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EVALUATION OF OCCLUSAL PLANE PARALLELISM AT DIFFERENT LEVELS OF ALA-TRAGAL LINES IN DIFFERENT AGE GROUPS USING PHOTOGRAPHIC AND CEPHALOMETRIC METHOD IN DENTULOUS AND EDENTULOUS PATIENTS-AN IN VIVO STUDY

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ABSTRACT

Precise orientation of the occlusal plane plays a vital role in providing optimal esthetic, phonetics and mastication. It has been a great deal of controversy regarding the anatomic reference point taken in identifying ala-tragus line to which the occlusal plane is oriented parallel while making complete denture.

Purpose: To determine accurately the part of tragus to be used to form the ala-tragus line or camper's line while establishing the occlusal plane by comparing dentulous and edentulous patient using photographic and cephalometric methods.

Methodology: Total 60 subjects were selected and divided into two groups dentulous and edentulous. Downs analysis was used for base value. Lateral cephalogram and life size lateral profile photographs in natural head position were taken in all subjects. Three points were marked on tragus as superior, Middle and inferior and were joined with ala of the nose to form ala-tragus lines. The angle formed by each line with FH plane was measured. In dentulous subjects angle between FH plane and the natural occlusal plane was measured both in lateral cephalogram and life size lateral profile photographs. The obtained result was subjected to descriptive analysis and unpaired t-test.

Result and conclusion: The present study revealed that in dentulous and edentulous subjects, the line drawn from the ala of the nose to the inferior part of the tragus was relatively parallel to occlusal plane both in lateral cephalogram and lateral profile photograph. There is no significant difference found between angle measured on lateral cephalogram and profile photograph.

INTRODUCTION

Developing an occlusion that is compatible with functional movements of stomatognathic system is one of the crucial factors in determining the prognosis of the completely edentulous patient. One of the important step that help us in the establishment of ideal occlusion is the orientation of the occlusal plane.

The correct orientation of the occlusal plane plays a vital role in optimal esthetic achievement. In natural smile, the incisal tips follows the curve of the lower lip. This effect is an expression of a correctly oriented occlusal plane; if the plane hangs posteriorly, the lip-line viewed from the front will appear straight and contribute more than any other factor to the so–called "denture look". When the occlusal plane is correctly oriented, the natural anterior curve will be achieved almost automatically and contribute proper sense of perspective to the dental composition.[1] From the functional point of view, the plane of the occlusion forms an essential part of the concept of mechanically balanced articulation. The position of occlusion plane in denture wearer should be as close as possible to the plane, which was previously occupied by natural teeth. Such position of the occlusal plane provides normal function of the tongue and cheek muscles, thus enhancing the denture stability.[1]

The occlusal plane in anterior and posterior regions may vary and therefore, these should be evaluated separately. It is generally agreed that in the anterior region, the vertical height of the occlusal plane is governed by the esthetics requirements and less frequently by the functional demands.[2] It may be determined by lip relationships at the rest and when smiling. Speech also provides for positional accuracy. When viewed from the front, anterior occlusal plane should be parallel to the

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interpupillary line.[3] On the other hand, there are contrasting views in regards to the orientation of occlusal plane in posterior region. Over the years, various intraoral and extra oral landmarks had been used to determine and orient the occlusal plane which include:

- Establishing the occlusal plane parallel to the ala-tragus line.[4]
- Positioning the occlusal plane parallel to and midway between the residual ridges.[5]
- Positioning it at the level of lateral border of the tongue.[6]
- Terminating the occlusal plane posteriorly at the middle or upper 3rd of the retromolar pad.[6]
- Orienting the occlusal plane with the buccinator grooves and commissure of lips.[7]

However, the most acceptable method of orienting the occlusal plane is to make it parallel to the ala-tragus or camper's line as reported in several modern text books. In spite of its widespread acceptability, it is astonishing to note that the exact location of the point on tragus while marking ala-tragus line is unclear. This has created lots of confusion while selecting a point for marking ala-tragus line. So this study was therefore undertaken to decide the most appropriate point on tragus to be used as a reference point while marking ala-tragus line.

