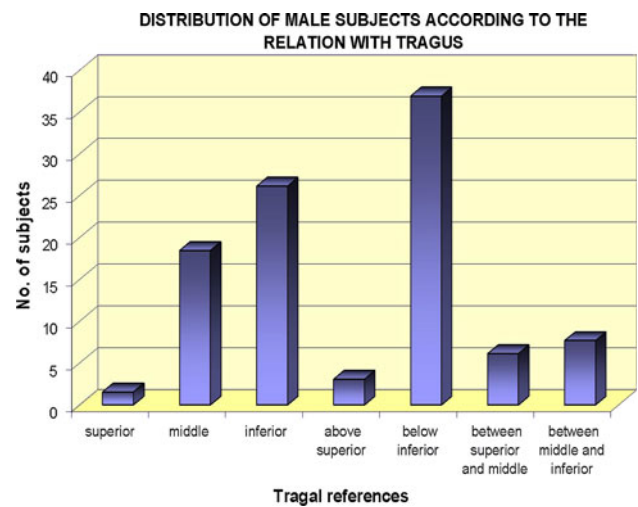


**Fig. 3** Tracing of the cephalogram

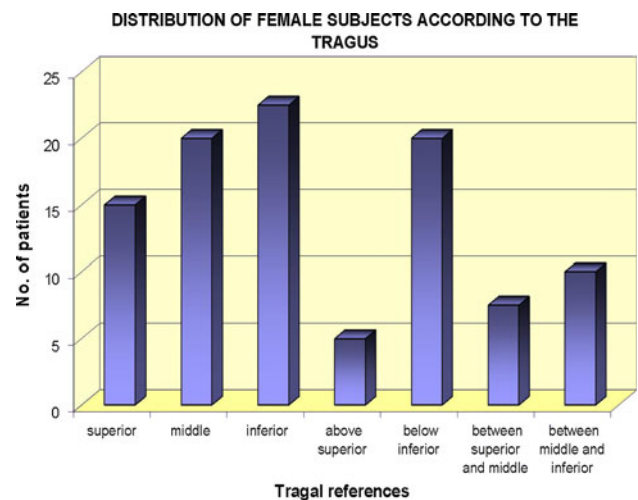
inferior (30.48%) followed by inferior border (24.76%). The least common tragal reference was above superior (3.82%) followed by superior border (6.66%) and tragal reference between superior and middle (6.66%). The percentage of tragal references from middle and below the middle of tragus was determined to be 82.82%.

**Discussion**

Determining the plane of occlusion is an important step in complete denture therapy. Due to absence of any concrete intraoral or extraoral anatomical landmark, its determination is prone to subjective variation. Different authors have advocated the use of various landmarks for its determination. Guidelines such as the position of the tongue,



**Fig. 4** Bar diagram showing the distribution of male subjects according to the relationship of the tragus with the line passing through the base of the ala and parallel to the plane of occlusion in male subjects



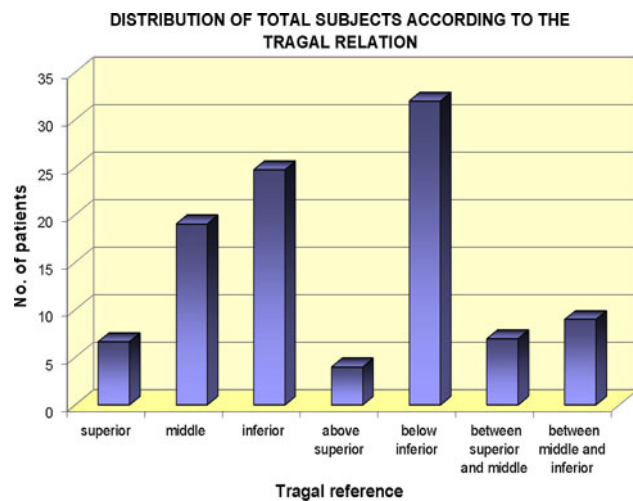
**Fig. 5** Bar diagram showing the distribution of female subjects according to the relationship of the tragus with the line passing through the base of the ala and parallel to the plane of occlusion in female subjects

retromolar pad, and Stenson’s duct; and bisecting the space between the residual ridges have been advocated [5–8].

