

# Evaluating the Relation of Posterior Occlusal Plane to Ala-Tragal Line According to Age and Sex

Safoura Ghodsi<sup>1</sup>, Soroush Sef Omrani<sup>2</sup>, Sara Mogharrabi<sup>2</sup>, Sara Valizadeh<sup>3</sup>

<sup>1</sup> Dental Research Center, Dentistry Research Institute, Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Department of Prosthodontics, School of Dentistry, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

<sup>3</sup> Restorative Dentistry Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

**Corresponding author:** Sara Valizadeh, Restorative Dentistry Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran;  
Email: valizadeh\_s@sina.tums.ac.ir

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## Abstract

**Introduction:** Occlusal plane orientation affects the esthetic, function, and success of removable or fixed prostheses. The most prevalent index for determination of this plane is the ala-tragus line while there are controversies in the exact location of tragus reference point.

**Aims:** This study aimed to determine the best point on tragus as the posterior reference of ala-tragal line in relation to occlusal plane according to age and sex.

**Materials and methods:** The study included 136 participants of both sexes who were randomly divided into three age groups: 20-35, 36-50, and older than 50. Fox plane was stabilized on incisal edge-occlusal table of maxillary teeth. A lateral photograph was obtained from each participant sitting in predetermined standard position. Using Auto-Cad software, three lines were traced from nasal ala base to superior, middle, and inferior borders of the tragus, and evaluated for being parallel to occlusal plane.

**Results:** The coordination between occlusal plane and ala was 20.5% for superior, 35.6% for middle, and 43.9% for inferior border of tragus. There was a significant difference in the relationship between sex and plane position ( $p=0.003$ ), while the relationship between age and plane could not reach statistical significance ( $p=0.65$ ). The results were analyzed using chi-square test, and ANOVA ( $p<0.05$ ).

**Conclusions:** Ala-inferior border of tragus line was the most parallel, and ala-superior border of tragus line was the least parallel line to the occlusal plane. The parallelism between occlusal plane and ala-superior border was more prevalent in women, while the men demonstrated significantly more parallelism with inferior border of tragus.

## Keywords

complete denture, dental prosthesis, jaw relation record, occlusal plane

## INTRODUCTION

Edentulism is a pervasive problem all around the world.<sup>[1]</sup> There are various treatment options available for partial or complete edentulism including fixed or removable pros-

thetic options.<sup>[2]</sup> In all the treatment options, the occlusal plane orientation is one of the factors that affects the esthetics, function, and success of prosthesis<sup>[3]</sup>, and the major reference for maxillary teeth arrangement<sup>[4]</sup>. The occlusal plane is defined as a hypothetical plane which coincides

with the incisal edges of maxillary central incisors and mesiopalatal cusps of first maxillary molars.<sup>[3]</sup> This plane helps in normal deglutition and respiration, supplies mechanical, esthetic, and phonetic needs<sup>[5]</sup>, and determines the position and angulation of teeth settlement for prosthetic rehabilitations. Different anatomical landmarks suggested to determine the correct position and orientation of occlusal plane include upper lip, lip commissures<sup>[6]</sup>, lateral borders of the tongue, retromolar pad<sup>[7]</sup>, hamular notch, incisal papilla, and parotid papilla.<sup>[8,9]</sup> However, one of the most prevalent indices is the ala-tragus line<sup>[10,11]</sup>, which connects the auditory meatus to the ala of the nose<sup>[4]</sup>. The confusing variations that exist in the ala-tragus line definition go mainly back to disagreement about the exact location of the posterior reference point.<sup>[12,13]</sup> Some authors believe the superior border of tragus is the correct posterior reference point<sup>[14,15]</sup>, while the others introduce middle<sup>[16-18]</sup>, or even inferior point as the correct posterior reference.<sup>[19]</sup> On the other hand, different studies show conflicting results regarding the relationship between occlusal plane and available indices (**Table 1**).<sup>[2,4,12,13,20-25]</sup> Meanwhile, the relation between available occlusal plane of dentate patients and ala-tragus line could be the best guide to find the correct orientation of this questionable plane to be used in edentulous patients who missed the predetermined indices relationships.

## AIM

The present study aimed to determine which point of tragus plays the best role as the posterior reference of ala-tragus line according to the plane orientation in dentate patient, and evaluate if there are any differences according to age and sex. The null hypotheses were that the mid-tragus point was the best posterior index for ala-tragus line and there was no difference between different age and sex groups for the relation of occlusal plane and ala-tragus line.