HOFRATH, a german prosthodontist shares an honour of introducing cephalometry in dentistry along with an American orthodontist, BROADBENT, is considered as a gold standard for establishing a spatial relationship between the various parts of the craniofacial and dental structures.[8] But there are certain limitations to cephalometry for example patient's who have cephalograms taken absorb small amounts of radiations, second, cephalometrics requires a radiation source and a head holder to make the technique accurate. Therefore, it would be beneficial to have a low cost, low technology technique to determine the plane of occlusion. Lateral profile photographs can be used to measure the facial landmarks. In fact photographic evaluation of craniofacial characteristics has been already profitably utilized in orthodontics and other fields in dentistry and showed to be acceptably reproducible in earlier studies.[9,10] Recent developments of digital photography and wide use of personal computers have made these technique inexpensive and readily available, also do not expose the patient to potentially harmful radiation. Photographs are widely used for documentation and treatment planning in dental profession. Also it used in digital smile designing. Due to wide application of photography in dental field, the goal of current study is whether the occlusal plane measurement on digital photographs were reliable or not for the reconstruction of the occlusal plane.

Objectives of present study

- To evaluate the relation of ala-tragus line from three different parts of tragus to occlusal plane and FH plane in dentulous patients in lateral cephalogram.
- To evaluate the relation of ala-tragus line from three different parts of tragus to FH plane in edentulous patient in lateral cephalogram.
- To evaluate the relation of ala-tragus line from three different parts of tragus to Eye-ear plane and occlusal plane in life-size lateral profile photographs in dentulous and edentulous patient.
- To determine the effect of age on the selection of part of tragus for location of ala-tragus line
- To correlate the measurements on the life size digital photographs with the standardized lateral cephalogram.

MATERIALS AND METHOD

The present study was carried out in the Department of Prosthodontia, crown and bridge, Government Dental College & Hospital, Ahmedabad. It was approved by the Institution Ethics Committee Govt. Dental College & Hospital, Ahmedabad Letter No. IEC GDCH/PR.6/2017. A total of 60 subjects were selected for the study and equally divided into two groups:

Dentulous group

Inclusion criteria

- Age group :18-30 years
- Subjects should have full complement of permanent dentition(28-32 teeth present) and Angle's class I molar relation without any supra eruption and drifting
- Edentulous group:

Inclusion criteria

- Age group : 40-70years
- Having sound denture bearing area
- Normal maxillomandibular relationship and competent lips
- No history of trauma, TMJ disorder and neurological disorder

For all the edentulous patient denture construction procedure were initiated according to a standard clinical procedure. The occlusal plane was adjusted according to the technique advocated by Wright *et al*.[11]

Lateral Cephalometric study

Preparation of the subjects for cephalogram:

Figure 1 Armamentarium used for Lateral Cephalometric study

Armamentarium used for this study shown in (Figure 1). Subjects were seated on the stool in an upright position with their head unsupported. Two lines were drawn on the superior and inferior most points on the tragus with an indelible pencil. The distance between these two points was measured with a digital caliper (Figure 2). The values obtained were divided into three: superior, middle and inferior. Against these marks,

metallic balls were adhered with the help of double sided adhesive tape so that these points were visible on the radiograph (Figure 2).

Figure 2 Patient preparation before exposing to X-Rays (dentulous patient)

Lateral cephalogram of all subjects were obtained in natural head position, by using Care stream "Cephalometric machine" at 10 ma and 65-75 KVP. For dentulous patient, the cephalograms were taken with the subject closing in maximum intercuspal position. For edentulous patient, metal foil was adapted over the maxillary occlusal rim (Figure 3) so that it was recorded as radiopaque line in the lateral cephalogram (Figure 3).All the lateral cephalogram were traced using CS 3D imaging software (Figure 4).

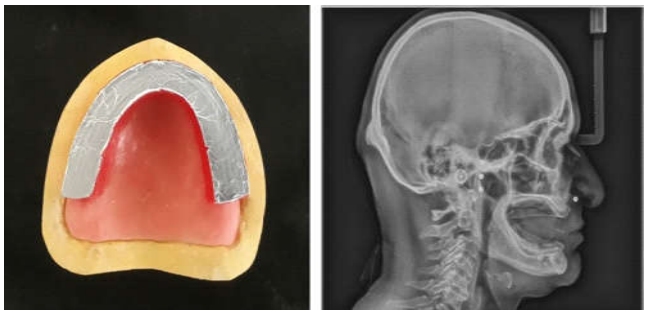


Figure 3 Metal foil adapted over maxillary rim and Standardized Lateral cephalogram of edentulous patient

