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Effect of Facial Outline, Age and Sex on Inclination of Plane of Occlusion in Dentulous Subjects: Lateral Cephalometric Study

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Abstract
Background/aim: One of the key factors in successful treatment outcome for prosthodontics treatment is establishing the correct orientation of occlusal plane. So much research has been done in determining the correct plane of occlusion, still confusions exist regarding universal acceptable approach in determining the plane of occlusion. Study was aimed to find out the relation between inclination of occlusal plane and facial outline, age and gender in completely dentate patients
Materials and methods: Lateral cephalographs were selected from the department of Oral medicine and Radiology, based on inclusion and exclusion criteria. All the selected radiographs were traced for occlusal plane and Frankfurt Horizontal plane. Angle between these two planes were studied based on facial profile, age and gender of the cephalographs. Correlation was established using independent regression analysis.
Results: There was significant correlation between gender and occlusal plane angle. In males it was found to be more as compared to than that of females. There was no significant correlation found with occlusal plane as related to age and facial profile of the selected samples.
Conclusion: While fabricating the complete dentures, occlusal plane can be adjusted more steeper in males as compare to than that of females. Further studies with larger samples are needed to establish correlation with age and facial profile.
Key words: Occlusal Plane, Cephalographs, Facial Profile, Complete Denture

Introduction: In the past, ideas regarding occlusion were often based on complete dentures. Because of the problems of instability of denture bases, the concept of balanced occlusion was developed to consider bilateral contacts in all functional excursions to prevent tipping of the denture bases. One of the most important factors to be consider is inclination of occlusal plane.

In complete denture construction the prosthodontist is responsible for restoring the natural esthetics of the patient and for developing an occlusion that is compatible with functional movements of the mandible.[1] Establishing the occlusal plane position is the basis for successful treatment outcome for the complete denture patients. There is no dearth of data released on this topic but there is no conclusive result came out of this information. So, there is still confusion related to its clinical application. The established occlusal table, which act as

a milling surface, should be strategically place such that the muscles present on either side, in the form of tongue and buccinator, should be able to position the food bolus onto it and hold it there while mastication takes place.

For prosthesis to be in-tandem to the stomatognathic system, establishing an occlusion in a correct occlusal plane is the crucial factor for the prognosis of the treatment. 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 surface. [2]

Occlusal plane is an essential part for establishing the balanced occlusion. Artificial teeth should be positioned as near as possible in the occlusal plane, which was previously occupied by the natural dentition. [3] By arranging teeth in such plane delivers normal functions of the oral musculature including tongue and cheek muscles, thus augmenting the stability of the denture. The concept of an occlusal plane is a useful but confusing one. Examination of living subjects, dry skull or study models, shows that there is no anatomical entity which might be described as a plane of occlusion, the occlusal alignment of the teeth rather tending to lie on a curve and consisting of discrete areas of contact which are themselves curved. [4]

It is in agreement that esthetic prerequisite determines the vertical height of the occlusal plane in the anterior region. Functional demand has less role in this.[3] Lip relationship at rest and during smile, speech and interpupillary line are the anterior determinants of the maxillary occlusal plane. [5,6]

Various authors have postulated various landmarks for determining the occlusal plane in the posterior region, e.g. retromolar pad [7,8], side of the tongue [9,10], the buccinators groove and commissure of the lips [11], Establishing the occlusal plane 1-3 mm below the resting lip anteriorly and parallel to the ala-tragus line (AT line) posteriorly, positioning the occlusal plane parallel to and midway between the residual ridge. [12]

In all these concepts, references used for positioning the occlusal plane are soft tissue landmarks which are liable to change with aging as-well-as with the judgement of the individual. Cephalometrics is a technique which uses reliable hard tissue cranio-facial structures to determine occlusal plane.

The search for a method that establishes an occlusal plane that is in complete harmony with the environment of an edentulous situation is yet not accomplished. What relation does inclination of the occlusal plane is having with different non dental parameters so that correct occlusal plane can be established for optimum function of the complete denture? This study was conducted with the aim to find out the correlation between occlusal plane angle and facial profile, age and sex in dentate patients.

