

RELATIONSHIP BETWEEN THE OCCLUSAL PLANE AND THREE DIFFERENT LEVELS OF ALA-TRAGUS LINE IN A SAMPLE OF SUDANESE ADULTS

Relación entre el plano oclusal y tres niveles diferentes de la línea ala-trago en una muestra de adultos sudaneses

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ABSTRACT

Aim: Correct orientation of the occlusal plane plays a vital role in achieving the perfect occlusal balance and function of complete dentures. This study aimed to evaluate the most reliable posterior reference point of the ala-tragus line (ATL) concerning occlusal plane (OP) in a sample of the dentate Sudanese population.

Materials and Methods: A total of 150 subjects with healthy and well-aligned permanent teeth were randomly selected. Right lateral profile photographs were taken with subjects having a fox plane placed intra-orally, contacting the occlusal plane. Reference points corresponding to inferior, middle, and superior borders of the tragus and inferior border of the ala of the nose were marked on photographs. The angles between the lines were measured using the Auto-CAD software program, and the most parallel relationship was determined. Descriptive statistics in terms of means and standard deviations were presented. Independent t-test and one-way ANOVA tests were used to compare as appropriate. A p -value < 0.05 was considered significant.

Results: The mean angle formed by the OP and ATL was $8.5 \pm 3.69^\circ$ for the superior level, $4.68 \pm 3.13^\circ$ for the middle line, and $2.89 \pm 2.57^\circ$ for the inferior line. A significant difference was found between the means of the three angles ($p < 0.001$), while no significant difference ($p > 0.05$) was found between both genders regarding the measured angles.

Conclusions: The line joining the inferior border of the ala of the nose with the inferior border of the tragus of the ear was the most reliable line in terms of parallelism to determine the occlusal plane orientation.

Keywords: Occlusal plane; Denture, complete; Prosthodontics; Anatomic landmarks; Cephalometry; Sudan.

RESUMEN

Antecedentes: La orientación correcta del plano oclusal juega un papel vital para lograr el equilibrio oclusal perfecto y la función de las prótesis completas. Este estudio tuvo como objetivo evaluar el punto de referencia posterior más confiable de la línea ala-trago (ATL) con respecto al plano oclusal (OP) en una muestra de la población dentada de Sudán.

Materiales y Métodos: Se seleccionaron aleatoriamente un total de 150 sujetos con dientes permanentes sanos y bien alineados. Se tomaron fotografías de perfil lateral derecho de sujetos a los que se les colocó un plano de zorro intraoralmente, en contacto con el plano oclusal. En las fotografías se marcaron los puntos de referencia correspondientes a los bordes inferior, medio y superior del trago y al borde inferior del ala de la nariz. Los ángulos entre las líneas se midieron utilizando el programa de software Auto-CAD y se determinó la relación más paralela. Se presentaron estadísticas descriptivas en términos de medias y desviaciones estándar. Se utilizaron prueba-t independiente y prueba ANOVA unidireccional para las comparaciones, según correspondiera. Se consideró significativo un valor de $p < 0,05$.

Resultados: El ángulo medio formado por OP y ATL fue de $8,5 \pm 3,69^\circ$ para el nivel superior, $4,68 \pm 3,13^\circ$ para la línea media y $2,89 \pm 2,57^\circ$ para la línea inferior. Se encontró una diferencia significativa entre las medias de los tres ángulos ($p < 0,001$), mientras que no se encontró diferencia significativa ($p > 0,05$) entre ambos sexos con respecto a los ángulos medidos.

Conclusión: La línea que une el borde inferior del ala de la nariz con el borde inferior del trago de la oreja fue la línea más confiable en términos de paralelismo para determinar la orientación del plano oclusal.

Palabras Clave: Oclusión dental; Dentadura completa; Prostodoncia; Puntos anatómicos de Referencia; Cefalometría; Sudán.

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INTRODUCTION

The construction of a complete denture for edentulous patients is one of the most challenging parts of dentistry. One of these challenges is establishing a functional occlusal plane in harmony with the dentofacial structures.¹ The orientation of the occlusal plane must be as close as possible to the plane, which was previously occupied by natural dentition,² as this position improves denture stability, restores the original patient's appearance, and is necessary for normal function.³

The high occlusal plane interferes with the tongue position, prevents stability of the mandibular denture, and increases the tendency to accumulate food in buccal and lingual areas.⁴ According to esthetic requirements, the occlusal plane established anteriorly should be parallel to the interpupillary line.⁵ For the posterior part, the most commonly used landmarks are Camper's line (ala-tragus line), hamular notch incisive- papilla plane, and 3.3mm below the parotid papilla, lateral border of the tongue, corner of the mouth, and 2/3 height of the retromolar pad area.⁶ Among all, the ala-tragus line is considered the most commonly used reference.⁷