Cephalometric analysis

The points used for tracing were:

- Orbitale(Or): lowest point on the inferior border of bony orbit
- Porion(Po): mid-point of upper edge of the external auditory meatus
- Superior(S) : superior part of tragus
- Middle(M) : Middle part of tragus
- Inferior (I) : Inferior part of tragus
- Ala of the nose(A) : inferior border of the ala of the nose

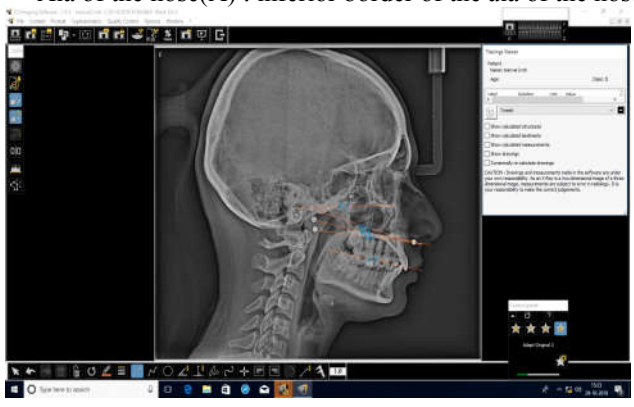


Figure 4 CS imaging software used to make angular measurements on lateral cephalogram images without any magnification

By using this Cephalometric points, various Cephalometric planes were drawn (Figure 4). These were:

- Frankfort horizontal plane (FH): extending from the porion to Orbitale points.
- Occlusal plane (OP): a line bisecting the occlusal surfaces of permanent molars and incisal overbite.
- SA plane: superior point of tragus to the ala of the nose
- MA plane: middle point of tragus to the ala of the nose
- IA plane: Inferior point of tragus to the ala of the nose

By intersecting this planes, various angles were measured (Figure 7).

For Dentulous subjects

- COO- (cant of occlusal plane) angle between FH plane and occlusal plane.
- SFH- angle between FH plane and SA plane.
- MFH- angle between FH plane and MA plane.
- IFH- angle between FH plane and IA plane.

For Edentulous patient

- SFH- angle between FH plane and SA plane.
- MFH- angle between FH plane and MA plane.
- IFH- angle between FH plane and IA plane.

Angle COO was used as a standard which is the angle formed between the FH plane and the occlusal plane.In Downs analysis, the occlusal plane used was formed by marking a line bisecting the occlusal surfaces of permanent molars and incisal overbite. Mean value of angle COO was found to be 9.3º and ranges between 1.5º to 14º in those samples used in downs study. This angle measures the slope of the occlusal plane relative to Frankfort horizontal plane.

Over the traced cephalographs of dentulous patient, the values of angles COO, SFH, MFH, and IFH were measured, tabulated and compared with the value of average COO angle from downs analysis. On cephalograms of edentulous subjects, the angle between FH and SA, MA and IA was measured, tabulated and compared with the value of average COO angle from downs analysis.

Photographic Study

Same 60 subjects were subsequently chosen for lateral profile photography. The digital camera (NIKON) mounted with the lens (EF 100mm, 100mm Macro Lens, shutter speed -1/200, ISO-100 and aperture (f) =25) flash was used for all photographic records. It was secured on a tripod for stabilization and adjustment according to the subject's height. Magnification was set at 1:10 with distance fixed at 1 meter from Reid's horizontal plane to camera lens. The 100mm macro lens was chosen to avoid facial deformations and maintain natural proportions. The camera was used in its manual mode to achieve maximum image quality. Studio light was used for illumination. Two plastic scales each of 30 cm were joined in such a way that it makes 90º angle parallel to midsagittal and Reid's horizontal plane (Reid's horizontal plane passes through the outer cantus of the eye and the superior attachment of the ear).

Red adhesive strip of 1mm in diameter was placed at right orbital point and modified true byte occlusal plane plate (fox bite plane) was placed in the mouth in such a position that it touched the incisal edges of the maxillary incisors and the cusps of the left and right maxillary first molar. The plane was held in the position by pressure from the opposing teeth. The outer wing of the plate indicate the position of the occlusal plane and these are readily seen in the photographs. The dots on superior, middle and inferior margins of the right tragus and lower point of ala of nose were directly placed on the photo in computer.

