EVALUATION AND ASSESSMENT OF ALA-TRAGUS LINE AS A GUIDE IN DETERMINING THE OCCLUSAL PLANE IN DIFFERENT FACIAL DIVERGENCES: AN IN VIVO STUDY

Dissertation submitted to

Maharashtra University of Health Sciences, Nashik

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for the award of the Degree of

MDS

IN

ORTHODONTICS AND DENTOFACIAL ORTHOPEDICS

BRANCH V

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Through

VSPM DENTAL COLLEGE AND RESEARCH CENTRE
HINGNA, NAGPUR

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CERTIFICATE

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Has been prepared by

DR. SHWETALI BALASAHEB JADHAV

Under my direct supervision and guidance in partial fulfillment of the regulations for the award of the

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Her work on the subject has been checked by me from time to time. I am satisfied regarding the authenticity of her observations, clinical material and experimentation in this dissertation and it conforms to the standards of Maharashtra University of Health Sciences, Nashik.

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of Maharashtra University of Health Science, Nashik and has not been submitted previously for the award of any diploma or degree from any University.

Date: 25/03/2021

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DR. SHWETALI BALASAHEB JADHAV

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CONTENTS

LIST OF GRAPHS

LIST OF TABLES

COLOUR PLATES

SR. NO.	PLATE NO.	TITLES
1	I	FIG A: DIGITAL LATERAL CEPHALOGRAM MACHINE
		FIG B. DIGITAL PRINTER (FUJIFILM DRY PIX SMART)
2	II	FIG C. COPY OF LATERAL CEPHALOGRAM
		FIG D. CALIBERATION OF LATERAL CEPHALOGRAM
3	III	FIG. E: TRACING OF LATERAL CEPHALOGRAM ON ACETATE SHEET
		FIG. F: GROWTH PATTERN: DOWN'S ANALYSIS
4	IV	FIG. G: FOX PLANE
		FIG. H: POSITIONING PATIENT FOR PHOTOGRAPH AS SAME AS CEPHALOGRAM

LIST OF ABBREVIATIONS

OP	Occlusal plane
ST	Superior tragus line
MT	Middle tragus line
IT	Inferior tragus line
MST	In between middle to superior tragus line
MIT	In between middle to inferior tragus line
FH	Frankfort’s horizontal plane
IOP	Inferior tragus occlusal plane
SOP	Superior tragus occlusal plane
MOP	Middle tragus occlusal plane
OP-FH	Angle between the occlusal plane to Frankfort’s horizontal plane

INTRODUCTION

In orthodontics, various planes are used as reference planes in diagnosis and treatment planning. The occlusal plane in being the plane of dentition occupies a prime position in cephalometrics and treatment mechanics. The correct orientation of the occlusal plane plays a vital role in optimal esthetic and functional achievement. The correctly oriented occlusal plane causes the incisal tips to follow the curve of the lower lip which is a prime requisite for an aesthetic smile line. The occlusal plane hanging posteriorly leads to a straight lip-line which contributes to a 'denture look'[1]. With the occlusal plane correctly oriented, however, the natural anterior curve will be achieved almost automatically and will contribute a proper sense of perspective to the dental Composition[1]. The form and inclination of the occlusal plane hold individual characteristics that are connected not only with the function of the stomatognathic system but also with the esthetics of dentofacial appearance.

The configuration of the occlusal plane is important as slight variations will lead to occlusal instability. It should be in harmony with other components of the masticatory system. It forms the basis by which occlusal surfaces of teeth can be related to one another and to other structures of the head. The occlusal plane is the average plane established by the incisal and occlusal surfaces of the teeth; it is not a plane but represents the planar mean of the curvature of the surfaces. The inclination of the occlusal plane is one of the key factors governing occlusal balance. The plane of occlusion forms an essential part of the concept of balanced articulation[2,3].

According to contemporary concepts, Facial harmony is achieved when teeth are set in their proper relation. The position of the occlusal plane of orientation forms the basis for ideal teeth arrangement and should perform the necessary basic functions like effective mastication, proper esthetics, and phonetics[4]. It should lead to the normal function of the tongue and cheek muscles, thus enhancing stability. Improper orientation of the occlusal plane will jeopardize the interaction between tongue and buccinator muscles and result, in biting of the cheek and tongue[5].

In orthodontics, various planes are used as reference planes in diagnosis and treatment planning[6]. The occlusal plane being the plane of dentition occupies a prime position in cephalometric analysis and treatment mechanics. Control of the occlusal plane during orthodontic mechano-therapy should be an integral part of every clinician's treatment plan[7].

The occlusal plane in complete denture construction is typically determined with a device called Fox plane[8] which is positioned parallel to the Camper's Plane[9,10] (ala-tragus line)[11]. Controversies in the exact definition of the ala-tragus line exist

because exact points of reference do not coincide[12,13,14]. According to anthropologic definitions, Camper's line is a line passing from the ala of the nose to the center of the tragus of the external auditory meatus[15]. The tragal references recommended for the ala-tragus lines are conflicting and controversial[16]. Further, the ambiguity of the tragal nomenclature makes it difficult as to which part of the tragus should be considered to define the ala-tragus line[17]. Three tragal references are commonly recommended for the ala-tragus line. These are the superior border of the tragus[18,19,20], the middle of the tragus[11], and the inferior border of the tragus[21]. This concept is also applicable in orthodontic tooth movement when the ultimate goal is maintaining harmony in an occlusal plane relationship during the treatment.

The horizontal facial planes are commonly used to determine the degree of divergence on lateral cephalometric radiographs. Since these planes always diverge anteriorly; the degree of divergence from an idealized divergency in normal facial pattern refers to as hyperdivergence and hypodivergence and hence Vertical and Horizontal growers respectively[22,23,24]. The treatment of Horizontal and vertical growers must attempt to enhance the mandibular response because mandibular response facilitates improvement in facial balance and harmony.

To enhance the response of the mandible to treatment, the horizontal planes, especially the occlusal plane, must be controlled[25]. Ala-tragus line (Campers line) is a line extending from the tip of the anterior nasal spine to the center of the bony external auditory meatus[26]. Various concepts for locating occlusal plane and ala-tragus line have been published to facilitate the positioning of artificial teeth in a position as occupied by the natural teeth in prosthodontics[27].

In analyzing the deviation in belief, we must heed the words of Lau-Tze, the Chinese philosopher who said, “The journey of a thousand miles begins with one step.” Determination of an accurate location of the occlusal plane will definitely aid in the landmark during ongoing orthodontic treatment in particular, and the patient in general. Hence the purpose of this study is to determine the relationship between the growth pattern and orientation of the occlusal plane relation to the ala-tragus line.

AIMS AND OBJECTIVES

PRIMARY RESEARCH QUESTION

Which of the three most commonly used posterior reference points of the ala tragus line are close, as a guide in determining the angulations of the occlusal plane in Different facial divergence?

NULL HYPOTHESIS:

There is no correlation between the three most commonly used posterior reference points of the ala tragus line as a close guide in determining the angulations of the occlusal plane in Different facial divergence.

PRIMARY HYPOTHESIS:

There is a definite correlation between the three most commonly used posterior reference points of the ala tragus line as a close guide in determining the angulations of the occlusal plane in Different facial divergence.

OBJECTIVES:

- **PRIMARY OBJECTIVES**

To evaluate the occlusal plane and ala-tragus line in Different facial divergence.

To assess the relationship of the occlusal plane and ala-tragus line in Different facial divergence.

- **SECONDARY OBJECTIVES**

To compare the relationship of the occlusal plane and ala-tragus line in normodivergent and hypodivergent patients.

To compare the relationship of the occlusal plane and ala-tragus line in normodivergent and hyperdivergent patients.

To compare the relationship of the occlusal plane and ala-tragus line in hypodivergent and hyperdivergent patients.

REVIEW OF LITERATURE

The landmarks for the establishment of the occlusal plane have gone a lot of evolution, since the first published literature in the 17th century by Petrus Camper regarding the Camper's line. Replacement of teeth in completely edentulous patients, demands a correct location of the occlusal plane, to restore efficiently the function and esthetics.

Radiographic cephalometry was first introduced into orthodontics in the 1930s when Broadbent[28], an Orthodontist, and Hofrath[29], a Prosthodontist simultaneously and independently developed cephalograms to produce cephalometric radiographs in a standardized manner. The method, however, gained a wider acceptance for practical application from the 1950s. Broadbent's idea was mainly to provide a method to measure facial growth changes, while the objective of Hofrath was to evaluate the results of prosthetic reconstruction. A great deal of information has been gleaned from cephalometrics by orthodontists, while the investigations by those interested in

prosthetic reconstruction have been fewer and less objective. But, the use of cephalometrics in prosthodontics for diagnosis, treatment planning, and tooth positioning cannot be flouted.

Various concepts for locating occlusal plane and ala-tragus line have been published to facilitate the positioning of artificial teeth in a position as occupied by the natural teeth originally.

In orthodontics; occlusal stability is the most important aspect for treatment retention. So the occlusal plane prior to the treatment in the particular subject has to be maintained throughout the treatment. Any change in the occlusal orientation in the subject may hamper the long-term stability of the treatment. So it is very important to know how the occlusal plane is oriented in the particular type of growth patterns in vertical planes of growth.

The occlusal plane plays a very important role in this manner.

Petrus Camper[26], a Dutch anatomist postulated the Camper's plane in 1780. He defined it as a line extending from the tip of the anterior nasal spine to the center of the bony external auditory meatus.

Broomell I, Norman[30] in 1897 proved that the natural tooth line is parallel to a horizontal baseline extending from the center of the glenoid fossa to the anterior nasal spine. He said that this can also be used as a guide for partial denture cases with only anterior teeth remaining.

Clapp,George W[31] in 1910 was the first to relate Camper's line/plane to occlusal plane. The occlusal plane is established parallel with a line drawn from the

lower margin of the external auditory meatus to the lower margin of the alae of the nose."

Dalby WC[32] in 1912 also observed that the occlusal plane should be parallel to a line drawn from the lowest point of the external auditory meatus to the lowest point at the ala of the nose, the anterior extremity of the plane being one-sixteenth inch below the upper lip at rest.

He altered this definition in 1914[33] saying that the occlusal plane should be parallel to a line drawn from the lowest point of the ala of the nose to a point at least one-fourth inch lower than the lowest point of the external auditory meatus.

Wilson, George H[34] in 1917 written a book named "A Manual Of Dental Prosthetics" on the basis of their observations and studies and agreed that the occlusal plane should be oriented parallel to a line extending from the ala of the nose to the inferior border of the external auditory meatus.

Ruppe L[35] in 1920 designed an apparatus to determine the position of the occlusal plane in prosthetic and orthodontic cases known as 'The Occlusal'. He deduced that the occlusal plane should be parallel to the Camper's line per se.

Wilder HH[36] in1920 described that Camper's line which is an anthropologic measurement on skulls projected to the living head as a line passing from the ala of the nose to the center of the tragus of the external auditory meatus.

Clapp and Tenth[37] in 1921 said the occlusal plane is parallel to a line extending from the alae of the nose to the superior border of the external auditory meatus."

Giffen, William A[38] in 1925 gave the fundamentals of denture construction and said that the occlusal plane should be parallel to a line extending from the ala of the nose to the external auditory meatus, keeping the plane as close to the mandible as esthetics allows based on their study on the dentate subjects. In accordance to maintain the same that was already present in the subjects.

Clapp, George W, Tench, Wilford R[39] in 1926 established that the occlusal plane is parallel to a line extending from the ala of the nose to the superior border of the external auditory meatus.

Gillis, Robert R[40]in 1933 said that the occlusal plane should be parallel to a straight line from the corner of the mouth, at rest, to the lower border of the ear lobe.

Kurth[41] in 1940 mentioned the importance of the posterior occlusal plane in maintaining proper balance and maintaining equilibrium. The posterior occlusal plane is very important in maintaining a proper functional balance of the mandible as well as maintain balance occlusion. The occlusal plane is tentatively located in accord with Camper's line (the points of a location being superior to the external auditory meatus and the lower border of the alae of the nose).

Evaluation of the ridges relative to the weak and strong arch orients the plane in a sagittal direction. Further consideration assigns a transverse cant to the occlusal plane, all dependent on the conditions present.

Landa, Joseph S[42] in 1947 proved that the occlusal plane should be parallel to the ear-nose plane drawn from the ala of the nose to the middle point of the tragus of the ear following their study.

Downs, W.B.[22] in1948 conducted a study to determine whether there is any abnormal relationship is present between a range of skeletal and dental pattern which one might expect to be normal or in harmony or there is any unusual relation that exists between these normal. The method employed in the study was cephalometrics. The control group was made of twenty individuals ranging from age group 12 to 17 years and equally divided into groups according to their sex. Models, photographs, cephalometric as well as intraoral roentgenograph were taken for each individual. Every individual had excellent occlusion intraorally. Many parameters were examined to determine the variation in the facial relationship and their significance in diagnosis and treatment. He validated the use of Frankfort's horizontal plane in cephalometric analysis and its importance.

He observed the importance of variations in facial relationships & their significance in treatment and prognosis, to determine different facial planes and their importance in treatment planning and prognosis.