## MATERIALS AND METHODS

The present descriptive epidemiological study was carried out on 136 participants each giving their informed consent prior to their inclusion in the study. The study protocol was registered and approved in institutional Ethics Committee (IR.JSUMS.REC.1395.483). The study was performed in full compliance with the ethical standards of the revised Helsinki Declaration, and the information and photographs we saved were confidential.

The participants were divided into 2 groups based on their sex. Each group was divided into three subgroups by age: young adults (20-35 years old), middle aged (36-50 years), and old aged (more than 50 years). The inclusion criteria included systemically healthy participant with class-I Angle classification of occlusion, without skin diseases, periodontal diseases, or bone problems; existence of

enough posterior maxillary teeth to determine the occlusal plane without interfering supra-eruption or drift; and lack of any history of orthodontic treatments, orthognathic problems, and facial or temporomandibular joint surgery.

A sterilized Fox plane was held in touch with the incisal edge of maxillary central incisors and first molar palatal cusps while the head was stabilized in chin part of panoramic radiographic system, and the Frankfort plane was kept parallel with the horizontal plane. This adjustment was confirmed using a horizontal line traced on the wall behind the patient's head. The Frankfort plane was kept parallel to the line by looking through the camera at the level of the mentioned line. Lateral photographs were taken from 1-meter distance, perpendicular to profile and at proper height for every participant. The position and distance of each patient's head was adjusted by the fixed distance between the chin positioner of panoramic system and the camera. Afterwards, three lines were traced by Auto-cad software (Autodesk Inc., California, USA) connecting inferior border of ala to either inferior, middle, or superior border of tragus on each photograph (**Fig. 1**). Auto-cad data were analyzed by SPSS (SPSS Inc, Illinois, Chicago) using chi-square test, and one-way ANOVA test ( $p<0.05$ ).



**Figure 1.** Different tragus lines plan.

## RESULTS

The study was conducted with 136 participants, 81 men (58.9%) and 55 women (41.1%), with the mean age of 32.5 years (range 18-73 years). **Table 2** summarizes the descriptive results on parallelism percentage of occlusal plane and ala-tragus line traced in different orientations. The occlusal plane showed higher percentage of parallelism with ala-tragus line traced to the inferior border of tragus in men. The highest percentage for parallelism in women was seen with superior border of tragus while this position showed the least percentage of parallelism in men. In other words, the parallelism between the occlusal plane and ala-superior border was more prevalent in women, while the men

**Table 1.** Review of the available literature on comparing parallelism of occlusal plane and Camper line

Author	Index for comparison	Parallelism percentage/ mean of angle	Results
Priest <sup>[4]</sup>	Horizontal plane	+3.25	Both horizontal plane and ALT1 (superior border of tragus) were parallel to occlusal plane
	ALT1	+3.03	
	ALT3	-4.09	
Shetty <sup>[20]</sup>	ALT1	12.1%	In a large number of subjects, the occlusal plane was parallel to ALT3.
	ALT2	24.7%	
	ALT3	50.8%	
Nayar <sup>[2]</sup>	AT-S	5.8	No parallelism exists between the occlusal plane and the ala-tragus line, but AT-I was the most parallel line to the occlusal plane.
	AT-M	4.8	
	AT-I	4	
Quran <sup>[21]</sup>	Camp I	2.1	The most common place for posterior reference point of ala-tragal line was the superior border
	Camp II	3.2	
	Camp III	6.2	
Hinducha <sup>[12]</sup>	Superior	6.66%	The most common place for posterior reference point of ala-tragal line was the sub inferior and then the inferior border.
	Middle	19.05%	
	Inferior	24.76%	
	Above superior	3.82%	
	Below inferior	30.48%	
	Between superior and middle	6.66%	
Lahori <sup>[22]</sup>	Between middle and inferior	8.57%	The most parallel line to the occlusal plane was ALT2 in Cl I and Cl II participants and ALT3 in Cl III ones.
	Sub inferior border		
	Inferior border		
Sheikh <sup>[23]</sup>	Superior border		There was a significant relationship between age and occlusal plane; inferior border in young adults and superior border in old people is the reference line.
	ALT1		
	ALT2		
Shigli <sup>[13]</sup>	ALT3		The most parallel line to OP was middle border and the least one was superior border.
	Superior		
	Middle		
Chaturvedi <sup>[24]</sup>	Inferior		There was not significant relationship between sex and occlusal plane. The inferior point marked on tragus is the most appropriate point for marking the ala-tragus line.
	SA plane		
	MA plane		
Kumar <sup>[25]</sup>	IA plane		AT <sub>3</sub> (inferior border) was the most parallel line to the occlusal plane. There was no relationship between sex and occlusal plane
	AT <sub>1</sub>	16.44±2.08	
	AT <sub>2</sub>	13.67±1.93	
	AT <sub>3</sub>	10.31±2.03	