Materials and methods: This was analytical cross-sectional study done with lateral cephalograms of the patients. For this study 300 lateral cephalograms were collected from the department of Oral Medicine and Radiology. Cephalograms not mentioning the gender and age of the patient, were not considered. This was for the purpose of identification of gender and age. Selected radiographs were divided into two grops, less than 30 years and more than 30 years. Cephalograms with full component of natural teeth were selected. Any sign of pathologic involvement, trauma, habits or prosthesis were not included in the study.

Cephalograms were traced on tracing paper. For reorientation purpose, tripodal markes were scribed on cephalogram. After tracing the tripodal marks, soft tissue outline was traced and soft tissue nasion, soft tissue point A and soft tissue point B was identified. Outline of the maxillary and mandibular first molar and maxillary and mandibular central incisor was traced. Orbital rim was identified and traced and orbitale was marked. Condyle of the temporomandibular joint was identified and posterior to it, Porion was identified and traced. On tracing, Occlusal plane (OP) and Frankfort Horizontal plane (FH plane) were marked (fig. 1). Slant formed between these two planes was measured and tabulated. On

cephalogram, facial outline was determined for each tracing by joining the soft tissue Nasion, soft tissue point A and soft tissue point B. Facial profile to be identified as straight, convex or concave. Variation in the angulation of occlusal plane angle was correlated with the gender, age and facial profile of the dentate subjects. The intergroup comparison for the angulation of the occlusal plane between different facial profiles and age groups and gender was done using the independent regression test.

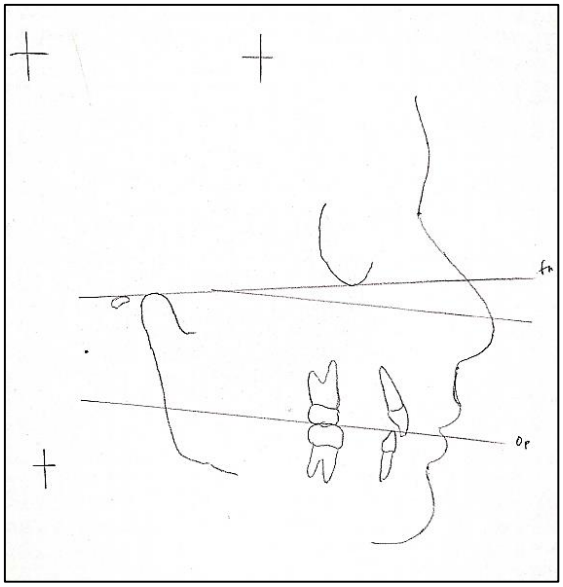

Figure. 1 Cephalometric tracing

Results:

Correlation between gender and angle: In this present study association between Gender and occlusal plane angle was estimated using the independent t test and was found to be statistically significant with p value of 0.001 ($p \leq 0.05$ is significant). Overall mean for the occlusal plane angle was 10.776 ° in the studied samples. The occlusal plane angle was found to be more in males (mean = 11.76 °) as compared to females (mean = 10.18 °)(Table 1,2).

Correlation between age and angle: In this present study correlation between angle and age groups was estimated using the independent t test and was found to be statistically non-significant with p value of more than 0.05 (Table 3).

Correlation between facial profile and occlusal plane angle: In the studied 300 samples, concave facial profile was not found and straight profile were found to very few (only 5) and did not produce any significant result as related to occlusal plane angle.

Table 1: Correlation Between Gender and Angle

Gender	N	Mean	Std. Deviation	Std. Error Mean
Female	188	10.186	5.856	0.427
Male	112	11.767	4.628	0.437

Table 2: Independent t- test for gender correlation

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

						Lower	**Upper**
Equal variances assumed	-2.440	298	0.015	-1.58169	0.64836	-2.85764	-0.30573
Equal variances not assumed	-2.587	275.152	0.010	-1.58169	0.61134	-2.78518	-0.37819

Table 3:Independent t-test with p value more than 0.05 is non-significant

	N	Mean	Std. Deviation	Std. Error Mean
Less than 30	234	10.910	5.315	0.654
More than 30	66	10.303	6.033	0.672