Figure 5 Set up for the photographic technique

Each subject was told to sit upright on the stool which is placed 1meter away from the mirror and look straight and also self-align the midline of the head with the vertical ruler, which helped the subjects to assume the natural head position. Maintaining the perpendicular distance between subject's sagittal plane and photographic film was 1.5meters and true size lateral digital photographs were taken (Figure 5).

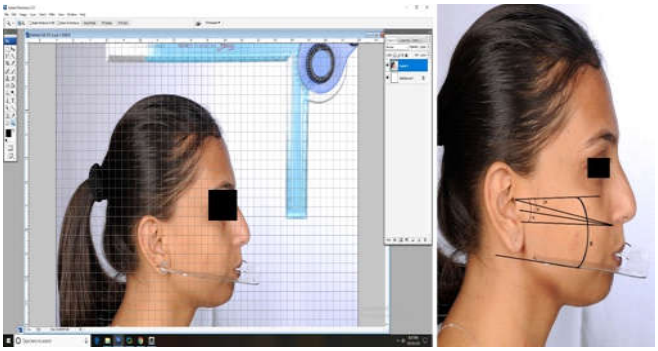


Figure 6 Grid added in adobe photoshop software for making true size photographs and Line digitalized on the photographs and angles were measured

The true size lateral profile photos obtained was processed in Adobe Photoshop software version 10 and grid (1cm x 1cm) was incorporated and integrated according to scale which was joined at 90̊ angle parallel to Reid's horizontal plane and mid sagittal plane. Adjustment of approximately 5% zoom in or zoom out was done to obtain 1:1 true size photograph. All measurements were taken using Adobe Photoshop software CS3 version 10.0 (Figure 6).

Photographic analysis

The following points were digitalized on all photographs on the computer:

- The superior margin of the tragus(T1)
- The middle margin of the tragus(T2)
- The inferior margin of the tragus(T3)
- Inferior border of the ala of the nose(A)
- Orbital point(O)

The following lines were digitalized on all photographs

- The Eye-Ear plane(EEP) was marked as a line connecting the orbital point(O)(red strip) to tragion, rounded eminence anterior to external auditory meatus, superior border which is approximately on the level with superior margin of the tragus(S) i.e. OT1 plane is comparable with the Frankfort plane.
- AT1 plane: from ala (A) to superior margin of tragus(T1)
- AT2 plane: from ala (A) to middle margin of tragus(T2)
- AT3 plane: from ala (A) to inferior margin of tragus.(T3)
- Occlusal plane(OP): A line extending from the outer wing of the face bow comparable to occlusal plane

Various angles measured were

- For dentulous patient (Figure 6):
- Angle between OT1 and occlusal plane(OP)
- Angle between OT1and AT1plane.
- Angle between OT1 and AT2 plane.
- Angle between OT1 and AT3 plane.
- For Edentulous patient (Figure 6):
- Angle between OT1 and AT1 plane.
- Angle between OT1 and AT2 plane.
- Angle between OT1 and AT3 plane.

Of the three angle formed by the eye-ear plane(OT1) and ala-tragus lines, the one closest to the angle formed between Eye-Ear plane(OT1) and occlusal plane(OP) was used to determine the occlusal plane of orientation. In edentulous subjects angle between Eye-ear plane and ala-tragus lines were measured and compared with the mean value of angle formed between the Eye-ear plane and occlusal plane of dentulous patient. The closest angle was used to determine the occlusal plane of orientation.

RESULT

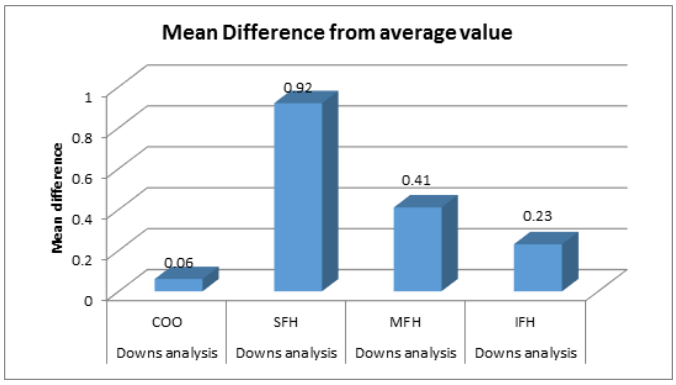
In present study, unpaired t-test was applied for comparison of average COO value of Down analysis with mean value of SFH, MFH and IFH in dentulous and edentulous subjects.