Boucher CO[43] in 1950 said that the occlusal plane location should be determined by the height of the anterior teeth at one end of the plane and the height of the second molar at the other end. The top of the distal end of the retromolar pad should be used as a reference point for orienting the second molar. In 1953[44], he described occlusion in prosthodontics and mentioned that the occlusal plane is the plane on which upper and lower teeth occlude but it is not a plane; rather, it is a curve because the occlusal surfaces of the teeth seldom lie on the same plane.

Downs[23], in1952 stated the role of cephalometrics in orthodontic case analysis & diagnosis. The cephalometrics helped in accurately appraising the relationships of

the parts of the face leading to a description of the mean or average facial form of normal occlusion and also the range of variation that may occur. And hence classified the facial types. He has described this in two simple terms Static analysis and Dynamic analysis depending on the time of examination.

The method of study and description of the skeletal and dental patterns of an individual at any particular time was described as a Static Analysis by Downs. When comparisons are made of these records of the same individual at different times, the result was a quantitative and qualitative interpretation of changes. And anything that changes was called a Dynamic Analysis. It was evident that variations occur in the same manner in which the face grows. And so it was concluded that cephalometrics will supplant other methods of analysis; rather it should be looked upon as an aid in understanding the others. And he again concluded the role in determining facial patterns.

Sloane, Robert B, Cook J[45] in 1953 performed a study to determine whether a relationship exists between fixed craniometric landmarks common to the skull and edentulous maxillary casts and plane of occlusion. For that, he has done the study on twenty-six skulls put in such a way that their Frankfort plane should be horizontally placed. They have selected the points of reference that would not affect either by degenerative processes or surgical interference, and that could readily be identified on an edentulous maxillary cast. The hamular notch and the anterior nasal spine were chosen since they are constant to both the maxillary cast and the skull. They have taken two photographs one in lateral view and one in frontal view and the horizontal and vertical lines were marked, and certain measurements were made to determine the

relationship with the occlusal plane. The divergences and the parallelism between the drawn planes and occlusal planes are measured and significantly analyzed.

Then they concluded that there was a relationship that was sufficiently constant to allow the projection of the plane of occlusion when certain fundamental individual adjustments were incorporated into a mechanical device that correlates these basic relationships.

Augsburger RH[46] in 1953 performed a study to evaluate the relationship of occlusal plane to facial type. He conducted a study on 200 lateral cephalograms of senior dental students to determine whether or not the correlation exists between facial type and occlusal plane location of natural dentition. He used Broadbent-Bolton's Cephalostat along with other well-established methods to evaluate the relationship of the facial type and occlusal plane of 200 senior dental candidates. In prior studies the extensive biological, as well as physiological experiments, have established the functional relationship of muscle tissues to the hard tissues i.e. both osseous and dental hard tissues; whereas the muscle tissue seems to holds away over the hard tissues. The mean values of the landmark investigated in the study shown significant and definitive characteristics. On the statistical evaluation of these findings, the majority of results bear out as being statistically significant in 21 out of 28 values measured.

So by the study and statistical analysis, he concluded that there is a strong correlation between the location of the occlusal plane of the natural dentition to given facial types, in the lateral aspect. Additional data during the investigation revealed

that the location of the anterior teeth to the occlusal plane is according to the facial type of the particular subject in the lateral or profile aspect.

Rickets RM[47]in 1956 described the role of cephalometrics as a useful tool in the diagnosis of certain conditions. Each face has its own characteristics and these can be classified by the application of cephalometric procedures. The clinical application of cephalometrics should lead to a better treatment prescription and prognosis. It is, therefore, important that a cephalometric record be obtained so that treatment procedures can be evaluated, and that the changes that occur after and during the treatment can be recorded. The success or failure of treatment procedure after years of wear can thus be evaluated.

Ausburger's Z[48] study in 1959, which indicated a strong correlation between the occlusal plane and the lateral aspects of facial types. The position of the tongue to the hard palate with the teeth in centric occlusion was also added up in his investigation as it would have strong relationships with the inclination of the occlusal plane.

Rickets RM[49] in 1960 gave a paper defining the importance of cephalometrics in orthodontics to determine growth patterns and other important findings. in that he said; Any treatment plan is a prediction of change. This article stresses the need for more understanding of the application of cephalometrics in treatment planning. A cephalometric procedure was thus shown to help establish the objectives for a particular case. Such terms as prediction, projection, prognosis, estimation, predetermination, and cephalometric setup have come to be related to anticipation of the future behavior of an orthodontic case. The term "cephalometric synthesis" has

been employed to mean a putting-together of many related growth and anchorage factors to yield the product or the planned result in a new tracing."Synthesis" was divided into "static" and "dynamic" types with regard to the growth of the jaws. When static conditions exist, or when little or no growth is expected, a formula for tooth arrangement was suggested for the individual case depending upon local environmental factors. The APog plane or the "denture plane" was held to be of greatest use for this purpose because it represents a reciprocal relationship of the denture bases to which the anterior teeth must be related functionally. Thus, a mutual role is played by the lower incisor to both the maxilla and the mandible

Olsson A, Posselt U[50] in 1961 investigated the relationship of various skull reference lines. The average angles were measured between three reference lines used i.e

1. Frankfort's line
2. Camper's line
3. Occlusal line of maxilla

The angles that open anteriorly were designated as plus and those that open posteriorly were indicated as a minus. The angles were ranked according to the magnitude of the variation.

Silverman, M[51] in1962 conducted a study on the comparison of occlusion in prosthesis and that of the natural dentition. On the basis of the observations concluded that, in general, the resultant of the forces of mastication is in a forward direction, nearly perpendicular to the occlusal plane. Variation in the origin and insertion of the

muscles is caused by varying relative positions of the mandible and maxillae. These lines of forces differ with the various facial types. The plane of occlusion and facial type may be harmonious

Hartono B[27] in 1967 evaluated the occlusal plane in relation to facial types. The purpose of the study was to find a correlation between the lateral aspects of the occlusal plane of natural teeth and facial types, which might be used in the construction of complete dentures. The study was employed because of two reasons one is to identify the part of the tragus to mark the ala-tragus line and another is to define the relation of different facial type and their corresponding occlusal planes. He examined fifty-three dental hygiene students in the study and concluded that, among the different facial types studied, the line connecting the lowest point of the ala of the nose to the inferior margin of the tragus was nearly parallel to the occlusal plane. This line was referred to as Camper's plane. The correlation between facial types and the location of the occlusal plane, when considered from the lateral aspect, was also indicated.

R. Hartono[52], in his study named the occlusion plane in relation to a facial pattern in 1967 described the different Simon's six facial types. The line connecting the lowest point of the ala of the nose to the inferior margin of the tragus is nearly parallel to the occlusal plane. This line is referred to as Camper's plane when used by prosthodontists. The correlation between facial types and the location of the occlusal plane, when considered from the lateral aspect, was also indicated.

Ismail and Bowman[13] in their study conducted on the topic Position of the occlusal plane in natural and artificial teeth in 1968. The aim of the study and the

purpose of this investigation was to study one aspect of tissue on which the prosthesis is supposed to be given and comparing the occlusal plane established prosthetically with the one that existed before extraction of the teeth in each subject. Lateral cephalometric roentgenograms of twenty subjects, nine men and eleven woman, ranging between 19 and 60 years of age, with a mean age of 41.5 years, were included in this study. Cephalograms were obtained for the subjects with their natural teeth in centric occlusion the superimpositions were also don for the same depending on before and after extraction criterion. Standardized extraction techniques were used to remove remaining teeth. The complete denture preparations were done following 9 to 12 weeks of treatment.

The difference existed between the anterior plane of natural and artificial dentition was statistically significant. He concluded that a line passing from the ala of the nose to the center of the tragus of external auditory meatus can be taken as the reference line.

L'Estrange PR, Vig PS[53] in 1975 conducted a comparative study of the occlusal plane in dentulous and edentulous subjects. The dentulous group had twenty-six male subjects, ages ranging from 25-35 years. The occlusion of these subjects was not ideal but was acceptable. Another edentulous group had again twenty-six subjects out of which eight were male and remaining females ranging from 36-78 years of age. Cephalometric tracings were done for both groups. They determined the location of the occlusal plane as related to the maxillomandibular space in both dentulous and edentulous subjects. In the dentulous group, significant associations were found

between the angulation of occlusal plane to maxillary plane and height and length of maxillomandibular space.

The occlusal plane is the long and the low type of maxillomandibular space tends to be more parallel to the maxillary plane, while the occlusal plane in short and high types of maxillomandibular space tends to be more steeply angulated to the maxillary plane. The occlusal plane deviates away from the mean angulations to the maxillary plane when the height and length of the maxillomandibular space tend to be toward the opposite extremes of the normal range.

Heartwell CM, Rahn AO[19] in 1980 concluded that the occlusal plane should coincide with a line from the inferior border of the ala of the nose to the superior border of the tragus of the ear, known as the Camper's line.

Spratley MH[54] in 1980 discussed the various landmarks for the determination of occlusal plane. He suggested a simplified technique for the determination of the occlusal plane by making it parallel to the interpupillary line in the anterior region and to the ala-tragus line in the posterior region using direct vision.

Karkazis HC, Polyzois GL[55] in 1991 conducted an investigation to check the hypothesis that the angulation of the occlusal plane is generally related to the skeletal base of the maxillae. It was concluded that there was

1. No strong linear correlation between the following variables:

(i) The length of Cook's plane to Cook's occlusal plane angle

(ii) The length of maxillary plane to the maxillary occlusal plane angle, and

(iii) The Po-Na-ANS angle to the occlusal Frankfort plane angle

2. No correlation between the predicted and clinically determined occlusal plane.

D'Souza NL, Bhargava K[56] in 1996 carried out a cephalometric study in which they compared the occlusal plane in dentulous and edentulous subjects in relation to the maxillomandibular space, and also evaluated the validity of Camper's plane as a guide to determine the occlusal plane in edentulous subjects. Results revealed that the maxillomandibular angle was significantly correlated with both the occlusal and maxillary plane angle and occlusal and mandibular plane angle. Similarly, the length of the maxillomandibular space was significantly correlated with occlusal and maxillary plane angle.

Sylvie Lamarque et al[7] in 1995 conducted a study named The importance of occlusal plane control during orthodontic mechano-therapy. He explained the importance of vertical control in the treatment mechanics and how does the treatment vary in different growth pattern. He has presented a series of cases in the same paper. All the cases showing different malocclusion and growth patterns. He has explained how the occlusal plane of the patient acts as an area of workbench throughout the treatment. The successful correlation of different types of the orthodontic problem depends on the horizontal plane basically the occlusal plane.

He concluded that Control of the occlusal plane during orthodontic mechano-therapy should be an integral part of every clinician's treatment plan for successful results.

Solomon EGR[17]in 2000 discussed how the tragus morphology and its relation to the Camper's line has been a subject of controversy in the literature. He said that the ambiguity of the tragal nomenclature makes it difficult to select which part of the tragus should be considered to define the ala-tragus and the tragus-canthus lines. He concluded that the choice of the tragal location for the determination of occlusal plane is either a matter of convention or convenience that is not supported by scientific evidence.

Solomon EGR, Shetty NS, Marla V[57] in 2000 conducted an investigation to study the anatomical features, variations, and the location of various landmarks of tragus to the ala-tragus line in view of its importance as a useful reference in establishing Camper's plane. 2048 tragi forms were studied in subjects of 18-25 age groups comprising of both sexes. Besides the shape of the tragus, the preciseness of the superior border, middle and inferior border of the tragus was studied, as these landmarks have been recommended as references to form the ala-tragus line/plane. It was found that the tragus had several morphological variations and it was classified as typical pointed, rounded, notched, and rudimentary tragus. The middle of the tragus was definable only in the typical pointed tragus. The preciseness of superior border and the inferior border was not always definable. Therefore, its validity as a reference was questionable. Camper's plane was found to be parallel to the occlusal plane when

the tragal reference point was situated between the superior border and the middle of the tragus and not from the usual hitherto recommended reference points.

Solomon EGR, Shetty NS, Shetty O, Mudia PK[58] in 2000 conducted a study in edentulous subjects to determine age changes in the tragus. The shape of tragus in edentulous subjects varied from pointed, round, notched and rudimentary types with the rudimentary type predominating in the edentulous subjects. No significant differences in the tragal forms were noticeable as age advances except for a few changes occurring in the skin.

Nissan J, Barnea E, Zeltzer C, Cardash HS[59] in 2003 conducted a cephalometric study on 34 complete denture wearers to investigate the relationship between the anatomical structures commonly used to determine the occlusal plane and the facial skeletal shape. The results showed no correlation between the shape of the skeletal face, the gonial angle, and the length of the mandible versus the location of the retromolar pad, the occlusal plane, and Camper's plane. However, a significant correlation was found between the facial skeletal shape and the location of Camper's plane.

Hence, it was concluded that cephalometric analysis alone cannot determine the location of the occlusal plane in edentulous patients. Intra-oral structures should also be considered.