To analyze the level of ala-tragus line, various instruments have been used such as bite plane leveler, J plane, Camper's plane indicators, occlusal plane analyzer, and, recently, occlusal plane oriental.⁸⁻¹⁰ Currently, there is no consensus on a single precise, scientific method for determining the level of

the occlusal plane during complete denture construction for edentulous patients.¹¹

There is also the controversy of the occlusal plane orientation using ala-tragus line due to disagreement on the exact point of reference for the posterior landmark, and several researches were done to determine the exact position on the tragus that can be used as the correct guide for the orientation.¹²

Hence, it seems important to evaluate the most appropriate ATL for each population. Therefore, the aim of this study was to evaluate the most reliable posterior reference point of ATL in relation to the occlusal plane in a sample of dentate Sudanese population.

MATERIALS AND METHODS

This cross-sectional photograph-based study was carried out in the Department of Prosthodontics, Faculty of Dentistry at the University of Khartoum.

A total of 150 subjects were randomly selected (31 males and 119 females). Inclusion criteria were: minimum age of 18 years, full dentition, orthognathic profile, and class I molar relationship. The exclusion criteria were: subjects with occlusal discrepancies or previous history of orthodontic treatment, missing teeth other than the third molar, symptoms of temporomandibular disorders, facial asymmetries, congenital facial defects, and presence of advanced periodontal diseases.

Also, history of facial trauma, presence of fixed/removable prosthesis, cleft, dentofacial

acquired or developmental defects, and defects in the ala or tragus. Before commencing the study, the purpose of the study was explained to each participant, and written consent was obtained.

Subjects were asked to sit in an upright position with their back straight and head unsupported, with the fox-plane held intraorally using both thumb fingers so that it touched the incisal edges and cusps of left and right upper teeth. Right lateral profile photographs were taken for all subjects with a digital camera (Canon EOS 600 D, 18 megapixels, EF lens, Tokyo, Japan).

The setting of the camera was set to default and the source of light was sunlight. For standardization, the height of the camera was adjusted and mounted on an adjustable tripod and kept at a distance of one meter at the level of the midsagittal line of the subject.

All photographs were transferred to the computer for angle measurements. The three points on the tragus (superior, middle, and inferior) were marked, and then the angular measurements to check the parallelism were recorded using the software Auto-CAD program (version 2016).

The following lines were connected on the photograph using the program:

Occlusal plane (fox-plane);

Ala of the nose and the superior border of the tragus (ATLs);

Ala of the nose and the tip (middle) of the tragus (ATLm);

and ala of the nose and the inferior tragus (ATLi).

The angles were measured between the occlusal plane and these three lines in the program (Figure 1). Descriptive statistics in terms of means and standard deviations were presented. An independent t-test was used for comparison between males and females. One-way ANOVA for inter-comparison between the measurements was conducted. A *p*-value < 0.05 was used to find out the level of statistical significance.

RESULTS

Among the 150 participating subjects, there were 79.3% females and 20.7% males. The mean angle measured between the occlusal plane and ATLs was found to be the highest (8.05 ± 3.69) followed by the

Table 1. Means, SD, minimum, and maximum of the angles between occlusal plane and different levels of ala-tragus line.

Level	N	Mean	SD	Minimum	Maximum
Superior	150	8.05	3.69	0	18
Middle	150	4.68	3.13	0	14
Inferior	150	2.89	2.57	0	11

SD: Standard Deviation.

Table 2. Frequencies and cumulative percentages of the different measured angles with the different levels of ala-tragus line.