Table 1 Descriptive statistics of values obtained by calculating various angles in cephalogram

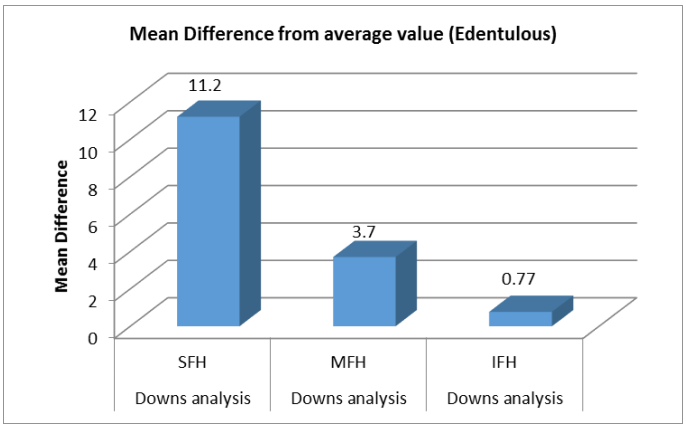
Parameter	N	Minimum	Maximum	Mean	Std. Deviation
COO dentulous	30	6	15	9.90	2.155
SFH dentulous	30	15	23	18.50	2.146
MFH dentulous	30	9	18	13.40	2.673
IFH dentulous	30	4	13	9.53	2.097
SFH edentulous	30	13	25	20.50	2.898
MFH edentulous	30	9	18	13.00	2.435
IFH edentulous	30	4	13	8.53	2.825

Table 2 Comparison of average COO with SFH, MFH and IFH

Angles	Mean Difference	t value	P value	95%CI Lower	95% CI upper
SFH dentulous	-9.2	21.2	<0.001**	-10.06	-8.33
MFH dentulous	-4.1	7.96	0.001*	-5.13	-3.06
IFH dentulous	-0.23	0.541	0.590 NS	-1.07	0.64
SFH edentulous	-11.2	20.01	<0.001**	-12.32	-10.08
MFH edentulous	-3.7	7.68	0.001*	-4.66	-2.73
IFH edentulous	0.77	1.82	0.073 NS	-0.076	1.61



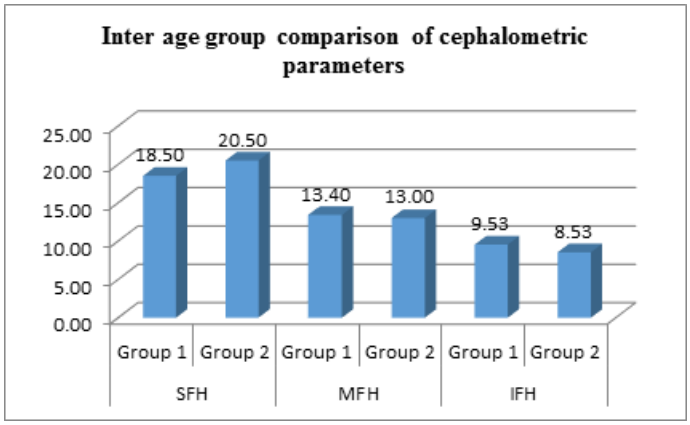
Graph 1 Shows difference between mean of cephalometric values and average value of Down analysis in dentulous subjects



Graph 2 Shows difference between mean of cephalometric values and average value of Down analysis in edentulous subjects

Table 3 Comparison of Cephalometric parameters among various age groups

Parameter	AGE GROUP	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	P value
SFH	Group 1	30	18.50	2.146	.392	-2.000	0.054 NS
	Group 2	30	20.50	2.898	.529		
MFH	Group 1	30	13.40	2.673	.488	.400	0.547 NS
	Group 2	30	13.00	2.435	.445		
IFH	Group 1	30	9.53	2.097	.383	1.000	0.125 NS
	Group 2	30	8.53	2.825	.516		