Rostamkhani F, Sahafian A, Kermani H[60] in 2005 conducted a cephalometric study considering the importance of the occlusal plane orientation in complete denture prostheses, a study was conducted on the relationship between this plane with ala-tragus and Camper's lines in soft tissue among individuals with class

III malocclusion. The study determined the relationship of the occlusal plane with the 3 different posterior reference landmarks of the Camper's plane in patients with Angle's Class III malocclusion. Thirteen participants with angle's class III malocclusion were selected. The radioopaque points were marked and the cephalogram was taken. The angle between occlusal pane to the superior, middle, and inferior ala-tragus line was measured. After application of appropriate statistical analysis; It was concluded that in Class III malocclusion the inferior border of the tragus was the most accurate posterior landmark for the Camper's plane

K.Shigli B. R. Chetal, J. Jabade[61] in 2005 conducted a study to assess the validity of soft tissue landmark in determining the occlusal plane. A study was carried out to ascertain the role of intraoral and extraoral soft tissue landmarks in determining the occlusal plane. 30 Indian subjects ranging in age from 19-23 years were selected by them a group of 200 dental students. The soft tissue landmarks taken for the study were retromolar pad, parotid papilla, commissure of the lips, buccinator groove, and ala-tragus line. A naturally fabricated "Occlusal plane relator" was used to find out the relative parallelism of the ala-tragus line and the occlusal plane. This device had a base with a vertical arm over which a sliding ball and socket joint was placed for the measurement. This joint had a direct connection with the anterior occlusal plane indicator anteriorly and the ala-tragus line indicator posteriorly.

Two readings on the ala-tragus line indicator on either side of the face and the mean were calculated. The line in which the difference between the two readings was least was considered as a parallel to the occlusal plane. The line drawn from the ala of

the nose to the middle of the tragus was found to be parallel to the maxillary or upper Occlusal plane.

Sadr K, Sadr M[62] in 2009 did a photographic study in dentulous subjects to define the best posterior reference point of the ala tragus line for orientation of the occlusal plane in complete denture fabrication. Fifty-three dental students (27 females and 26 males) with complete natural dentition and Angel's Class I occlusal Relationship were selected. The photographs were taken in a natural head position while clenching on a Fox plane. After tracing the photographs, the angles between the following lines were measured: the occlusal plane (Fox plane) and the superior border of ala-tragus, the occlusal plane (Fox plane) and the middle of ala-tragus as well as the occlusal plane (Fox plane) and the inferior border of ala-tragus. Descriptive statistics, a one-sample t-test, and an independent t-test were used. A P-value less than 0.05 was considered significant. There was no parallelism between the occlusal plane and ala-tragus line with three different posterior ends, but one sample t-test showed that the angles between them were significantly different from zero ($P < 0.05$). However, the superior border of the ala-tragus line had the lowest mean angle, 1.80°, and was almost parallel to the occlusal plane.

They concluded that there was no parallelism between the occlusal plane and the ala tragus line with 3 different posterior ends. However, the superior border of the ala tragus line had the lowest mean angle and hence was suggested as the posterior reference for the ala tragus line.

Firas AM, Quran AL, Hazza A, Nahass NA[63] in 2010 conducted a cephalometric study named position of the occlusal plane in artificial and natural

dentition to craniofacial planes. The study aimed at determining the most reliable ala-tragus line as a guide for the orientation of the occlusal plane in complete denture patients by use of cephalometric landmarks on dentate volunteers. The forty-seven dentulous subjects were selected to determine the most accurate posterior reference landmark of the ala-tragus line. Lateral cephalograms were taken of the subjects and the angle between the occlusal plane and line joining the lower border of the ala of the nose to the 3 different posterior reference landmarks was marked.

It was concluded that the angle between the occlusal plane and the line joining the lower border of the ala of the nose to superior border of tragus had the lowest mean angle and hence was the most accurate posterior reference point for the ala-tragus line.

Hindocha AD, Vartak VN, Bhandari AJ, Dudani M[64] in 2010 conducted a cephalometric study on 105 dentulous subjects to determine the relationship between the plane of occlusion and the Camper's line. 7 different posterior reference landmarks of the Camper's line were studied viz., superior border of the tragus, middle of the tragus, inferior border of the tragus, above the superior border of the tragus, below inferior border of the tragus, between superior and middle of the tragus, and between middle and inferior of the tragus. It was concluded that the most viable tragal reference as a posterior landmark for the orientation of the plane of occlusion was below the inferior border of the tragus. However, it was also proved that no single tragal reference could fulfill the criteria of being the posterior landmark for the orientation of the plane of occlusion.

Venugopalan SK, Satishbabu CL, Rani MS[65] in 2012 conducted a cephalometric study to determine the relative parallelism of the occlusal plane to ala-tragus lines in various malocclusions. A total of sixty subjects belonging to Class I, Class II, and Class III malocclusions were selected for the study. A radiopaque marker of 1 mm diameter adhered against the superior, middle and inferior border of the tragus as well as against the lower border of the ala of the nose.

Lateral cephalograms were obtained for all of the patients and Tracings were performed. Analysis of Variance (ANOVA) test and Post-Hoc test of Bonferroni were done to compare the angles formed at the superior, middle, and inferior borders of tragus with the occlusal plane. The result from the present study showed that in Class I and Class III malocclusion, the line drawn from the lower border of the ala of the nose to the inferior position of the tragus (Camper' plane C) was relatively parallel to the occlusal plane; whereas, in Class II malocclusion, the line drawn from the lower border of the ala of the nose to middle border of the tragus (Camper's plane B) was relatively parallel to the occlusal plane.

So they concluded that in class I and class III malocclusions, the line is drawn from the lower border of the ala of the nose to the inferior border of tragus was parallel to the occlusal plane, and in-class II malocclusion, the line drawn from the lower border of the ala of the nose to middle of tragus was parallel to the occlusal plane.

Riccardo Rosati et al[25] in 2012 conducted a study named The occlusal plane in the facial context: inter-operator repeatability of a new three-dimensional method. The aim of the study was to assess the inter-operator repeatability of the occlusal

plane angular measurements obtained by a new non-invasive protocol. the three-dimensional (3D) position of the occlusal plane in the face is assessed and the Dental virtual models and soft tissue facial morphology of 20 adult subjects were digitally integrated. The 3D stereophotogrammetric imaging system was used to do so. The coordinates of facial and dental landmarks were obtained by two different operators digitally 3-dimensionally. Both the planes Camper's (facial) and occlusal (dental) were individuated, and their 3D relationships were analyzed. The repeatability of the protocol was investigated first and it showed no significant differences in repeated digitizations.

The angle between occlusal and Camper's planes were small in the frontal and horizontal projections. In the sagittal projection, the angle was observed to be, on average. The good agreement was obtained in occlusal plane pitch, roll, and yaw values, with previously published data obtained by different protocols. The currently used non-invasive method was repeatable. Comparisons with data obtained by different protocols and technology were performed and concluded that The occlusal plane was parallel to Camper's plane in the frontal and horizontal projections. No 'roll or yaw' of the maxillary dental arch in a facial context was demonstrated in his research.

Manesh Lahori etal[66] 2012 knowing the importance of the occlusal plane orientation in complete denture prostheses, conducted a study on the relationship between occlusal plane with ala-tragus and Camper's lines in soft tissue among individuals with class I, class II and class III occlusion. The study was aimed to determine the best soft tissue index to locate the inclination of the occlusal plane in

complete dentures that could be established. 60 subjects were selected for the same study and Lateral cephalograms were obtained. Tracings and analysis were done to confirm to the skeletal relationship of subjects to be class I (normal), class II (prognathic maxilla), and class III (retrognathic maxilla). 20 Subjects of each group were screened for further analysis. By adding Radiopaque markers to the intended points on soft tissue; standard lateral cephalograms were obtained from each subject. The following measurements were done: Occlusal line, Camper's line (ala-porion), AT1 (ala-superior border of tragus), AT2 (ala-mid-tragus), and AT3 (ala-inferior border of tragus).

The mean values and standard deviations were calculated for all three groups. The calculated values were subjected to repeated ANOVA test and significance was checked. Comparison of the results by the ANOVA test exhibited a significant difference in all three groups. In class I subjects, it was evaluated that 75 % of individuals, the posterior reference point was found to be the mid-tragus; and also in 60 % individuals of class II group. Whereas for class III subjects, in 75 % of individuals, the posterior reference point was found to be the inferior border of the tragus. They concluded that the tragal difference in this study population (class 1,2,3) was more towards the mid-tragus and inferior border of the tragus.

Therefore, the orientation of the plane of occlusion with the posterior landmark as the superior border of the tragus may be considered questionable, based on the findings of this study.

Kumar S, Garg S, Gupta S[67] in their study conducted in 2013 named A determination of occlusal plane comparing different levels of the tragus to form an

ala-tragal line or Camper's line: A photographic study. They determined accurately the part of the tragus to be used to form the ala-tragal line or Camper's line. 150 dentate subjects aged 18-40 years with an orthognathic profile were sampled. Life-size lateral digital photographs of the face with fox plane were taken in natural head position. Different angles between the Eye-Ear plane and occlusal plane (OT1 -OP), Eye-Ear plane and the ala-superior border of the tragus (OT1-AT), Eye-Ear plane and the ala-middle border of the tragus (OT1-AT2), and Eye-Ear plane and the ala-inferior border of the tragus (OT11AT) were calculated using a computer software package(AutoCAD 2004). The occlusal plane of orientation was determined from the three angles formed by the Eye-ear plane (OT3 or FH plane) and the ala-tragal lines, the one closest to the angle formed between the Eye-Ear plane (OT) and occlusal plane (OP). The results were subjected to ANOVA F test, Tukey's Honestly significant difference test, followed by Karl Pearson coefficient of correlation test. P values of less than 0.05 were taken as statistically significant.

It was concluded that the line joining ala of the nose to the lower border of the tragus was parallel to the occlusal plane in maximum subjects and there was no influence of sex on the level of the occlusal plane.

Chaturvedi S, Thombare R[68] in 2013 decided to conduct a study to find a most appropriate point on tragus to be used as a reference point at the time of marking ala tragus line while establishing occlusal plane. Data collection was done and distributed in two groups of subjects: 1) Dentulous 2) Edentulous having a sample size of 30 for each group with equal gender distribution (15 males, 15 females each). Lateral cephalograms were taken for all selected subjects and Down's analysis was

used for base values. The points were marked on the tragus of the ear as Superior (S), Middle (M), and Inferior (I) and then they were joined with ala (A) of the nose to form ala-tragus lines. The angle formed by each line (SA plane, MA plane, IA plane) with Frankfort Horizontal (FH) plane was measured with custom made device; a modified protractor in all dentulous and edentulous subjects.

Also, in addition to that angle between the Frankfort Horizontal plane and the natural occlusal plane was also measured in dentulous subjects. The measurements obtained were subjected to; descriptive analysis, Student's unpaired t-test, and Pearson's correlation coefficient. The results demonstrated, the angle COO (cant of the occlusal plane), IFH [Angle between IA plane (plane formed by joining inferior point-I on tragus and ala of the nose- A and FH plane) in dentulous and edentulous subjects. The inferior point marked on the tragus is the most appropriate point for marking the ala-tragus line.

So, they have conducted a cephalometric study to determine the most appropriate point on the tragus to be used as a reference point at the time of marking ala tragus line while establishing occlusal plane. They concluded that the inferior point marked on the tragus is the most appropriate point for marking the ala-tragus line for establishing the occlusal plane in edentulous subjects.

Jin-le Li et al[69] in 2014 conducted research were to determine if there were any differences in the inclination of OP in subjects with three types of skeletal malocclusion and also investigated the characteristics and differences of the functional occlusal plane (FOP) compared to bisected occlusal plane (BOP). A sample of 90 Caucasian patients was selected and skeletally classified into three (n = 30)

groups, and pre-and post-treatment cephalograms were digitized. Six linear and eight angular cephalometric measurements were measured.

The changes of OP inclination within each group along with the differences among the three groups pre-and post-treatment were compared with paired t-test and ANOVA test, respectively. The comparison and correlation between BOP and FOP were analyzed with paired t-test and coefficient of correlation, respectively. The Changes of occlusal plane inclination after orthodontic treatment in different dentoskeletal frames were observed. They came with a result BOP was a more reproducible reference plane compared to FOP during the cephalometric tracing process, while FOP showed stability in orthodontically treated patients with all three skeletal patterns.

Sanjna Nayar etal[70] in 2015 observed Relationship between occlusal plane and ala-tragus line in dentate individuals. In their cross-sectional study; 50 dental students (35 females, 15 males) with complete natural dentition and Angle's class - I occlusion was selected between the age groups of 20–25 years. The subjects were asked to hold a Fox plane that was covered with dental wax, between their teeth for stability. Left profile photographs were taken with a digital camera, with the subjects standing still in a natural head position. After tracing photographs, the angle between Fox plane and superior, inferior, and middle borders of the ala-tragus line was measured and statistical analysis was performed using SPSS and CAD software, version 13. (IBM SPSS Statistics Ltd. (USA).

They have concluded that the inferior border of the tragus is suggested as the posterior reference for the ala tragus line. The positioning of the occlusal plane depends on mature clinical judgment and must ultimately satisfy esthetics, function, and denture stability.

MATERIAL AND METHOD

RESEARCH METHODOLOGY:

Study Design: It is a cross sectional study

Study setting: The study will be conducted in the Department Of Orthodontics And Dentofacial

Orthopaedics. Ethical committee approval will be obtained from the Institutional EthicalCommittee.

Study population: Patient visiting the Department Of Orthodontics And DentofacialOrthopaedics for seeking orthodontic treatment and the subjects will be included in the studyas per the inclusion and exclusion criteria's.

SAMPLE SIZE:

Sample size is determined considering superior ala-tragus line as main outcome in dentatepatients.