Angle	Superior		Middle		Inferior	
	Frequency (%)	Cumulative Percent	Frequency (%)	Cumulative Percent	Frequency (%)	Cumulative Percent
0	3 (2.0)	2.0	16 (10.7)	10.7	34 (22.7)	22.7
1	3 (2.0)	4.0	14 (9.3)	20.0	18 (12.0)	34.7
2	1 (0.7)	4.7	8 (5.3)	25.3	24 (16.0)	50.7
3	13 (8.7)	13.3	17 (11.3)	36.7	24 (16.0)	66.7
4	8 (5.3)	18.7	17 (11.3)	48.0	10 (6.7)	73.3
5	11 (7.3)	26.0	22 (14.7)	62.7	19 (12.7)	86.0
6	12 (8.0)	34.0	17 (11.3)	74.0	6 (4.0)	90.0
7	11 (7.3)	41.3	13 (8.7)	82.7	4 (2.7)	92.7
8	20 (13.3)	54.7	9 (6.0)	88.7	5 (3.3)	96.0
9	13 (8.7)	63.3	6 (4.0)	92.7	4 (2.7)	98.7
10	17 (11.3)	74.7	4 (2.7)	95.3	1 (0.7)	99.3
11	13 (8.7)	83.3	3 (2.0)	97.3	1 (0.7)	100.0
12	10 (6.7)	90.0	2 (1.3)	98.7	Na	Na
13	5 (3.3)	93.3	1 (0.7)	99.3	Na	Na
14	5 (3.3)	96.7	1 (0.7)	100.0	Na	Na
15	1 (0.7)	97.3	Na	Na	Na	Na
16	2 (1.3)	98.7	Na	Na	Na	Na
18	2 (1.3)	100.0	Na	Na	Na	Na
Total	150 (100.0)		150 (100.0)		150 (100.0)	

Table 3. Pairwise comparison between both genders for each level.

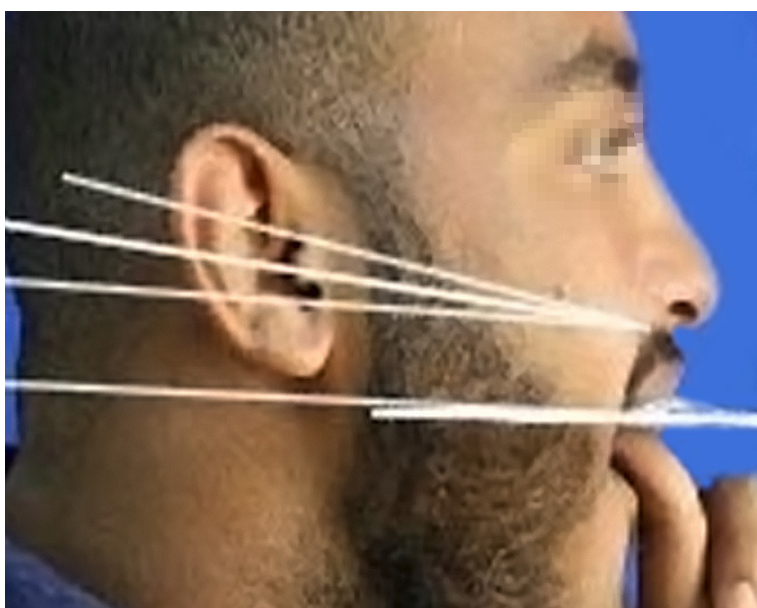
		Mean±SD	Mean Difference	95% Confidence interval of the Difference		t (df) degrees of freedom	p-value
				Lower	Upper		
Superior	Male	8.13±3.45	0.10	-1.38	1.57	0.13 (148)	0.898
	Female	8.03±3.76					
Middle	Male	4.77±2.65	0.12	-1.13	1.37	0.19 (148)	0.852
	Female	4.66±3.26					
Inferior	Male	2.65±2.50	-0.31	-1.34	0.71	-0.60 (148)	0.548
	Female	2.96±2.60					

Table 4. One-way ANOVA test for comparison between the levels.

		Mean Difference	95% CI of the difference		p-value
			Lower	Upper	
Superior	Middle	3.37	2.51	4.23	0.000
	Inferior	5.16	4.30	6.02	0.000
Middle	Inferior	1.79	0.93	2.65	0.000

F: 102.89; $p < 0.001$). **ANOVA test:** Sum of Squares= 2059.86. **CI:** Confidence interval.

Figure 1. Photograph illustrating the three points on the tragus (superior, middle, and inferior) and the angular measurements: occlusal plane (fox-plane); ala of the nose and the superior border of the tragus (ATLs); ala of the nose and the tip (middle) of the tragus (ATLm); and ala of the nose and the inferior tragus (ATLi). The angles were measured between the occlusal plane and these three lines using a software program.



angle formed between the occlusal plane and ATLm (4.68 ± 3.13), and the angle when the inferior level of the tragus was considered gave a mean of (2.89 ± 2.57) which was the lowest or nearest to parallel (Table 1).

The frequency of subjects who had their occlusal plane absolutely parallel to the ATLs line were only 3 subjects (2.0%), while 16

(10.7%) subjects had the absolute parallelism to ATLm line, and 34 (22.7%) subjects had their occlusal plane parallel to the ATLi line.