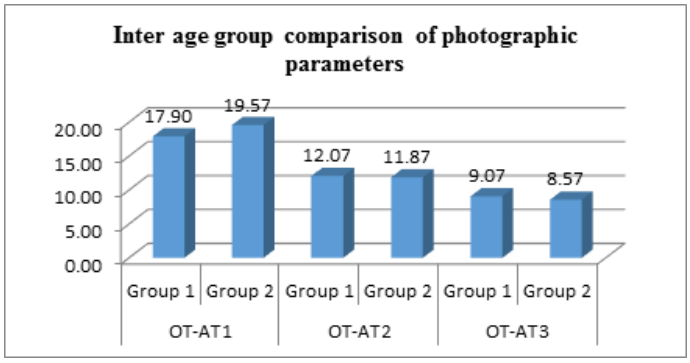
Graph 3 Inter age group comparison of various cephalometric parameters

Table 4 Descriptive statistics of values obtained by calculating various angles in lateral profile photographs of dentulous and edentulous subjects

Parameter	N	Minimum	Maximum	Mean	Std. Deviation
OT1-OP dentulous	30	5	14	9.20	2.188
OT1-AT1 dentulous	30	14	21	17.90	2.249
OT1-AT2 dentulous	30	8	18	12.07	2.638
OT1-AT3 dentulous	30	4	13	9.07	2.067
OT1-AT1 edentulous	30	15	25	19.57	2.648
OT1-AT2 edentulous	30	9	18	11.87	2.432
OT1-AT3 edentulous	30	5	12	8.57	1.942

Table 5 Inter age group comparison of various photographic parameters

Parameter	Age Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	P value
OT1-AT1	Group 1	30	17.90	2.249	.411	-1.667	0.011*
	Group 2	30	19.57	2.648	.483		
OT1-AT2	Group 1	30	12.07	2.638	.482	.200	0.761 NS
	Group 2	30	11.87	2.432	.444		
OT1-AT3	Group 1	30	9.07	2.067	.377	.500	0.338 NS
	Group 2	30	8.57	1.942	.355		

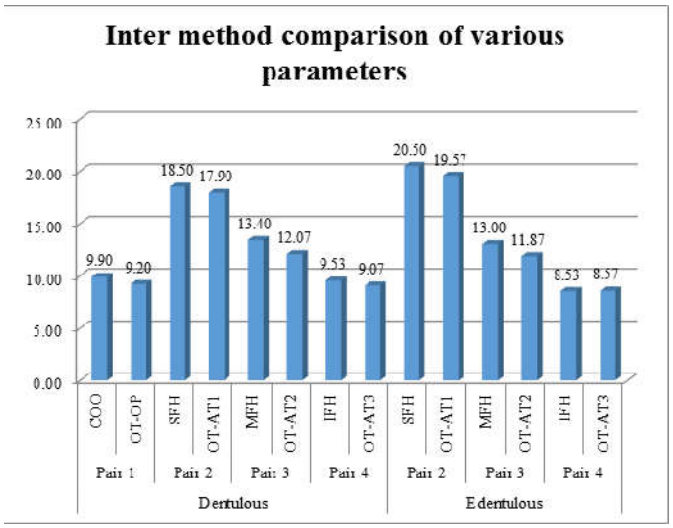


Graph 4 Inter age group comparison of various photographic parameters

Table 6 Comparison between cephalometric values and photographic values

Dental status	Pair	Parameter	Mean	N	Std. Deviation	Std. Error Mean	Mean Difference	P value
Dentulous	Pair 1	COO	9.90	30	2.155	.393	.700	0.001*
		OT1-OP	9.20	30	2.188	.399		
	Pair 2	SFH	18.50	30	2.146	.392	.600	0.001*
		OT1-AT1	17.90	30	2.249	.411		
	Pair 3	MFH	13.40	30	2.673	.488	1.333	0.001*
		OT1-AT2	12.07	30	2.638	.482		
	Pair 4	IFH	9.53	30	2.097	.383	.467	0.109 NS

		OT1-AT3	9.07	30	2.067	.377		
	Pair 2	SFH	20.50	30	2.898	.529	.933	0.005*
		OT1-AT1	19.57	30	2.648	.483		
Edentulous	Pair 3	MFH	13.00	30	2.435	.445	1.133	<0.001**
		OT1-AT2	11.87	30	2.432	.444		
	Pair 4	IFH	8.53	30	2.825	.516	-.033	0.917 NS
		OT1-AT3	8.57	30	1.942	.355		