Following assumptions made on the basis of research article (Relationship between occlusalplane and ala-tragus line in dentate individuals: A Clinical pilot study)

1. mean +- SD (AT-S) = 5.759 +- 1.321
2. Relative precision = 5% (0.2875)
3. Confidence interval = 95%

So, required sample size n = 81 (~90)

So that 90 subjects will be included in study and further equally divided in 3 sub groups.

SAMPLING THECHNIQUE:

Convenience sampling

90 untreated subjects with different facial divergence between age 16 – 25 years visiting theDepartment Of Orthodontics And Dentofacial Orthopedics for seeking orthodontic treatmentunder inclusion criteria will be included in the study.

The subjects can be divided into sub-groups of facial divergence considering proportionateallocation and the parameters of interest can be compared across sub-groups

MATERIALS:

90 subjects with different facial divergences; For example

GROUP 1 : 30 subjects of normodivergence

GROUP 2 : 30 subjects of hypodivergence

GROUP 3 : 30 subject of hyperdivergence

The following materials and armamentarium were used in the study:

For obtaining Cephalograms

- Standard Broadbent-Bolton Radiographic Cephalometer. [Xtropan 2000 Imaging Systems, 12mA, 50-85 kV, Magnification of Cephalogram - 1.1]
- Computerized Radiographic System – X-ray Reader and Developer [CR-30X, AGFA]
- Extra-oral Digital Cassette containing film of 8" x 10"

For tracing Cephalograms

- Acetate tracing paper
- 15 cm metal scale
- 15 cm plastic scale
- Scissors
- Adhesive tape
- Protractor
- 0.5 mm 2B mechanical pencil
- 2B lead box
- Mathematical set square

- 30 cm Plastic Scale
- 16 cm Roll – N – Draw Ruler
- Paper Clips
- Eraser
- X-ray illuminator

APPROPRIATE STUDY INSTRUMENT:

For tracing of radiographs

- Lateral Cephalometric radiographs in natural head posture.
- Materials for tracing the cephalogram. (lead acetate sheet, pencil, scale, eraser,protractor etc.)

For clinical observation

- Fox plane
- Scale
- Marking pencil

Inclusion criteria

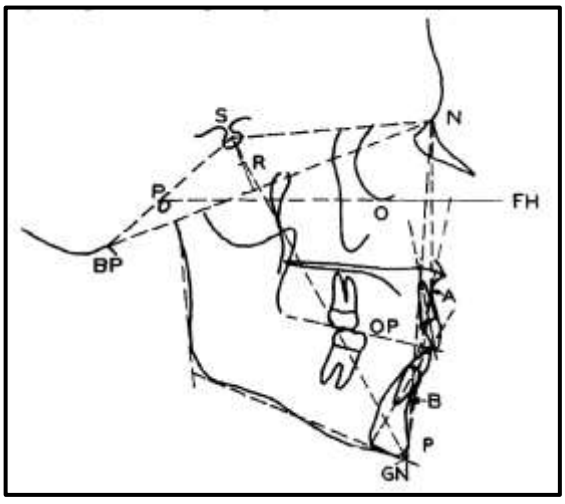
- Subjects with complete natural dentition except 3rd molars.
- Subjects within Age group of 16-25 yrs.
- Subjects with average, horizontal, vertical growth pattern.
- Subjects with overjet within range of 2-6 mm.
- Subjects with overbite in range 2-4 mm.

Exclusion criteria

- Subjects who have undergone orthodontic treatment/orthognathic surgeries.
- Subjects with severely mutilated dentition where occlusal plane has been corrected.
- Medically compromised subjects.
- Facial asymmetry and craniofacial anomaly.
- Subjects with periodontally compromised teeth, attrition of teeth, missing teeth, removable or fixed prostheses.
- Subjects with history of trauma & TMJ disorders

METHOD:

Pre-treatment lateral cephalograms of subjects, aged 16-25 years, with good definition of both hard and soft tissue landmarks, molars in maximum intercuspation with lips unstrained in natural position were taken ,and determined if they are horizontal or vertical growers on the basis of divergence of planes, at the Department of Orthodontics and Dentofacial Orthopedics.



The cephalometric measurements were obtained from tracing the cephalogram.After which cephalometric analysis was carried out to obtain readings for Down's analysis. Then with results of Down's analysis subjects were categorized whether they belongs to horizontal or vertical growers on the basis of divergence of planes. The subjects were then divided into group I, II, III.

The occlusal planes of the subjects were observed clinically and compared it with the camper's line i.e. the line joining the ala of nose and tragus of ear.

In order to determine the validity of three most commonly used posterior reference points of the ala tragus line as a guide in determining the occlusal plane in horizontally and vertically growing patient. 3 points on the tragus of the ear representing superior point(ST), middle point(MT), inferior point(IT) were marked, after which, with the help of Fox-Plane the parallelism of occlusal plane and camper's line was compared.

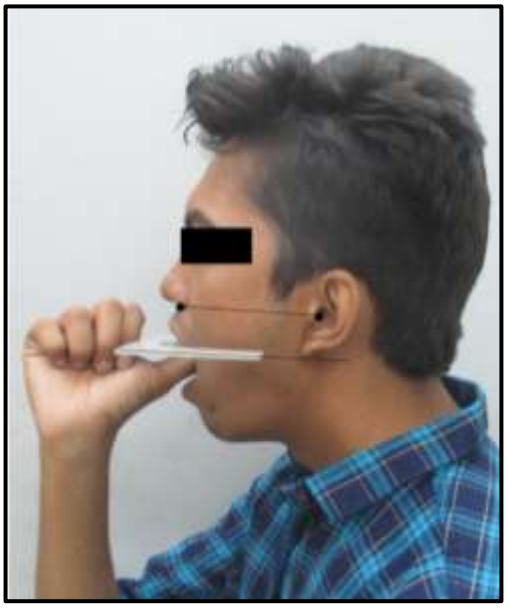
The angulation of occlusal plane and the Frankfort horizontal plane was measured in different growth pattern. And the variations in pattern were noted.

Photography of Subject seated in upright position as same as the postion for shooting lateral cephalogram

Arrow pointing the three different points on the tragus of the ear (ST, MT, IT)

Checking the parallelism of the occlusal plane to ST

Checking the parallelism of the occlusal plane to IT



Checking the parallelism of the occlusal plane to MT

STATISTICAL ANALYSIS AND RESULTS

Sample size was determined considering superior ala-tragus line as main outcome in dantate patients. Following assumptions were made on the basis of research article (Relationship between occlusal plane and ala-tragus line in dentate individuals: A Clinical pilot study)

1. mean +- SD (AT-S) = 5.759 +- 1.321
2. Relative precision = 5% (0.2875)
3. Confidence interval = 95%

So, required sample size n = 81 (~90)

so that 90 subjects will be included in study and further equally divided in 3 sub groups.

SAMPLING THECHNIQUE

Convenience sampling

STATISTICAL ANALYSIS

Data was coded and analyzed in statistical software. Descriptive statistics like mean standard deviation will be calculated to summarized quantitative variables. Frequency in percentage will be used to summarized quantitative variables.

Inferential statistics :

Procedure will include estimation procedure where mean will be estimated along with 95% confidential interval for entire group i.e. n = 90 .Test applicable was ANOVA test. Inferential statistic included analysis of various comparison of means across 3 groups, Boneferroni multiple comparison test was used to compare pair wise differences in mean of;

- Normodivergence vs. hypodivergence
- Normodivergence vs. hyperdivergence
- Hypodivergence vs. hyperdivergence

The mean values of occlusal plane- fox plane along with standard deviation and frequency distribution for positions of occlusal plane- ala-tragus line was calculated using descriptive statistics amongst the three skeletal groups.

Group 1: Normodivergent pattern

Group 2: Hypodivergent pattern

Group 3: Hyperdivergent pattern

The statistical analysis was done using the Statistical Package for the Social Science (SPSS version 22, Armonk, NY: IBM Corp). The mean values of occlusal plane-fox plane were statistically evaluated using the one-way analysis of variance test (ANOVA) for comparison amongst the three skeletal groups.

The position of occlusal plane – ala-tragus line was at middle tragus amongst the majority of patients (n=24, 83.3%) followed by middle to inferior tragus (n=5, 16.7%) in the normodivergent group. Amongst the hypodivergent group, the position of occlusal plane – ala-tragus line was at inferior tragus amongst (n=25, 83.3%) followed by middle to inferior tragus (n=5, 16.7%). The position of occlusal plane – ala-tragus line was at superior tragus amongst the majority of patients (n=21, 70%) followed by inferior tragus (n=6, 20%) and middle to superior tragus (n=3, 10%) in the hyperdivergent group. (tab 1, fig 1)

The difference between the mean values of occlusal plane- fox plane amongst the three skeletal groups was statistically significant (p=0.05). The values were highest in the hyperdivergent group (10.51 ± 2.8) followed by normodivergent group (8.73 ± 0.9) and hypodivergent group (7.85 ± 1.0). (tab 2)

The difference between the mean values of occlusal plane- fox plane amongst the three skeletal groups was statistically significant (p=0.05). The values were highest in the hyperdivergent group (10.51 ± 2.8) followed by normodivergent group (8.73 ± 0.9) and hypodivergent group (7.85 ± 1.0). (tab 2a)

When subject to post hoc analysis, it was observed that a statistically significant difference was observed between hyperdivergent and normodivergent groups (p=0.05) and hyperdivergent and hypodivergent groups (p=0.03). (tab 2b)

Amongst the normodivergent group, the position of occlusal plane- ala-tragus line was at middle tragus amongst the class 1 (n=14, 46.7%) and class 2 (n=3, 10%); at middle to inferior tragus amongst the class 1 (n=2, 6.7%) and class 2 (n=2, 6.7%). (tab 3a, fig 2a)

Amongst the hypodivergent group, the position of occlusal plane- ala-tragus line was at inferior tragus amongst class 1 (n=17, 56.7%), class 2 (n=4, 13.3%) and class 3 (n=4, 13.3%); at middle to inferior tragus amongst class 1 (n=4, 13.3%) and class 3 (n=1, 3.3%). (tab 3b, fig 2b)

Amongst the hyperdivergent group, the position of occlusal plane – ala-tragus line was at superior tragus amongst class 2 (n=16, 53.3%), class 1 (n=6, 20%); at inferior tragus amongst the class 2 (n=4, 13.3%), class 1 (n=2, 6.7%) and at middle to superior tragus amongst the class 1 group (n=2, 6.7%). (tab 3c, fig 2c)

Tab.1. Position of occlusal plane-Camper's line amongst normodivergent, hypodivergent, and hyperdivergent groups

Position of occlusal plane-Camper's line	**Skeletal groups**			
	Normodivergent (n=30)	Hypodivergent (n=30)	Hyperdivergent (n=30)	p-value
OP-IT	0	25 (83.3%)	6 (20%)	**
OP-MT	25 (83.3%)	0	0	**
OP-ST	0	0	21 (70%)	**
OP-MIT	5 (16.7%)	5 (16.7%)	0	**
OP-MST	0	0	3 (10%)	**
p-value	**	**	**	

**No statistical test was applied due to 0 subjects in the cell

Tab.2a. Descriptive statistics depicting the distribution of occlusal plane-fox plane amongst normodivergent, hypodivergent, and hyperdivergent groups

	Skeletal groups				
	Normodivergent (n=30)	Hypodivergent (n=30)	Hyperdivergent (n=30)	F-value	p-value
OP-FH (Mean ± SD)	8.73 ± 0.9	7.85 ± 1.0	10.51 ± 2.8	15.82	0.05*

*p<0.05: statistically significant using ANOVA

Tab.2b. Multiple comparisons between the groups

Groups	Mean difference	p-value
Hyperdivergent-Normodivergent	1.78	0.05*
Hypodivergent-Normodivergent	-0.88	0.71
Hyperdivergent-Hypodivergent	2.66	0.03*

*p<0.05: statistically significant using post hoc Tukey test

Tab.3. Distribution of position of occlusal plane-Camper's line amongst the three malocclusion groups

Tab.3.a. Distribution of position of occlusal plane-Camper's line amongst the normodivergent group

Position of occlusal plane-Camper's line	Normodivergent group (n=30)			p-value
	Class 1	Class 2	Class 3	
OP-IT	0	0	0	*
OP-MT	14 (46.7%)	3 (10%)	0	
OP-ST	0	0	0	
OP-MIT	2 (6.7%)	2 (6.7%)s	0	
OP-MST	0	0	0	
p-value	*			

*No statistical test was applied due to 0 subjects in the cell

Tab.3.b. Distribution of position of occlusal plane-Camper's line amongst the hypodivergent group

Position of occlusal plane-Camper's line	Hypodivergent group (n=30)			p-value
	Class 1	Class 2	Class 3	
OP-IT	17 (56.7%)	4 (13.3%)	4 (13.3%)	0.05*
OP-MT	0	0	0	**
OP-ST	0	0	0	
OP-MIT	4 (13.3%)	0	1 (3.3%)	
OP-MST	0	0	0	
p-value	**			

*p<0.05: statistically significant using Chi square tests; **No statistical test was applied due to 0 subjects in the cell

Tab.3.c. Distribution of position of occlusal plane-Camper's line amongst the hyperdivergent group