Discussion: Complete dentures must have the occlusal plane positioned correctly for both functionality and aesthetics. Anteriorly, the plain of occlusion mainly helps in achieving aesthetic and phonetics while posteriorly, it forms a milling surface where the tongue and the buccinator muscle are able to position the food bolus onto it and hold it there during mastication. The synchronisation between the tongue and the buccinator muscles can be affected by improper alignment of plane of occlusion, which may result in possible problems including food buildup in the sulcus or inadvertent tongue or cheek biting. Thus, incorrect record of occlusal plane would hamper aesthetics, phonetics and mastication.[13]

During complete denture construction, the plane of occlusion should be positioned as near to its natural location as is practical. This is because the presence of natural teeth allows the tongue and cheek muscles to work at their best. These muscles are able to stabilise the bolus just as well as previously by raising the plane of occlusion to its initial vertical position. [9,14]

The results of this investigation may prove useful in determining the plane of occlusion in individuals without teeth.

The facial profile is a key determinant of aesthetic harmony and often influences treatment decisions in orthodontics and prosthodontics. The occlusal plane's angle relative to the facial profile can significantly impact facial aesthetics. By examining radiographs, we aim to elucidate whether specific facial profiles are associated with distinct occlusal plane angles. We discovered no evidence of a significant correlation between occlusal plane angle and facial profile in our investigation. In our study samples, there were no concave profile found and only 5 straight profiles were observed among 300 samples. Much larger samples may be required in future studies to establish their association.

Age-related changes in dentition and facial morphology can influence the occlusal plane's orientation. Understanding how the angle of the plane of occlusion varies with age is crucial for predicting and managing age-related dental changes. Through our radiographic study, we endeavour to uncover any age-related trends in occlusal plane orientation. While age-related changes in occlusion are well-documented, individual variability in dental development, tooth wear patterns, and skeletal morphology can influence occlusal plane orientation independently of age. Individuals may exhibit compensatory mechanisms in response to age-related changes in occlusion, such as dental attrition, drift, or adaptive alterations in occlusal relationships. Age and occlusal plane angle may not show statistically significant relationships because of this inherent biological variability. Present study divided the age in two groups i.e. less than 30 and more than 30 years. In more than 30 years group,

There wasn't much deviation in age. Insufficient sample size, particularly within specific age groups, could diminish the statistical power to detect associations between age and occlusal plane angle. Larger sample sizes, especially in older age groups where occlusal changes may be more pronounced, might be necessary to identify significant age-related trends.

Sexual dimorphism in craniofacial structures is well-documented, with variations observed in both dental and skeletal morphology. It is plausible that differences in occlusal plane angle exist between males and females. Hormonal factors, particularly during developmental stages, can influence craniofacial growth and dental development differently in males and females. Hormonal fluctuations, such as those occurring during puberty, can affect the timing and rate of craniofacial growth, potentially leading to differences in occlusal plane orientation between sexes. Males and females may exhibit distinct patterns of dental compensation in response to variations in craniofacial morphology or occlusal discrepancies. These compensatory mechanisms, such as dental drift or alterations in occlusal relationships, could lead to differences in occlusal plane angle between sexes. Moreover, Variations in masticatory patterns, chewing forces, and functional demands between males and females may influence the development and maintenance of occlusal relationships. Differential functional adaptations could result in differences in occlusal plane orientation between sexes. Socio-cultural factors, such as dietary habits, oral habits, or cultural norms related to oral health and dental care, may differ between males and females. These factors can influence dental morphology, occlusal relationships, and consequently, occlusal plane angle. Genetic factors regulating craniofacial growth and development may manifest differently in males and females, leading to variations in orientation of the occlusal plane between sexes.

Prosthodontists have disagreed on whether to use the Ala-Tragus line or Camper's plane to determine the plane of occlusion in edentulous patients. Selecting the superior, intermediate, or inferior border of the Tragus as a point of reference is an interesting consideration. The fascinating results of the current investigation might contribute to settling this dispute.