Considering that parallelism of ≤ 5 is clinically acceptable, the cumulative percentage of the inferior level was the highest, where 86% of the sample were within this range, followed

by the cumulative percentage of the middle level (62.7%), while the lowest cumulative percentage was with the superior level (26.0%), Table 2. No statistically significant differences ($p > 0.05$) between both genders were found in relation to all levels (Table 3). One-way ANOVA showed statistically significant differences ($P < 0.001$) between the measured angles at all three levels (Table 4).

DISCUSSION

The position of the occlusal plane forms the basis of the ideal tooth arrangement. It fulfills the necessary mechanical, esthetic, and phonetic requirements, which aids respiration and deglutition in complete denture patients.

It is essential to locate the occlusal plane in edentulous patients accurately. It is established anteriorly according to esthetics and function and posteriorly determined separately by using different landmarks.⁸

The ala tragus line remains the most commonly used provisional extraoral landmark to guide establishing the correct posterior occlusal plane orientation.⁶ There is still some confusion in the definition of the ATL because of the existing controversy in the determination of the exact posterior reference point for this line. Hence, this study was carried out to evaluate the most reliable posterior reference point of the ATL line in relation to the occlusal plane in the Sudanese population.⁹

Previous studies gave conflicting results regarding the orientation of the occlusal plane. In Iranians, the superior border of the tragus was considered the best posterior reference point; in Lebanese, the inferior border was found to be the best reference point, while in Indians, several researchers reported different results.⁹⁻¹¹

This study was a photographic evaluation used to define the most suitable posterior reference point used for orientation of the occlusal plane in dentate Sudanese individuals. The subjects' age ranged from 19-24 years. By the age of 18 the growth of the face is considered completed, and there is no change in the relationship of the ala tragus line.⁶

The technique used was standardized and straightforward; when taking measurements from two-dimensional images of three-dimensional objects, three types of errors may develop, namely; errors of projection, mechanical errors in drawing lines between points, and errors of landmark location. Projection errors were reduced by the use of angular measurement because the values of the angles remain constant regardless of the enlargement factors. Errors introduced in drawing the lines and measuring the angles manually were eliminated by using machine computation (AutoCAD program).⁶

The results of this study revealed that the mean angle between the line connecting the ala of the nose with the inferior border of the tragus and the occlusal plane has the lowest deviation from zero degrees and is

considered more parallel, followed by the middle and the superior border of the tragus respectively. Therefore, the inferior border of the tragus was the most acceptable posterior reference point of the ala-tragus line for occlusal plane orientation in the Sudanese population.

This finding is in agreement with the results of studies carried out by Rathod *et al.*,¹² Karkazis *et al.*,¹³ Ghosn *et al.*,⁹ and Van Niekerk *et al.*,¹⁴ all of them advocated the use of inferior border of the tragus.

On the other hand, the findings of Ismail *et al.*,⁵ Krishna *et al.*,¹⁰ Bondekar *et al.*,¹⁵ and Shigli *et al.*,¹⁶ suggested the use of the middle part of the tragus while Madhav, Gupta *et al.*,⁸ and Sadr *et al.*,¹¹ suggested the superior border of the tragus to be the reference point.¹⁷ These differences might be related to the ethnic differences in dimensions and shapes of face and skull.

There was no statistically significant difference between the mean values recorded for both genders. This is in agreement with the results of the study conducted by Kumar *et al.*,⁶ Whereas Gupta *et al.* reported that the posterior reference point of the ala tragus line and its parallelism to the occlusal plane varies in males and females. In males, it was the middle border of the tragus, while it was the superior border of tragus for females.⁸

The current investigation should be beneficial for both students and practitioners to clarify the most reliable location of the posterior reference point of ATL during the jaw relation step for complete denture

construction. This study was conducted in a small population; the results may vary with morphological changes, older age, or various maxillomandibular relationships. Another limitation of this study is that the measurements were performed in participants with skeletal class I.

Thus, it is recommended to further investigate the relationship between ala-tragus lines and occlusal planes among participants with different classifications of the skeletal malocclusion (e.g., class II and III) and with appropriate distribution of the gender.

CONCLUSION

Within the limitation of the current study, it can be concluded that the ATL line as an extraoral landmark is relatively considered parallel to the occlusal plane of a dentate Sudanese population.

The inferior border of the tragus was found as the most reliable posterior reference point for the ATL. Gender does not influence the level of the occlusal plane.

CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL

Informed consent was obtained from all participants.

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AUTHORS' CONTRIBUTIONS

Ismail I: Conceptualization and study design, Methodology, Validation, Writing-Review & Editing, Visualization, Supervision, Project administration.

Ahmed M: Conceptualization and study design, Data collection, Formal analysis, Writing-Original Draft.

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