Position of occlusal plane-Camper's line	Hyperdivergent group (n=30)			p-value
	Class 1	Class 2	Class 3	
OP-IT	2 (6.7%)	4 (13.3%)	0	*
OP-MT	0	0	0	
OP-ST	6 (20%)	16 (53.3%)	0	
OP-MIT	0	0	0	
OP-MST	2 (6.7%)	0	0	
p-value	*			

*No statistical test was applied due to 0 subjects in the cell

Graphs:

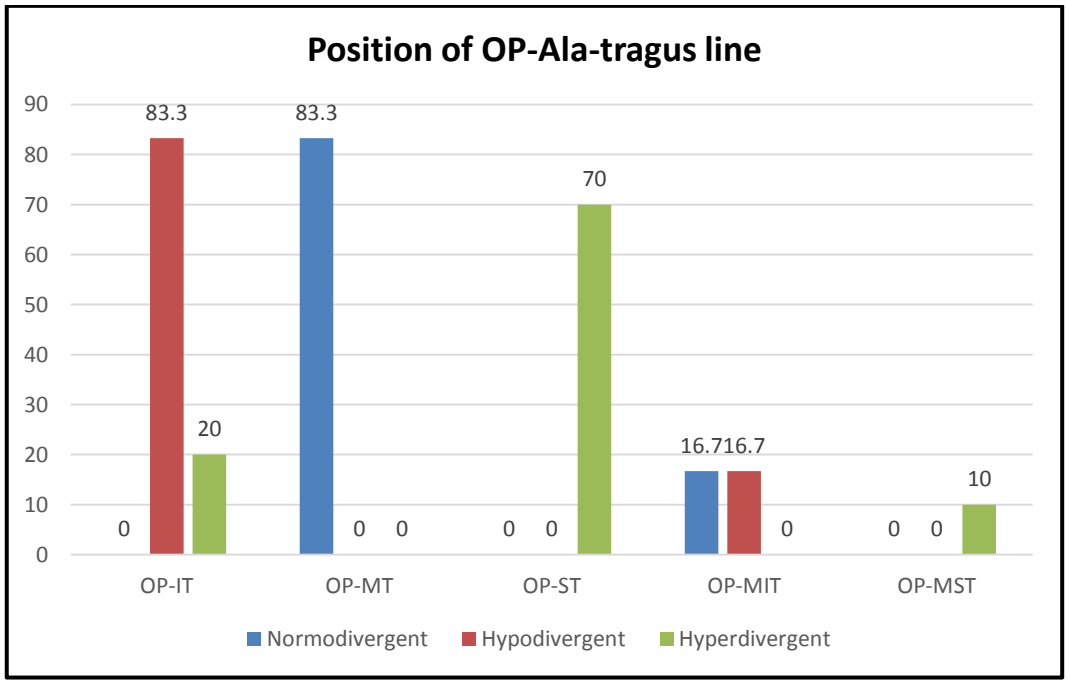


Fig 1. Position of occlusal plane-Camper's line amongst normodivergent, hypodivergent, and hyperdivergent groups

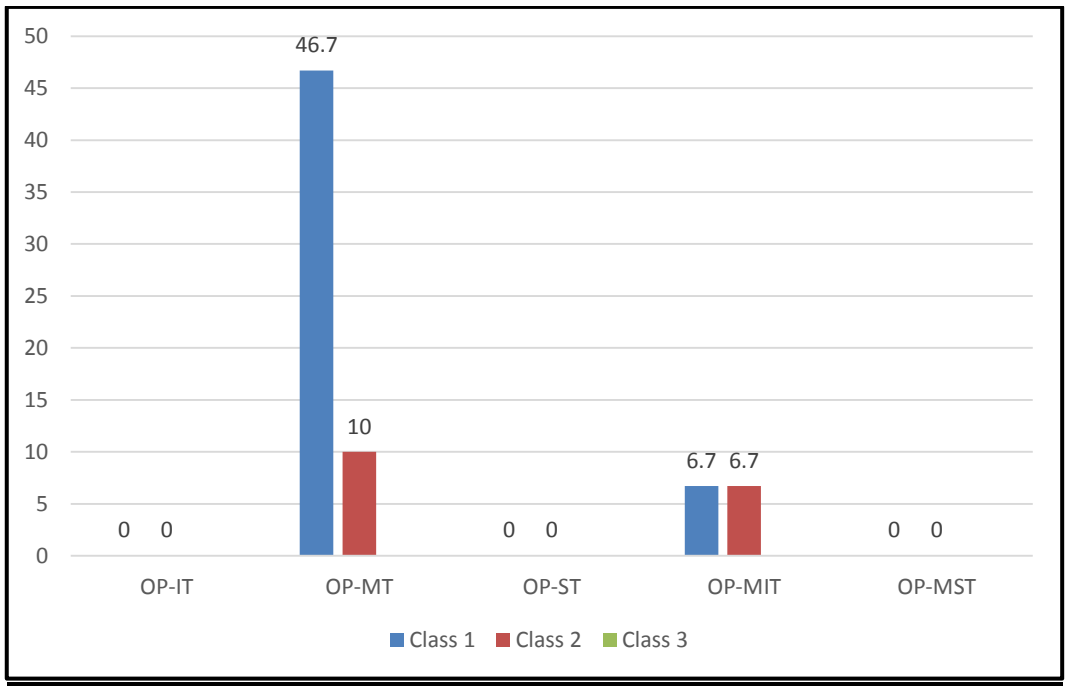


Fig 2a. Distribution of position of occlusal plane-Camper's line amongst the normodivergent group

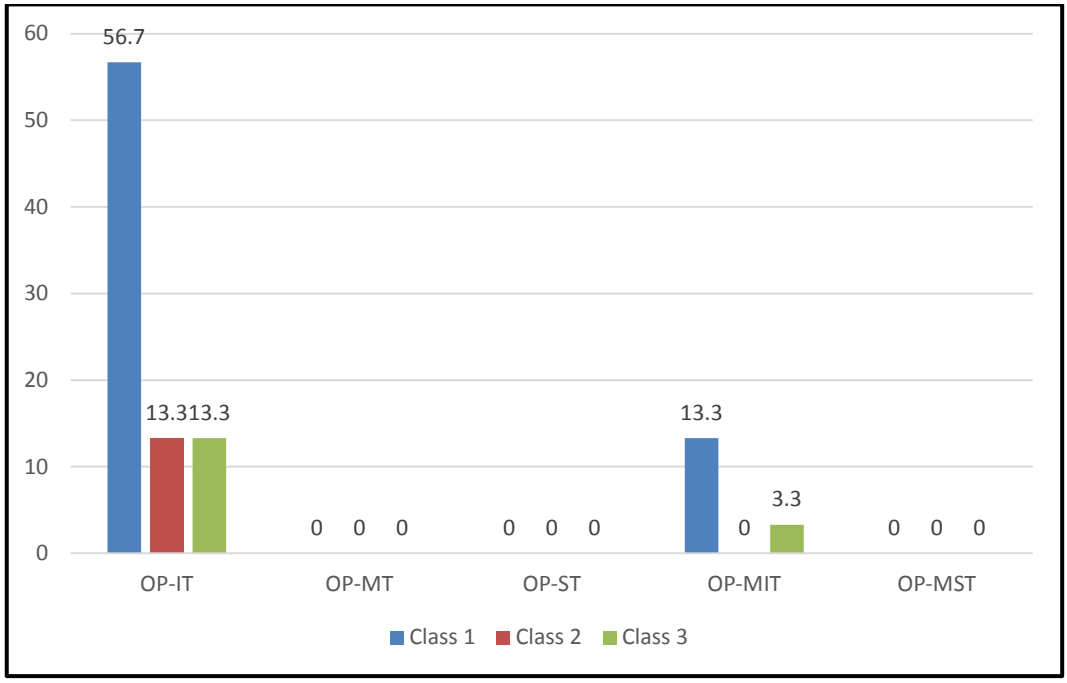


Fig 2b. Distribution of position of occlusal plane-Camper's line amongst the hypodivergent group

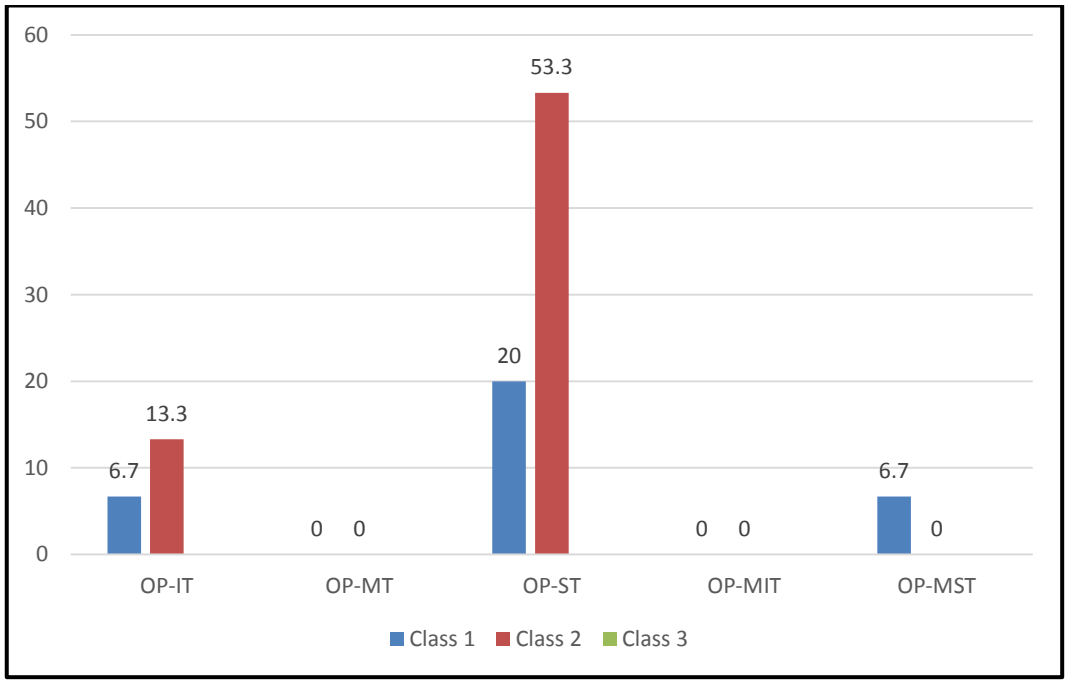


Fig 2c. Distribution of position of occlusal plane-Camper's line amongst the hyperdivergent group

DISCUSSION

The occlusal plane is designed in a fashion such as to be acknowledged as nature's wonderful expression of dynamic harmony within the craniomaxillary complex components. According to Boucher, "It seems to be obvious that if the soft tissue surrounding the denture is to figure around as they did around natural teeth, OP must be positioned exactly as it was when the natural teeth were present." This statement substantiates the biological plausibility of normally functioning tongue and cheeks musculature in the presence of natural teeth. This justifies for assessment of OP orientation in dentulous subjects to determine OP orientation in edentulous counterparts.

A literature review reveals that debate exists over the exact definition of the ala-tragus or Camper's line. Most of the controversy revolves surrounding which tragal reference is considered a posterior landmark during orientation of the plane of occlusion. Van Niekerk[21] et al. constructed the plane of occlusion consistent with their

subjective criteria of esthetics, function, and luxury. The already set plane of occlusion was then checked against the ala-tragus line only at the ultimate denture insertion appointment. Their out-turn showed a close relationship between the two planes if the ala-tragus line's tragal reference was dropped to the inferior border of tragus.

According to Boucher, "It seems obvious that if the soft tissue surrounding the denture is to figure around as they did around natural teeth, occlusal plane should be oriented exactly as it was when the natural teeth were present". It has been suggested that such an edge of the occlusal plane enhance denture stability and functional value. The occlusal plane forms a basis for ideal teeth arrangement and fulfils the necessary mechanical, esthetic requirement and aid in deglutition[21,43,44].

Establishing the plane of occlusion in rehabilitating completely edentulous patients is one of the important considerations that determine the case's prognosis. Based on the biomechanical and physiological considerations, the tongue and cheeks' musculature were trained such that they could function normally at this level where natural teeth were present. They will again function correctly when called upon to stabilize the bolus of food at the same vertical position of the occlusal table existed in the first place[1,71.]

Though there are several methods to set up the plane of occlusion, the ala-tragal line seems to be the most widely used guideline. Studies have demonstrated that all the three positions of the tragus, i.e. superior, middle and inferior, are considered to work out the ala-tragal lines to determine the plane of occlusion.

The results also support all three positions. However, there were not many studies found to have taken into consideration the skeletal malocclusions, i.e. Class I, Class II and sophistication III in determining which of the three positions of the tragus will help us in favourably locating an alatragal line that's acceptable from a biomechanical and physiologic point of view. Hence, this study was undertaken to work out which of the three positions on the tragus, i.e. superior, middle or inferior, while determining the Camper's plane in dentulous subjects will help us establish the plane of occlusion in normotensive, hypotensive and hypertensive individuals[52,71].

The use of the ala-tragus line (Camper's line) as a guideline and reference has gained popularity since it is easily visualized, thus making the plane of occlusion more convenient. Many studies have used it to determine the relationship between the plane of occlusion and the Camper's plane[64].

The present study was conducted to determine the Occlusal plane relationship to the ala – tragus line measured on 3 points – Superior (ST), middle (MT) and inferior (IT). Additional two readings of middle and superior point (MST) and middle to inferior (MIT).