Graph 5 Comparison between cephalometric values and photographic values

DISCUSSION

Relocation of occlusal plane in patients who have been rendered edentulous is one of the most important consideration for determining the prognosis of a case. Based on the biomechanical and physiological considerations, musculature of the tongue and cheeks were trained to function normally at this level where natural teeth were present, and will again function correctly when they are called upon to stabilize the bolus of food at the same vertical position of the occlusal table as originally existed.[1,12]

To aid in rehabilitation of occlusal plane numerous reference planes and landmarks have been suggested. Out of these, campers plane is the most commonly used reference plane as it is easily visualized. But the definition of ala-tragus line has created lots of confusion due to disagreement on the exact point of reference, on the ala and the tragus. Different authors have different opinions about the location of the line in relation to the position on the tragus as being superior, middle and inferior.

The Frankfort horizontal plane is a fixed anatomical craniometric landmark, thus being used as a skeletal guideline while locating occlusal plane posteriorly. It is not affected by the loss of teeth and it can be easily located with the help of lateral cephalographs, hence FH plane was used in this study.[13] To analyze level of ala-tragus line, various instruments have been devised and used. Bite plane leveler, J plane, camper's plane indicator and more recently occlusal plane analyser and occlusal plane orientor have been used to locate ala tragus line.[14, 15] Fox plane is the simplest and most widely used instrument to aid in determining occlusal plane. But it use is error prone and is associated with inter examiner variability. Also there are chances of parallax error.[14] However, its use is very rapid and simple and it is also less bulky than other instruments and is more suitable for photographic purposes. The chances of parallax error are reduced when images are subjected to photometric analysis. Also it is most commonly used instruments for establishing occlusal plane in edentulous patients. Therefore, fox plane was used for the present study.
The photographic technique used in this study is non-invasive and simple and entire technique was standardized. The subject camera distance (1.5 m) was set at approximately 10 times the distance from ear to nose (approximately 15cm) which reduces photographic distortion to less than 1%.[16] With respect to measurements from 2 dimensional image of a 3- dimensional objects, 3 types of error may arise[17] namely error of projection, mechanical errors in drawing lines between the points and error of landmarks locations. Projections error is reduced by the use of angular measurements because the values of angular measurements remain constant regardless of the enlargement factor. Error introduced in drawing and measuring lengths and angles by hand can easily be eliminated by machine computation, as done in this study, provided that the reproducibility of digitalization of individual points is high. The error of landmarks location is reduced by palpating anatomic points by three different prosthodontist.

Since the present study deals with the possible effect of soft tissue changes on level of ala-tragus line, age group intervals were adopted 18-30 years and 40-60 years. Subjects younger than 14 years would not have the full complement of teeth, hence the occlusion cannot be easily determined. Since most of edentulous patients are above 40 years of age two groups were selected for present study.

In this study, the widely accepted downs analysis was used as a base line for comparisons. Downs analysis on variations in facial relationship indicates that the cant of the occlusal plane (COO), the angular relation between the occlusal plane and Frankfort plane, ranged from 1.5° to 14° with a mean value of 9.3°.[18]

Table 1 shows the mean value of COO was observed to be 9.90º in this study which is closest to mean value of 9.3º as demonstrated in the Downs study. The difference of 0.6° is clinically insignificant and may be accredited to the variations in racial population. The mean angle IFH is observed in dentulous patient and edentulous patient were 9.53º and 8.53º respectively, which is closest to mean value of COO.

Table 2 depicts that the difference between mean value of SFH and MFH to that of average COO is clinically significant ($p<0.001$), on the other hand the difference between COO and IFH is clinically non-significant ($p=0.590$) in both dentulous and edentulous subjects. Thus the mean value of IFH angle is comparable to the mean value of occlusal plane angle established in downs analysis, which indicates that inferior part of tragus can be used reliably while marking the ala tragus line.(Graph 1 and 2)

The result of this study were in agreement with the previous studies done by *Hartono* (1967)[12] , *van Niekerk et al (*1985)[19] and *Chaturvedi and Thombare* (2013)[20] who have suggested that the plane of occlusion is parallel to a line drawn from the lower border of tragus to the lowest point of ala of the nose.