The use of the ala-tragus line (Camper’s line) as a guideline has gained popularity within the profession since

**Table 1** Distribution of the patients according to the relationship of the tragus with the line passing through the base of the ala and parallel to the plane of occlusion for male and female subjects (in percentages)

	Superior no. (%)	Middle no. (%)	Inferior no. (%)	Above superior no. (%)	Below inferior no. (%)	Between superior and middle no. (%)	Between middle and inferior	Total
Male	1 (1.55%)	12 (18.46%)	17 (26.15%)	2 (3.08%)	24 (36.92%)	4 (6.15%)	5 (7.69%)	65
Female	6 (15%)	8 (20%)	9 (22.5%)	2 (5%)	8 (20%)	3 (7.5%)	4 (10%)	40
Total	7 (6.66%)	20 (19.05%)	26 (24.76%)	4 (3.82%)	32 (30.48%)	7 (6.66%)	9 (8.57%)	105



**Fig. 6** Bar diagram showing the distribution of total subjects according to the relationship of the tragus with the line passing through the base of the ala and parallel to the plane of occlusion in total subjects

it is easily visualized, thus making the determination of plane of occlusion more convenient. Many studies have been carried out to determine the relationship between the plane of occlusion and the Camper's plane.

A review of literature reveals that debate exists within the prosthodontic community over the exact definition of the ala-tragus or Camper's line. Most of the controversy revolves around which tragal reference is to be considered as a posterior landmark during orientation of the plane of occlusion. van Niekerk et al. [9] constructed the plane of occlusion according to their subjective criteria of esthetics, function, and comfort. The established plane of occlusion was then checked against the ala-tragus line only at the final denture insertion appointment. Their results showed a close relationship between the two planes if the tragal reference of the ala-tragus line was dropped to the inferior border of tragus.

A study carried out by Karkazis and Polyzois [11] also advocates the use of the inferior border of tragus as a posterior landmark. Their cephalometric study concluded that the ala-tragus line or the Camper's line extending from the lower margin of the ala to the inferior border of the external auditory meatus presented the closest relationship to the natural occlusal plane. According to them, the inferior border of tragus is an excellent equivalent soft tissue landmark to the lower border of external auditory meatus.

The tragon which is located at the superior margin of the tragus [12] is considered equivalent to the porion [13]. The average size of the tragus is 8–10 mm which is equal to the average size of the external acoustic meatus, i.e., 8 mm [14]. Therefore, it is safe to assume that the statement made by Karkazis and Polyzois [11] that the inferior

border of tragus is an equivalent soft tissue landmark to the lower border of the external auditory is correct.

Also, Clapp (1910), Dalby (1912), and Wilson (1917) have suggested that the plane of occlusion is parallel to a line drawn from the lowest point of external auditory meatus (which according to Karkazis and Polyzois [11] is equivalent to the inferior border of tragus) to the lowest point of the alae of the nose [15].

However, the findings of Solomon et al. [16–18] are not in agreement with the above conclusions. In their study, the ala-tragus line (Camper's plane) was found to be parallel to the plane of occlusion when the tragal reference point was situated between the superior border and middle of the tragus. The inferior border of the tragus served as a poor reference according to their study.

Within the subject population of our study, it was found that the tragal reference (as a posterior landmark to determine the plane of occlusion) was more towards the inferior of the tragus and then below inferior. This finding mirrors the findings of van Niekerk et al. [9], Karkazis and Polyzois [11], and Clapp et al. [15]. It may be suggested that the definition of the Camper's plane or ala-tragus line given in the Glossary of Prosthodontic Terms 8 [10] (i.e., 'established by the inferior border of the ala of the nose and the superior border of the tragus of the ear') needs revision based on the findings of our study.

It must also be emphasized that statistical analysis revealed that none of the seven tragal references selected could be safely assumed as a posterior reference point. This finding seriously questions the use of the ala-tragus line (Camper's plane) as an accurate guideline to the determination of the plane of occlusion in completely edentulous patients (inspite of its convenience). The authors have further investigated the accuracy of cephalometrics in determining the plane of occlusion in the next phase of this study.

## Conclusions

From the results of the study, the following conclusions can be drawn:

1. For the total number of subjects (105), the most common tragal reference as a posterior landmark for the orientation of the plane of occlusion was below inferior in 32 subjects (30.48%) followed by inferior in 26 subjects (24.76%).
2. The least common tragal reference for the total number of subjects was above superior in four subjects (3.82%), followed by superior and the reference point between the superior and middle in seven subjects each (6.66%).

3. While considering the total data, the tragal reference below the middle of the tragus (in total number of subjects) was 63.81% and if the middle of the tragus was included in this group, it was found to be 82.86%.
4. It could be concluded that the tragal reference in this study population was more towards the inferior of the tragus, with most of the times being below the inferior border.
5. Also, the tragal reference points of superior, above superior and between superior and middle in the total number of subjects were just 17.14%. Therefore, the orientation of the plane of occlusion with the posterior landmark as superior of tragus (Camper's plane) may be considered as questionable based on the findings of this study.
6. From the statistical analysis of the data, it could also be concluded that no single tragal reference could fulfill the criteria of being the posterior landmark for the orientation of plane of occlusion. Hence, the reliability of the tragus as a posterior landmark for the orientation of the plane of occlusion is questionable.

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