Subjects were categorised into 3 groups, namely normodivergent, hypodivergent and hyperdivergent, with 30 individuals. The groups were divided by calculating the angle between the FH line and the mandibular plane. The occlusal plane's angle and the same FH line were calculated and generally in the range of 1.5 to 14 degrees.

SAMPLE SIZE

As the study recruited three groups of subjects with normodivergent, hypodivergent, and hyperdivergent to be evaluated separately, the sample size in each of these groups was kept as 30 subjects so that statistically significant conclusions might be drawn from the results of the study. This is in accordance with the previous study of Venugopalan SK et al., who had 20 patients in each category[65,70]. The dentulous subjects for this study were selected from patients and students from a dental college to meet the inclusion and exclusion criteria' requirements.

AGE GROUP

The age group of the study subjects chosen fell in the younger age range of 16-25 years, as the full complement of teeth with little or no wasting diseases can be found in this age group more willingly. Subjects with wasting diseases like attrition, extensive restorations (long span bridges- greater than 4 units), history of treatment and TMJ pathologies were excluded. These conditions influence jaw position and ridge relation. Subjects younger than 14 years wouldn't have the complete complement of teeth. Hence the occlusion cannot be easily determined, and subjects older than 24 years can have wasting diseases, TMJ pathologies, extensive restorations and periodontal problems, making them unsuitable candidates for the study65.

LATERAL CEPHALOGRAMS VERSUS PHOTOGRAPHS

Though photographs and lateral cephalograms have been used in earlier studies to determine the suitable plane of occlusion, in the present study, right lateral cephalograms were used to study the relationship between the three different Camper's plane and the occlusal plane, as lateral cephalograms can be standardized for all subjects. And also, it had been a far better method of locating the occlusal plane as compared to photographs. cephalogram is considered, a contemporary and popular diagnostic tool in prosthodontics. It was chosen because the mode for our study as radiographic studies have the potential to look at the relation between various cranial reference lines. The cephalometric analysis makes use of angular measurements which are relatively stable with reference to time, i.e., they're minimally suffering from age. They could provide useful information on the orientation of the OP in dentulous and edentulous subjects as they can re - establish the spatial position of lost structures such as teeth. One such universally accepted craniometric landmark, FH plane was taken as a standard reference plane[72,73].

In this study, the widely accepted Downs analysis[14,16] was used as a base line for comparison. Standardization of lateral cephalogram altogether the three planes was done to attenuate errors. FH plane is kept horizontal to the floor which is confirmed using a plumb line hung from the cephalostat to indicate the true vertical. Both ear rods of cephalostat machine ensured stability of the transverse plane. The nasion holder of the cephalostat stabilized the head in the vertical plane. Angular measurements were used rather than linear measurements within the current cephalometric analysis on the idea of the justification that they're practical, simple and are independent aged and sexual dimorphism[73,74].

NORMODIVERGENT GROUP

The occlusal plane – ala tragus line in the normodivergent group in the current study was found at middle tragus (83.3%) and OP -MIT (16.7%). In contrast, the study of Nitasha Gandhi et al[75]. showed that OP was oriented towards the inferior point of ala – tragus line in orthognathic completely edentulous population in class I jaw relationship. Sadr[62] et al., on the other hand, found a superior border of tragus as a posterior reference for ala tragal line. This variation could be attributed to the inclusion of diverse race and ethnic population.

HYPODIVERGENT GROUP

Amongst the hypodivergent group, the position of occlusal plane- ala-tragus line was at inferior tragus amongst class 1 (n=17, 56.7%), class 2 (n=4, 13.3%) and class 3 (n=4, 13.3%); at middle to inferior tragus amongst class 1 (n=4, 13.3%) and class 3 (n=1, 3.3%). (tab 3b, fig 2b)

HYPERDIVERGENT GROUP

Amongst the hyperdivergent group, the position of occlusal plane – ala-tragus line was at superior tragus amongst class 2 (n=16, 53.3%), class 1 (n=6, 20%); at inferior tragus amongst the class 2 (n=4, 13.3%), class 1 (n=2, 6.7%) and at middle to superior tragus amongst the class 1 group (n=2, 6.7%). (table 3c, figure 2c)

It can be observed from the above findings that different facial forms exhibit different occlusal plane orientation. This study finding was supported quite early in the literature. Hartono[52] conducted a study on 53 dental students to determine a correlation between the occlusal plane and facial types and determine the a part of the Tragus for the posterior reference point of Camper's plane. The different facial types

studied were maxillary protrusion, maxillary retrusion, bimaxillary protrusion, mandibular protrusion and mandibular retrusion. Occlusal plane inclination with respects Ala-Tragus plane was measured on lateral profile photographs. Statistical analysis and results of the study indicate that among the various facial types studied, the plane connecting rock bottom point of the Ala of the nose to the inferior margin of the Tragus is almost parallel to the occlusal plane, and this plane is mentioned as Camper's plane when employed by the Prosthodontists. Such occlusal plane orientation in patients with mandibular retrusion was steeper compared to what found in mandibular protraction cases. The author concluded that a correlation exists between facial types and the location of the occlusal plane.

The interesting finding that was observed during this study is about the class 2 and hyperdivergence because of extrution of posterior maxillary teeth. This results in the change in the orientation of occlusal plane. The occlusal plane in these particular cases were seen tipping upward anteriorly. This results in the conclusion that in the hyerdivergent subjects sometimes the OP may come parallel to inferior tragus line. So sometimes the orientation of occlusal plane varies depending upon the extrusion and intrusion of the posterior as well as anterior tooth. So in concluding, one has to check the subject intraorally and cephalometrically and then decide for the reference plane.

OVERALL ASSESSMENT

Thus, it can be inferred from the results of our study that the ala-tragus line passing through middle point on the tragus is the most suitable plane to orient the OP in normotensive, inferior tragal point in the hypodivergent and superior point of the

tragal line in the hyperdivergent population. Also, a definite correlation exists between facial types and the occlusal plane.

Post hoc analysis demonstrated a statistically significant difference was observed between hyperdivergent and normodivergent groups (p=0.05) and hyperdivergent and hypodivergent groups (p=0.03).

CONFLICTING CONCEPTS

A literature review 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 taken into account a posterior landmark during orientation of the plane of occlusion. Van Niekerk et al[21]. constructed the plane of occlusion consistent with their subjective criteria of esthetics, function, and luxury . The established plane of occlusion was then checked against the ala-tragus line only at the ultimate denture insertion appointment. Their results showed a close relationship between the two planes if the ala tragus line's tragal reference was dropped to the inferior border of the tragus.

VARIATIONS IN ANGLE

The difference between the mean values of the occlusal plane- fox plane amongst the three skeletal groups was statistically significant (p=0.05). The values were highest in the hyperdivergent group (10.51 ± 2.8), followed by normodivergent group (8.73 ± 0.9) and hypodivergent group (7.85 ± 1.0). IOP mean angular measurement in Nitasha Gandhi et al75. also reported similar values with 7.4650 + 4.66356 among SOP in the Ludhiana population. The MOP and IOP values were slightly lesser than the present study, with recordings of 4.895+3.69295 and

4.3350+3.07076, respectively. The variation in the two studies' values of angles is due to different populations under study inheriting varied ethnicity.

In contrast, Chaturvedhi et al[68]. also had a mean angular value of IOP 2.46 ± 2.48°, which was the least amongst SOP and MOP. Also similar to this observation was the study of van Niekerk et al[21]., who recorded and measured an angle between the occlusal plane of complete dentures and a ala tragus line (inferior point on tragus was used) as 2.45° (SD = 3.24). This means that the line drawn from the inferior point of tragus to ala of the nose was the parallel most line with the occlusal plane in subjects who where dentulous than the lines from the superior and middle point of tragus with ala of the nose. This underlined the importance of using "Inferior point" for marking the ala-tragus line during the recording of jaw relation for the edentulous patient.

Possible reasoning for the wide selection of the measured angles are often individual morphological variations. Further, this much variation may be deemed clinically acceptable since Shillingburg et al[76]. stated that up to 8° of difference in angular perception does occur in binocular vision. This is substantiated by Kumar[67] et al., stating that such a difference in vision reinforces a stable relation between the FH plane and OP. The studies by Siefert[77] and Kumar[67] et al. reinforced a relative consistency in the angle between OP-FH plane in dentulous subjects with Angle's Class I jaw relationship. These findings have an impact within the arena of complete denture therapy since they will be correlated, aiding in establishing an accurate method for OP determination in orthognathic completely edentulous individuals.

VALIDITY OF ALA TRAGUS LINE IN THE OCCLUSAL PLANE DETERMINATION

Some of the existing concepts regarding the occlusal plane's orientation in the edentulous patients believe that the occlusal plane has a relation with Camper's line. It is the oldest, simplest and most ordinarily used method. It would seem desirable to locate it accurately and propagate its use while establishing the occlusal plane. The definitions of the ala-tragus line have created confusion. The exact points of references on tragus and ala are not categorically specified[46].

Spratley described it as running from the centre of the ala to the centre (middle) of the tragus. Boucher [43,44] defines it as "The line running from the inferior border of the ala of the nose to the superior border of the tragus of the ear." However, out of the seven texts that propound its use, only one has provided a proper definition and cites Boucher's definition. Two texts recommended the concept without defining or illustrating it, while three provided only pictorial representation. The latter is of immediate concern, for in each illustration, Camper's line is depicted as extending to a point, not at the superior border, but the centre of the tragus of the ear[54].

CLINICAL SIGNIFICANCE:

From the basic principles of mathematics; if line A is parallel to line B (where A is occlusal plane & B is camper's line) and line C (FH plane) and line A are in angle say X; then line C will form same angle with line B.

So, Any change between the occlusal plane and the ala-tragus line angulation during the treatment can be directly related to the change in the orientation between the occlusal plane and FH plane.

According to Downs; in his dental parameters; he included the cant of occlusal plane. According to his observation the value may lie in minimal angular measurement $+1.5^0$ to max $+14^0$ with the mean of $+9.3^0$.

So after observation and results of this study related to the occlusal plane and most parallel position of ala-tragus line in the horizontal or vertical growers, the variation in the angulation can be judged during treatment; Hence the ala-tragus line can be used as a chair side guide for determination of occlusal plane variation during treatment, Considering ala-tragus line as fixed reference line.

LIMITATIONS

No table limitations of the current study are that the age changes within the tragus and ala of the nose were not considered as it may affect OP orientation in older edentulous patients. Second, reflection on variations within the angular relationships supported gender differences has got to be investigated.

SUGGESTIONS AND RECOMMENDATIOS

Literature fails to correlate certain anatomical planes as an anatomical guide to ease the lost occlusal plane's establishment. If the occlusal plane's concept has to be based on what existed naturally, then the two anatomical planes (i.e., Camper's plane and FH plane) are accurate. However, various parameters like a rise in, loss of neuromuscular control, tongue size, variability in resorption in both Mandible and Maxilla, sequel of natural tooth extraction are difficult to standardize in patients. Yet, further studies on a longer scale with definite inclusion criteria need to be conducted to understand more comprehensively.

LIMITATION

No table limitations of the current study are that the age changes within the tragus and ala of the nose were not considered as it may affect OP orientation in older edentulous patients.

Second, reflection on variations within the angular relationships supported gender differences has got to be investigated.

The orientation of the occlusal plane seen to be varying in the subjects having hyperdivergence because of the extrusion of the posterior teeth, so further study with the particular inclusion criterion has to be conducted to conclude the result more precisely.

SUMMARY

The above study says,

1. The occlusal plane position – the ala-tragus line was at middle tragus amongst most patients (n=24, 83.3%), followed by middle to inferior tragus (n=5, 16.7%) in the normodivergent group.

2. Amongst the hypodivergent group, the occlusal plane position – the ala-tragus line was at inferior tragus amongst (n=25, 83.3%), followed by the middle to inferior tragus (n=5, 16.7%).

3. The position of the occlusal plane – the ala-tragus line was at superior tragus amongst the majority of patients (n=21, 70%), followed by inferior tragus (n=6, 20%) and middle to superior tragus (n=3, 10%) in the hyperdivergent group.

4. The difference between the mean values of the occlusal plane- fox plane amongst the three skeletal groups was statistically significant (p=0.05). The values were highest in the hyperdivergent group (10.51 ± 2.8), followed by normodivergent group (8.73 ± 0.9) and hypodivergent group.

5. Ala tragal line can be used as a guideline for orienting OP among all different growth patterns.

CONCLUSION

1. The present study was conducted to determine occlusal plane orientation on the ala tragal line in various growth patterns
2. Ninety dentate subjects were included in the age range of 16 – 25 years.
3. Institutional ethical committee approval was obtained before the start of the study.
4. Cephalometric measurements were obtained through cephalogram tracings.
5. Down's analysis subjects were categorized as horizontal or vertical growers based on the divergence of planes. The subjects were then divided into group I, II, III
6. Subjects were categorised into 3 groups, namely normodivergent, hypodivergent and hyperdivergent, with 30 individuals.