ALT1: Ala to superior border of tragus line; ALT2: Ala to middle border of tragus line; ALT3: Ala to inferior border of tragus line

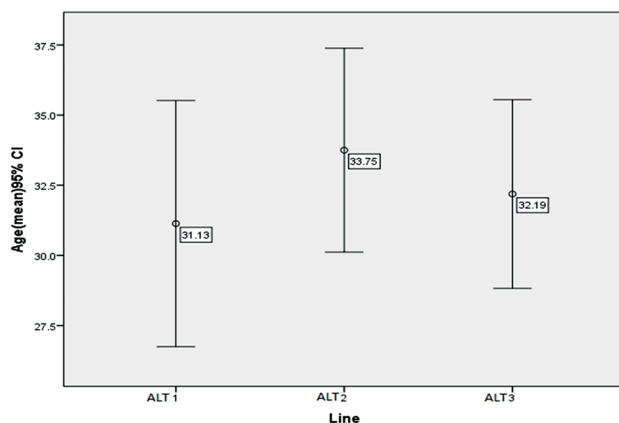
**Table 2.** Descriptive results for parallelism percentages

Different orientations of ala-tragus line	Parallelism percentage		
	Overall	Men	Women
Superior border (ALT1)	20.5%	11.7%	35%*
Middle point (ALT2)	35.6%	35.9%	34%
Inferior border (ALT3) *	43.9%	52.4%*	31%

\* Statistically significant; ALT1: Ala to superior border of tragus line; ALT2: Ala to middle border of tragus line; ALT3: Ala to inferior border of tragus line

demonstrated significantly greater parallelism with the inferior border of tragus. The parallelism percentages were closer for different posterior border positions in women while the men showed more variations. Generally, inferior tragus border had higher percentages of parallelism and superior border had the least.

Chi-square test showed a statistically significant difference for parallelism percentages in different genders ( $p=0.003$ ). The relationship between age and occlusal plane was not statistically significant ( $p=0.65$ ) (Fig. 2).



**Figure 2.** Age group comparison of lines parallelism. ALT1: Ala to superior border of tragus line; ALT2: Ala to middle border of tragus line; ALT3: Ala to inferior border of tragus line.

## DISCUSSION

Finding the correct orientation of occlusal plane helps to gain an index pattern to arrange the artificial teeth in their natural positions, and consequently provides the best lip support, esthetic, and function in any type of prosthesis.

The present study investigated the relationship between occlusal plane and different ala-tragus orientations. The null hypotheses were partially rejected since there was significant difference for the occlusal plane orientation in the different sexes, and the results confirmed higher percentages for parallelism with ala-tragus line traced from inferior border of tragus compared to superior or middle border; the general results were in accordance with the results reported by Shetty et al.<sup>[3]</sup>, Nayar et al.<sup>[2]</sup>, Hindocha et al.<sup>[12]</sup>, Chaturvedi et al.<sup>[24]</sup>, and Kumar et al.<sup>[25]</sup>, while in opposition to the results obtained by Priest et al.<sup>[4]</sup>, Firas<sup>[21]</sup>, Lahori et al.<sup>[22]</sup>, Sheikh et al.<sup>[23]</sup>, and Shigli et al.<sup>[13]</sup> The variations in the results of these studies could be attributed to race difference that calls for further studies, and using different index points in different race groups.

Considering the participant sex, the difference was also statistically significant ( $p=0.003$ ); the superior border of tragus was preferred as posterior reference point in women, while the inferior border showed better results in men for tracing the ala-tragus line.

This study also evaluated the relationship between ala-tragal line and occlusal plane in different age groups and found no statistically significant difference ( $p>0.05$ ). Kumar et al. reported no significant relationship between age and the angle between Camper (ala-tragal plane) and occlusal plane<sup>[25]</sup>; however, Sheikh et al. reported significant differences between the ala-tragal line orientation and age.<sup>[23]</sup> Their results suggested the inferior border of tragus as the preferred reference point in young adults while the middle point was preferred in aged individuals.