It was reported that the plane of occlusion - FH plane angulation was 11.42°in dentulous subjects[17]. Conversely, Celebic et al. suggested 9.43° and 8.53° for those who were dentulous and edentulous, respectively. [18] In our study mean occlusal plane – FH plane angle was determined to be 10.77 °. This variation may be due to demographic divergence.

In previous studies there is a disparity in results regarding establishing the plane of occlusion. There are studies suggesting lower portion of the tragus [19], centre of the tragus [20,21], while other studies propose upper portion of the tragus. [22] Present study may help in ending this controversy by defining the reason behind this inequality.

In our study males had a higher occlusal plane angle (11.76°) as compared to than that in females (10.18°). Significance of this finding can be used in establishing the occlusion plane in complete denture construction. In males it can be set by joining ala and upper part of the tragus. In females it can be located at lower level by joining ala nasi and lower or mid portion of the tragus. Establishing occlusal plane using upper portion the tragus will make angle of the occlusal plane steeper as compare to the angle which is set by locating lower portion of the tragus.

Tuncay et al, 1984 [16], stated that changes with in craniofacial complex, residual ridge resorption and position of denture were not greatly impacted by variables such as sex, years of edentulousness, night time wear, or skeletal pattern. Their observation was based on 10 years follow up. Study done by Sharma and Xin, 2014 [23] and Ardani et al, 2020 [24] also has non-significant effect of gender variation on skeletal and dental variation including occlusal plane. This could be attributed to racial development or ethinical factors.

Carey, 1978 [25], conducted a study to test masticatory efficiency when alignment of the plane of occlusion was varied. From the results obtained in this study it would appear that

within certain limits function was not noticeably affected and that a certain amount of leeway is permissible when orienting the occlusal plane. According to author, little bit of change of occlusal plane will not affect the function of the stomatognathic system. Though, author did not mention the amount of permissible variation.

Unlike the research done by Carey, Chaconas in 1986 [26] proposed that there is a strong clinical signal suggesting that problems with the temporomandibular joint (TMJ) may occur when the occlusal plane's posterior location is located furthest from the ramus's centre (Xi point). To guarantee appropriate occlusal function, it is advised that the occlusal plane intersects through the ramus's centre. In clinical practice, this plane typically passes across the top portion of the retromolar pad. Interestingly, the tragus was not mentioned when the occlusal plane was established.

Another study conducted by Okane et al, 1979 [20], investigated The effect of the occlusal plane's anteroposterior tilt on biting force and clenching muscle activity was examined. Also evaluated was the ala-tragus line's physiological compatibility. While keeping the vertical dimension of occlusion constant, patients' integrated electromyographic activity and biting forces were examined under three different anteroposterior occlusal plane inclinations. In their study, they took centre of the tragus as a posterior reference point to establish the occlusal plane. From their investigation, the following conclusions were made. They found occlusal table parallel to AT line as the most acceptable because there was at this plane most efficient biting force was excerted during maximum clenching. Also, lowest amount of muscle activity was observed at this position. Even deviation of 5 °, either decreasae or increase, maximum biting force was decreased.

Van Niekerk, 1985 [19] concluded that the ala-tragus line has a close relationship with the plane of occlusion and could be used as a landmark when At the plane of occlusion, the maxillary occlusion rim is trimmed. His reference point was the lower edge of the tragus. He said that the occlusal plane's placement ultimately needs to balance denture stability, function, and aesthetics, and it depends on experienced clinical judgment. In his study subjects were not categorised as per age or gender.

There were following limitations of the current study:

- Maxilla-mandibular relationship was not taken into consideration while correlating the occlusal plane.
- Sample size could have been more to include more facial profiles.
- Larger samples of age could have been included.

With in the limitations of the study, following conclusion can be drawn:

- In males, occlusal plane should be adjusted steeper as compared to than that of in females. In can be adjusted at the upper border of the tragus while marking the occlusal plane using Camper’s plane.
- In females, occlusal plane should be adjusted shallower as compared to than that of in males. In can be adjusted at the lower border of the tragus while marking the occlusal plane using the Camper’s plane.

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