7. The occlusal plane position – the ala-tragus line was at middle tragus amongst most patients (n=24, 83.3%), followed by middle to inferior tragus (n=5, 16.7%) in the normodivergent group.
8. Amongst the hypodivergent group, the occlusal plane position – the ala-tragus line was at inferior tragus amongst (n=25, 83.3%), followed by the middle to inferior tragus (n=5, 16.7%).
9. The position of the occlusal plane – the ala-tragus line was at superior tragus amongst the majority of patients (n=21, 70%), followed by inferior tragus (n=6, 20%) and middle to superior tragus (n=3, 10%) in the hyperdivergent group.
10. The difference between the mean values of the occlusal plane- fox plane amongst the three skeletal groups was statistically significant (p=0.05). The values were highest in the hyperdivergent group (10.51 ± 2.8), followed by normodivergent group (8.73 ± 0.9) and hypodivergent group.
11. In most of the normodivergent subjects, it can be concluded that the line of reference is middle tragus line. In hypodivergent subjects, the line of reference is inferior tragus line and in hyperdivergent, it is the superior tragus line for most of the times.
12. So, the respective line can be used as the guideline for occlusal plane orientation during orthodontic treatment which ultimately reduced frequency of exposure to the x-rays and intermittent radiographs mean while ongoing treatment.
13. Ala tragus line can be used as a guideline for orienting OP among all different growth patterns.

BIBLIOGRAPHY

1. Monteith BD. A cephalometric method to determine the angulation of the occlusal plane in edentulous patients. The Journal of prosthetic dentistry. 1985 Jul 1;54(1):81-7.

2. Shetty S, Zargar NM, Shenoy K, Rekha V. Occlusal plane location in edentulous patients: A review. The Journal of Indian Prosthodontic Society. 2013 Sep 1;13(3):142-8.

3. Rangarajan V, Yogesh PB, Gajapathi B, Ibrahim MM, Kumar RG, Karthik M. Concepts of occlusion in prosthodontics: A literature review, part II. The Journal of the Indian Prosthodontic Society. 2016 Jan;16(1):8.

4. Silverman SI. Denture prosthesis and the functional anatomy of the maxillofacial structures. Journal of Prosthetic Dentistry. 1956 May 1;6(3):305-31.

5. ČELEBIĆ A, VALENTICcar-PERUZOVIĆ M, Kraljević K, Brkić H. A study of the occlusal plane orientation by intra-oral method (retromolar pad). Journal of oral rehabilitation. 1995 Mar;22(3):233-6.

6. Radiographic Cephalometry : From Basics to 3-D Imaging By Richard Jacobson & Alex Jacobson

7. Lamarque S. et al; The importance of occlusal plane control during orthodontic mechanotherapy. Am J Orthod Dentofacial Orthop. 1995; (107):548–58.

8. Fox FA. The principles involved in full upper and lower denture construction. Dent Cosm. 1924;66:151.

9. The Academy of Prosthodontics. The glossary of prosthodontics terms. 6th ed. J Prosthet Dent 1994;71:41-121.

10. Kazanoglu A, Unger JW. Determining the occlusal plane with the Camper's plane indicator. The Journal of prosthetic dentistry. 1992 Apr 1;67(4):499-501.

11. Javid NS. A technique for determination of occlusal plane. J Prosthet Dent 1974;31:270-2.

12. Boucher CO. Swenson's Complete Dentures, ed. 6, St. Louis, The C. Mosby Company. 1970:1964.

13. Ismail YH, Bowman JF. Position of the occlusal plane in natural and artificial teeth. The Journal of prosthetic dentistry. 1968 Nov 1;20(5):407-11.

14. Karkazis HC and Polyzois GL. A study of occlusal plane orientation in complete denture construction. J Oral Rehab 1987;14:399-404.

15. Wilder HH. A laboratory manual of anthropometry. P. Blakiston's Son & Company; 1920.

16. EGR S. Dependability of Tragus Terminology. The Journal of Japan Gnathology. 1998 Sep 30;19(2):236-41.

17. Solomon EG. The morphology of tragus part I: confusion about tragus terminology. J Indian Prosthodont Soc. 2000;11(1):11-5.

18. The Academy of Prosthodontics: Glossary of Prosthodontic terms. 7 edition. J Prosthet Dent 1999;81:48-110.

19. Heartwell CM, Rahn AO. Syllabus of complete dentures. Lea & Febiger; 1980.

20. Winkler S. Essentials of complete denture prosthodontics. 2PSG publishing co., INC., Massachusetts 1998.

21. Van Niekerk FW, Miller VJ, Bibby RE. The ala-tragus line in complete denture prosthodontics. The Journal of prosthetic dentistry. 1985 Jan 1;53(1):67-9.

22. Downs WB. Variations in facial relationships: their significance in treatment and prognosis.Eur J Orthod. 1948; (34)812–40

23. Downs, W.B.: The role of cephalometrics in orthodontic case analysis and diagnosis, Am. J.Orthod.1952;(38)162-182.

24. Baum, A.T.: Downs' analysis template transparencies for application directly to cephalometric x-ray films, Angle Orthod. 1952;(22)224.

25. Rosati R, Rossetti A, Menezes MD, Ferrario VF, Sforza C. The occlusal plane in the facial context: inter-operator repeatability of a new three dimensional method. Int J Oral Sci. 2012;(4):34–7.

26. Camper P. Race and Esthetics in the anthropology of Petrous Camper1780:121.

27. Hartono R. The occlusal plane relation to facial types. J Prosthet Dent1967;(17)549-67.

28. Broadbent BH. A new x-ray technique and its application to orthodontia. The Angle Orthodontist. 1931 Apr;1(2):45-66.

29. Hofrath H. Die bedeutung der röntgenfern-und abstandsaufnahme für die diagnostik der kieferanomalien. Fortschritte der Orthodontik in Theorie und Praxis. 1931 Apr 1;1(2):232-58.

30. Broomell IN. The value of tempera-mental indications in the correct proshtesis of entire dentures. Dent. Cosmos. 1897;39:1-20.

31. Clapp GW. Mechanical side of anatomical articulation. Dental Digest; 1910.

32. Dalby WC: Importance of the occlusal plane. D. Items Interest. 1912;34:740-42.

33. Dalby WC: (1) How to obtain accurate measurements in artificial denture making. (2) Locating the fundamental lines used in anatomical articulation. D. Cosmos 1914;56:269-75.

34. Wilson, George H. A Manual of Dental Prosthetics, ed 3, Philadelphia, 1917, Lea and Febiger, p. 18,154.

35. Ruppe L. The occlusal. An apparatus to determine the position of the occusal plane in proshtetic and ortodontia cases. Dent. Rec.. 1920;40:637-9.

36. Wilder HH. A laboratory manual of anthropometry. P. Blakiston's Son & Company; 1920.

37. Clapp GW, Tench RW. Professional Denture Service. Dentists' Supply Company; 1921.

38. Giffen WA. The fundamentals of denture construction. D. Summary. 1925;45:894-901.

39. Clapp, George W, Tench, Wilford R. Professional Denture Service, New York, 1926, The Dentist's Supply Company, 1:51.

40. Gillis RR. A denture technic applicable by the average dentist. The Journal of the American Dental Association (1922). 1933 Feb 1;20(2):305-16.

41. Kurth LE. The posterior occlusal plane in full denture construction. The Journal of the American Dental Association. 1940 Jan 1;27(1):85-93.

42. Landa JS. Practical full denture prosthesis. Dental items of interest. 1946 Feb;68:155.

43. Boucher CO. Dental prosthetic laboratory manual. CV Mosby Company; 1950.

44. Boucher CO. Occlusion in prosthodontics. Journal of Prosthetic Dentistry. 1953 Sep 1;3(5):633-56.

45. Sloane RB, Cook J. A guide to the orientation of the plane of occlusion. Journal of prosthetic dentistry. 1953 Jan 1;3(1):53-65.

46. Augsburger RH. Occlusal plane relation to facial type. The Journal of Prosthetic Dentistry. 1953 Nov 1;3(6):755-70.

47. Ricketts RM. The role of cephalometrics in prosthetic diagnosis. Journal of prosthetic dentistry. 1956 Jul 1;6(4):488-503.

48. Ausburger, R. H.: Occlusal Plane in Relation to Facial Type, J. PROS. DENT. 1953 (3): 755-110.

49. Ricketts RM. An Exercise in stating objectives and planning treatment with tracings of roentgenogram. Am J Orthod. 1960;46:647-93.

50. Olsson A, Posselt U. Relationship of various skull reference lines. The Journal of Prosthetic Dentistry. 1961 Nov 1;11(6):1045-9.

51. Silverman MM. Occlusion in Prosthodontics and in the Natural Dentition. Mutual Publishing Company; 1962.

52. Hartono R The occlusal plane in relation to facial types. J Prosthet Dent 1967,17(6):549–558.

53. L'Estrange PR, Vig PS. A comparative study of the occlusal plane in dentulous and edentulous subjects. The Journal of prosthetic dentistry. 1975 May 1;33(5):495-503.

54. Spratley MH. A simplified technique for determining the occlusal plane in full denture construction. Journal of oral rehabilitation. 1980 Jan;7(1):31-3.

55. Karkazis HC, Polyzois GL. Cephalometrically predicted occlusal plane: Implications in removable prosthodontics. The Journal of prosthetic dentistry. 1991 Feb 1;65(2):258-64.

56. D'Souza NL, Bhargava K. A cephalometric study comparing the occlusal plane in dentulous and edentulous subjects in relation to the maxillomandibular space. The Journal of prosthetic dentistry. 1996 Feb 1;75(2):177-82.

57. Solomon EG, Sridhar Shetty N, Marla V. The morphology of tragus. part II: Reliability of tragus morphology and its reference to established camper's plane. J Inf Proc Syst. 2000;11(3):16-22.

58. Solomon EGR, Shetty NS, Shetty O, Mudia PK. Definability of tragus morphology as a refence landmark in edentulous subjects. J Indian Prosthodont Soc 2000;11:23-6.

59. Nissan J, Barnea E, Zeltzer C, Cardash HS. Relationship between occlusal plane determinants and craniofacial structures. Journal of oral rehabilitation. 2003 Jun;30(6):587-91.

60. Rostamkhani F, Sahafian A, Kermani H. A cephalometric study on the relationship between the occlusal plane, ala-tragus and camper's lines, in patients with angle's class III malocclusion. J Dent 2005;2:46-9.

61. Shigli K, Chetal BR, Jabade J. Validity of soft tissue landmarks in determining the occlusal plane. The Journal of Indian Prosthodontic Society. 2005 Jul 1;5(3):139.

62. Sadr K, Sadr M. A study of parallelism of the occlusal plane and ala-tragus line. Journal of dental research, dental clinics, dental prospects. 2009;3(4):107.

63. Quran FA, Hazza'a A, Nahass NA. The position of the occlusal plane in natural and artificial dentitions as related to other craniofacial planes. Journal of Prosthodontics: Implant, Esthetic and Reconstructive Dentistry. 2010 Dec;19(8):601-5.

64. Hindocha AD, Vartak VN, Bhandari AJ, Dudani M. A cephalometric study to determine the plane of occlusion in completely edentulous patients: Part I. The Journal of Indian Prosthodontic Society. 2010 Dec 1;10(4):203-7.

65. Venugopalan SK, SatishBabu CL, Rani MS. Determination of the relative parallelism of occlusal plane to three ala-tragal lines in various skeletal malocclusions: A cephalometric study. Indian Journal of Dental Research. 2012 Nov 1;23(6):719.

66. Lahori M, Nagrath R, Malik N. A cephalometric study on the relationship between the occlusal plane, Ala-Tragus and Camper's lines in subjects with

Angle's class I, class II and class III occlusion. The Journal of Indian Prosthodontic Society. 2013 Dec;13(4):494-8.

67. Kumar S, Garg S, Gupta S. A determination of occlusal plane comparing different levels of the tragus to form ala-tragal line or Camper's line: A photographic study. The journal of advanced prosthodontics. 2013 Feb;5(1):9.

68. Chaturvedi S, Thombare R. Cephalometrically assessing the validity of superior, middle and inferior tragus points on ala-tragus line while establishing the occlusal plane in edentulous patient. The journal of advanced prosthodontics. 2013 Feb;5(1):58.

69. Jin-Li, Kau CH, Wang M. Changes of occlusal plane inclination after orthodontic treatment in different dentoskeletal frames. Progress in orthodontics. 2014 Dec;15(1):1-0.

70. Nayar S, Bhuminathan S, Bhat WM, Mahadevan R. Relationship between occlusal plane and ala-tragus line in dentate individuals: A Clinical pilot study. Journal of pharmacy & bioallied sciences. 2015 Apr;7(Suppl 1):S95.

71. FU PS, HUNG CC, HONG JM, WANG JC. Three-dimensional analysis of the occlusal plane related to the hamular–incisive–papilla occlusal plane in young adults. Journal of oral rehabilitation. 2007 Feb;34(2):136-40.

72. Rajawat I, Venkataramana V, Patil P, Guram G, Gupta N, Lau M, Thakkar P, Shah DM. A cephalometric evaluation for co-relation of different facial types with occlusal plane in dentulous and edentulous patients. OHDM. December. 2014;13(4).

73. Walker GF, Kowalski CJ. Use of angular measurements in cephalometric analyses. Journal of dental research. 1972 Jul;51(4):1015-21.

74. Bansal N, Singla J, Gera G, Gupta M, Kaur G. Reliability of natural head position in orthodontic diagnosis: A cephalometric study. Contemporary clinical dentistry. 2012 Apr 1;3(2).