Study done by *Solomon et al* (2000)[21] were not in agreement with above conclusion. In their study ala-tragus line was found to be more 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 tragus served as a poor reference according to their study.

Table 3 shows there was statistically significant difference present between various age groups with respect to SFH (p=0.004) by independent t-test but no statistically significant difference is present between various age groups in other parameters(MFH and IFH), indicating that age is not an influencing factor for determining posterior reference point on tragus while marking ala-tragus line. It means for both the groups, ala tragus line was found to be parallel to occlusal plane when inferior border of tragus was considered as posterior reference point. (Graph 3)

The result of this for both the age group were not in accordance with the previous studies done by *Saquib Ahmed Shaikh* (2015)[22] who suggested that in young adult age group occlusal plane was found to be more parallel to ala-tragus line when inferior border of tragus is considered as posterior reference point whereas in middle and old age group, both middle and superior border of tragus can be taken as posterior reference point while orienting occlusal plane.

Table 4 shows descriptive statistics data of various photographic parameters in dentulous and edentulous subjects. The mean cant of occlusal plane as determined by measuring in lateral profile photographs was 9.20º which is comparable to study done by Down who found COO to be 9.30º. In both the group, mean OT1-AT3 was very close to the mean OT1-OP i.e. the angle formed between FH plane and occlusal plane was closer to the angle between FH plane and lower border of tragus..That means the occlusal plane is more parallel to the line drawn from the ala to the lower border of the tragus. This results are similar to the result obtained by tracing lateral cephalogram.

The results of this study are in accordance with study done by *Clapp(1910)*[23], *Dalby(1912)*[23] and *Wilson(1917)*[23] have suggested that the plane of occlusion is parallel to a line drawn from the lowest point of external auditory meatus to the lowest point of the ala of nose.

The study done by *Karkazis* and *polyzois (1986)*[24] contradicts the findings of our study. They found that the natural occlusion is not parallel to the camper's plane and also artificial occlusion determined at the time of complete denture construction was
Table 5 shows that the difference between various age group with respect to OT1-AT2 and OT1-AT3 is found to be statistically insignificant (p>0.05). This result is similar to the lateral cephalometric measurement result. (Graph 4)

Table 6 reveals no significant difference exist between photographic and cephalometric measurements with respect to IFH and OT1-AT3. The mean difference between angles observed is 0.467 in dentulous and 0.33 in edentulous patient, which is of no clinical relevance. (Graph 5)

Study done by *Petricevic et al* [25] in 2018, evaluated the reliability of digital photography for the establishment of lost occlusal plane in edentulous patients and concluded that the measurement of occlusal plane inclination from digital photographs could be helpful in future prosthodontic reconstruction treatment.

There were few limitations in the study,
`The size of the sample in this study was small in each group, considering only one geographical location and hence the result may vary with morphological changes (in facial/ skeletal features) among geographically distributed people.

The variations due to gender differences in occlusal plane were not considered in this study.

The difference in parallelism of the occlusal plane to the Ala-tragus lines in various malocclusion (angles class-I, II and III) was not studied, which may vary.

CONCLUSION

- From the present study it was observed that none of the three ala-tragal lines was absolutely parallel to the occlusal plane in all the subjects However, when comparing the relative parallelism of the three ala-tragal lines to the occlusal plane in subjects within two groups, the following conclusions were drawn from our study:
- In dentulous patients, there was no significant difference found between the cant of occlusal plane angle and the angle between FH plane and Inferior ala tragus line, hence it was concluded that the line joining the ala to the lower border of tragus was parallel with the occlusal plane in major fraction of the dentulous patient.
- The inferior point marked on tragus was the most appropriate point for marking ala-tragus line for establishing occlusal plane in edentulous patients.
- In lateral profile photographs, the line joining the ala to the lower border of tragus was parallel with the occlusal plane in majority of dentulous and edentulous patient.
- There was no influence of age on the level of occlusal plane i.e. in both young and old age group, the occlusal plane was found to be parallel to the line joining the ala to lower border of tragus.
- There was no significant difference found between the angles measured on the lateral cephalogram and on the lateral profile photographs, thus it was inferred that the photographic method was reliable and can be used for reconstruction of occlusal plane.

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