Occlusal plane redetermination should be based on dynamic functional requirements. The posterior occlusal plane in natural dentition is oriented to coordinate with temporomandibular joint, masticatory muscles, and dynamics of mastication. Static criteria help us to find the lost plane orientation resulting from posterior tooth loss. The determined plane could be used for complete or partial fixed or removable prostheses supported by either teeth or implants. However, different studies suggest possible effects of age, sex, and nationality on plane routine determinants. Comparison by considering only two determinants (age and gender) is one of the limitations of the present study that could be a subject for further study on other determinants. The controversies call for further extensive studies to register special criteria for selecting the best orientation compatible with all available structural and functional determinants.

## CONCLUSIONS

Considering the limitation of present study, the following conclusion can be made:

1. The occlusal plane showed the highest percentage of parallelism with ala-tragus line traced from tragus inferior border (43.9%); the percentage was 35.6% for middle tragus line, and 20.5% for the line traced from superior border.
2. Comparing different lines orientations, the difference between parallelism percentage was statistically significant ( $p<0.05$ ), and inferior border line showed significantly higher parallelism with occlusal plane.
3. Considering the participants' sex, the difference was statistically significant ( $p=0.003$ ); the application of superior border of tragus as posterior reference point is preferred in women, while the inferior border is suggested as reference in men for ala-tragus line.
4. Age has no statistically significant effect on the results obtained for the parallelism of ala-tragus (Camper) line with occlusal plane ( $p=0.65$ ).

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# Оценка отношения задней окклюзионной плоскости к алатрагальной линии в зависимости от возраста и пола

Сафура Годси<sup>1</sup>, Соруш Сеф Омрани<sup>2</sup>, Сара Могараби<sup>2</sup>, Сара Вализадех<sup>3</sup>

<sup>1</sup> Стоматологический исследовательский центр, Стоматологический исследовательский институт, Кафедра ортопедической стоматологии, Факультет стоматологии, Тегеранский университет медицинских наук, Тегеран, Иран

<sup>2</sup> Кафедра ортопедической стоматологии, Факультет стоматологии, Университет медицинских наук им. Ахваза Джундишапура, Ахваз, Иран

<sup>3</sup> Кафедра терапевтической стоматологии, Факультет стоматологии, Тегеранский университет медицинских наук, Тегеран, Иран

**Адрес для корреспонденции:** Сара Вализадех, Кафедра терапевтической стоматологии, Факультет стоматологии, Тегеранский университет медицинских наук, Тегеран, Иран; Email: valizadeh\_s@sina.tums.ac.ir

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## Резюме

**Введение:** Ориентация окклюзионной плоскости влияет на эстетику, функциональность и эффективность съёмных или несъёмных протезов. Наиболее распространённым показателем для определения этой плоскости является алатрагальная линия, в то время как существуют разногласия по поводу точного расположения точки отсчёта козелка.

**Цели:** Это исследование было направлено на определение наилучшей точки на козелке в качестве задней точки отсчёта алатрагальной линии по отношению к окклюзионной плоскости в зависимости от возраста и пола.

**Материалы и методы:** В исследование были включены 136 человек обоего пола, которые были случайным образом разделены на три возрастные группы: 20-35 лет, 36-50 лет и старше 50 лет. Плоскость Фокса стабилизировали на резцово-окклюзионном столике зубов верхней челюсти. Боковая фотография была получена от каждого участника, сидящего в заранее определённом стандартном положении. С помощью программного обеспечения Auto-Cad были проведены три линии от основания крыла носа до верхней, средней и нижней границ козелка и оценены на предмет их параллельности окклюзионной плоскости.

**Результаты:** Координация между окклюзионной плоскостью и крылом составила 20.5% для верхней, 35.6% для средней и 43.9% для нижней границы козелка. Выявлена достоверная разница в зависимости между полом и положением плоскости ( $p=0.003$ ), в то время как связь между возрастом и положением плоскости не могла достичь статистической значимости ( $p=0.65$ ). Результаты анализировали с использованием критерия хи-квадрат и ANOVA ( $p<0.05$ ).

**Заключение:** Наиболее параллельна линия крыло-нижняя граница козелка, а наименее параллельна окклюзионной плоскости – крыло-верхняя граница козелка. Параллелизм между окклюзионной плоскостью и верхним краем крыла был более выраженным у женщин, в то время как мужчины демонстрировали значительно больший параллелизм с нижним краем козелка.

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## Ключевые слова

полный съёмный протез, зубной протез, соотношение челюстей, окклюзионная плоскость

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