75. Gandhi N, Daniel S, Kurian N. Cephalometric study of the position of ala-tragus line in relation to Frankfort horizontal plane and occlusal plane among Ludhiana population. Indian Journal of Dental Sciences. 2017 Jul 1;9(3):165.

76. Shillingburg HT, Hobo S, Whitsett LD, Jacobi R, Brackett SE. Fundamentals of fixed prosthodontics. Quintessence Publishing Company; 1997 Jan.

77. Seifert D, Jerolimov V, Carek V, Ibrahimagić L. Relations of reference planes for orientation of the prosthetic plane. Acta Stomatologica Croatica. 2000 Dec 15;34(4):413-6.

COLOUR PLATES I

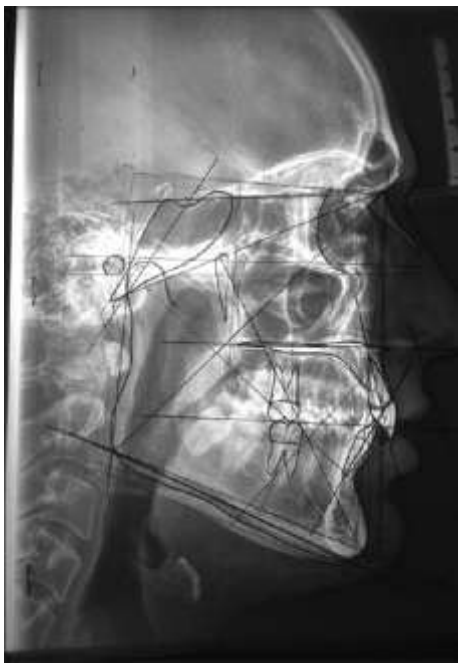
FiG A DIGITAL LATERAL CEPHALOGRAM MACHINE

Fig B. DIGITAL PRINTER (FUJIFILM DRY PIX SMART)

COLOUR PLATE II

Fig C. COPY OF LATERAL CEPHALOGRAM

Fig D. CALIBERATION OF LATERAL CEPHALOGRAM



COLOUR PLATE III

FIG. E: TRACING OF LATERAL CEPHALOGRAM ON ACETATE SHEET

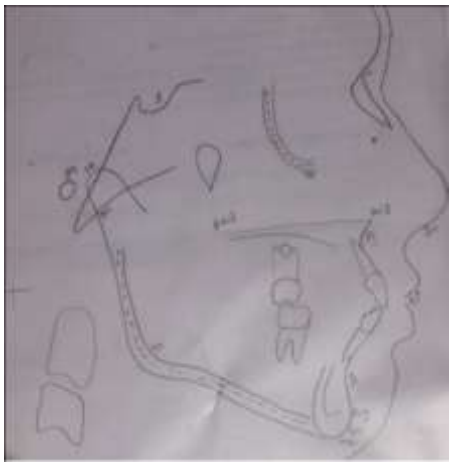
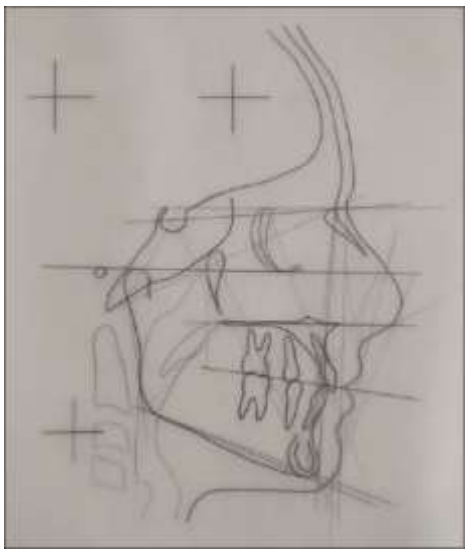


FIG. F: GROWTH PATTERN: DOWN'S ANALYSIS



COLOUR PLATE IV

FIG. G: FOX PLANE

FIG. H: POSITIONING PATIENT FOR PHOTOGRAPH AS SAME AS CEPHALOGRAM

CASE RECORD FORM

Date :

NAME: AGE/ SEX:

ADDRESS:

CONTACT NUMBER: OPD NUMBER:

Chief Complaint:

Past medical history:

Past dental history:

History of abnormal habit:

CLINICAL EXAMINATION:

- EXTRAORAL EXAMINATION:

  Facial profile:

  Facial symmetry:

  TMJ examination:

  Lip competency:

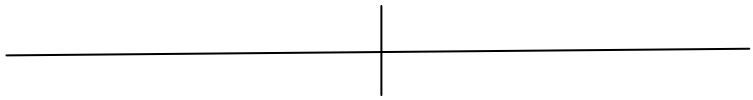
  Nasolabial angle:

  Mentolabial sulcus:

  Fox plane relation with Camper's line:

- INTRAORAL EXAMINATION:

Teeth present:



Teeth in occlusion:

Molar relation:

Canine relation:

Other findings:

Overjet:

Overbite:

Probable diagnosis:

Investigations:

Staff signature

(गोपनीय)

माहितीपूर्णसंमतीफॉर्म

'EVALUATION AND ASSESSMENT OF ALA-TRAGUS LINE AS A GUIDE IN DETERMINING THE OCCLUSAL PLANE IN DIFFERENT FACIAL DIVERGENCES: AN IN VIVO STUDY'

नाव: श्री/चि./श्रीमती/कु. ._____

निवासी: _____वय_____वर्ष.

माझ्याइच्छेच्या / निवडीचाकोणत्याहीस्वरूपाचाकोणताहीदबाव / प्रोत्साहननलावता, याद्वारे

डॉ. _____ नेप्रकल्पाचेआयोजनकरण्याचीमाझीमंजुरीदेतो/देते.

मी "रुग्णाच्यामाहितीपत्रकाची" पावतीस्वीकारतआहेआणिडॉक्टरांनीमलायासंशोधनप्रकल्पाबद्दलयोग्यआणिसूचनेबद्दलमाहितीदिलीआहे. मीमाझ्यामौखिकपोकळीत fox plane वापरकरण्याचीअधिकृतीदेतो.मीमाझ्याएक्स-रे, छायाचित्रे, आवश्यकतेनुसारइतरतपासण्याकरण्याससहमतआहे.

मीयाप्रकल्पातभागघेण्याससहमतीदेतोआणियाचाचणीच्याकाळातकोणतीहीइतरयोजनाएकत्रितकरणारनाही.

मीडेन्टलहॉस्पिटलमध्येकिंवाइतरठिकाणीदिलेल्यानियोजिततारखाआणिवेळांचेपालनकरीन.

मीप्रमाणितकरतोकीमीयाफॉर्मचीमाहीतीवाचलेलीआहेकिंवाकोणाकडूनवाचवूनघेतलीआहे.

_____दिनांक_____

_____रुग्ण / कायदेशीरपणेअधिकृतप्रतिनिधी

स्वाक्षरी

(Confidential)

Informed Consent Form

'EVALUATION AND ASSESSMENT OF ALA-TRAGUS LINE AS A GUIDE IN DETERMINING THE OCCLUSAL PLANE IN DIFFERENT FACIAL DIVERGENCES: AN IN VIVO STUDY'

NAME: Mr./Master/Mrs./Miss._____

Resident of: _____

_____aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent for the project to be conducted by **Dr. _____.**

I acknowledge the receipt of "patient's information sheet", and also the doctor has informed me about this research project suitably and sufficiently to my satisfaction.

I agree to undergo this procedure and allow fox plane relation to be taken as part of study

I agree to let my X-rays, photographs, other investigations to be taken as required.

I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time.

I certify that I have read or had read to me the contents of this form.

_____

_____Date _____

Patient /legally authorized representative signature

INFORMED CONSENT FORM

EVALUATION AND ASSESSMENT OF ALA-TRAGUS LINE AS A GUIDE IN DETERMINING THE OCCLUSAL PLANE IN DIFFERENT FACIAL DIVERGENCES: AN IN VIVO STUDY

वैयक्तीक माहिती

रूग्णाचे नाव :
वय/लिंग :
पत्ता :

दिनांक :

मोबाईल नंबर :

मी कबूल करतो की डॉक्टरांनी मला या संशोधन प्रकल्पाबद्दल समाधानकारक माहिती दिली आहे. मी माझ्या एक्स-रे, छायाचित्रे, इंप्रेशन आणि आवश्यकतेनुसार अन्य तपासण्या करण्यास सहमत आहे. मी या प्रकल्पात भाग घेण्यास सहमती देतो आणि या चाचणीच्या कालावधीत कोणतेही अन्य प्रकल्प एकत्रित करणार नाही. मला डेन्टल हॉस्पिटल किंवा इतर ठिकाणी दिलेल्या भेटीची तारीख आणि वेळ सांगितली आहे. मी डॉक्टर आणि पॅरामेडिकल कर्मचा-यांना सर्व बाबतीत सहकार्य करेल. या अभ्यासात मी माझ्या सहभागाचे निकाल प्रकाशित करण्यास परवानगी देतो. मला कोणतीही नुकसान भरपाई दिली जाणार नाही. असे करण्यासाठी कोणतेही कारण न देता मला कोणत्याही वेळी या संशोधन प्रकल्पातून बाहेर पडण्याचा अधिकार मिळालेला आहे. मी या अन्वये केलेल्या चाचणीत सहभागासाठी माझी संमती नोंदवित आहे.

_____	_____	_____	_____
१) रूग्णाचे नाव	स्वाक्षरी	तारीख	वेळ
_____	_____	_____	_____
२) साक्षीदाराचे नाव	स्वाक्षरी	तारीख	वेळ
_____	_____	_____	_____
३) डॉक्टरचे नाव	स्वाक्षरी	तारीख	वेळ

MASTER CHART

Sr.no.		OP to IT	OP to MT	OP to ST	OP to MIT	OP to MST	OP to FH(^{0})	CLASS 1	CLASS 2	CLASS 3
1.	hypodivergent	inferior					7	class 1		
2.					middle to inferior		9	class1		
3.		inferior					6		class 2	
4.		inferior					8	class1		
5.		inferior					7	class1		
6.					middle to inferior		9.5	class1		
7.		inferior					8.5			class3
8.		inferior					7			class 3
9.		inferior					7.5	class1		
10.		inferior					8			class3
11.		inferior					7.5	class1		
12.		inferior					7			class 3
13.		inferior					6.5		class 2	
14.		inferior					6.5		class 2	
15.					middle to inferior		8.5	class1		
16.		inferior						class1		
17.		inferior					8		class 2	
18.		inferior					9	class1		
19.		inferior					8	class1		
20.		inferior					7.5	class1		
21.		inferior					8.5	class1		
22.		inferior					7	class1		
23.					middle to inferior		8	class1		
24.		inferior					6.5	class1		
25.		inferior					7	class1		

Sr.no.		OP to IT	OP to MT	OP to ST	OP to MIT	OP to MST	OP to FH(^{0})	CLASS 1	CLASS 2	CLASS 3
26.		inferior					10	class1		
27.		inferior					8	class1		
28.					middle to inferior		8.5			class 3
29.		inferior					9	class1		
30.		inferior					9	class1		
31.	normodivergent		middle				10	class1		
32.			middle				8	class1		
33.			middle				9.5	class1		
34.			middle				8.5	class1		
35.			middle				8	class1		
36.			middle				10		class2	
37.			middle				7	class1		
38.					middle to inferior		7.5	class1		
39.			middle				9		class2	
40.			middle				10		class2	
41.			middle				8	class1		
42.			middle				8.5	class1		
43.			middle				9.5		class2	
44.					middle to inferior		7		class2	
45.					middle to inferior		7.5		class2	
46.			middle				9		class2	
47.			middle				8.5		class2	
48.			middle				9.5		class2	
49.			middle				10		class2	
50.			middle				10		class2	
51.			middle				10.5	class1		

Sr.no.		OP to IT	OP to MT	OP to ST	OP to MIT	OP to MST	OP to FH(^{0})	CLASS 1	CLASS 2	CLASS 3
52.			middle				9	class1		
53.			middle				9.5	class1		
54.			middle				8	class1		
55.			middle				8.5	class1		
56.					middle to inferior		7		class2	
57.			middle				10		class2	
58.			middle				9		class2	
59.			middle				8	class1		
60.					middle to inferior		7.5	class1		
61.	hyper divergent			superior			11.5		class2	
62.				superior			12		class2	
63.				superior			11		class2	
64.				superior			11.5		class2	
65.				superior			12.5		class2	
66.				superior			13		class2	
67.				superior			12		class2	
68.				superior			11.5		class2	
69.						superior to middle	11.5	class1		
70.						superior to middle	11	class1		
71.		inferior					5		class2	
72.		inferior					5.5		class2	
73.				superior			10.5	class1		
74.				superior			12	class1		
75.				superior			12.5		class2	
76.				superior			13		class2	

Sr.no.		OP to IT	OP to MT	OP to ST	OP to MIT	OP to MST	OP to FH(^{0})	CLASS 1	CLASS 2	CLASS 3
77.		inferior					6		class2	
78.				superior			13.5		class2	
79.				superior			12		class2	
80.				superior			14		class 2	
81.		inferior					4		class2	
82.		inferior					5.5	class1		
83.				superior			12	class1		
84.				superior			11	class1		
85.				superior			11.5	class1		
86.				superior			12	class1		
87.						superior to middle	10		class2	
88.				superior			11		class2	
89.				superior			11		class2	
90.		inferior					6	class1		