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Dr. Fakher Mounir Alagol
Post Graduated Student,
Department of Removable
Prosthodontics, Faculty of
Dentistry, Hama University,
Hama, Syria

Dr. Abdul Moueen Aljammal
Consultant in Prosthetic
Dentistry (Ph.D.), Head of
Removable Prosthodontics,
Faculty of Dentistry, Hama
University, Hama, Syria

Corresponding Author:
Dr. Fakher Mounir Alagol
Post Graduated Student,
Department of Removable
Prosthodontics, Faculty of
Dentistry, Hama University,
Hama, Syria

Effect of patient's age in the occlusal plane determinates by intra-oral landmarks in complete dentures

Dr. Fakher Mounir Alagol and Dr. Abdul Moueen Aljammal

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Abstract

Aim of the study: This research aims to study the possibility of using the mandibular occlusal plane to determine the maxillary occlusal plane in the complete dentures, and to study the effect of patient's age on the resulting occlusal plane.

Materials and Methods: Sample included 40 edentulous patients, ranging in age between 41-84 years (20 male and 20 females). Record bases had anterior occlusal wax rims at the anterior region only in maxillary and mandibular. The mandibular posterior occlusal plane was determined on the master cast at both sides, in line with the convergence of the middle third with the upper third of retromolar pad, and the posterior wax height of mandibular was constructed according to this plane. Then, this plane in patient's mouth was modified to fit the lateral border of the tongue and the commissure of the lips. The determinants of the registration of the centric relationship were fixed to the posterior inferior mandibular occlusal wax rims, and the posterior wax rims of maxillary was made according to the posterior wax rims of mandibular. The relationship of the posterior maxillary occlusal plane to Ala-Tragus line was examined using a double-level ruler specially designed for this purpose. The data obtained was statistically analyzed using Student's independent T-test, and Pearson correlation coefficients. The level of confidence was set at 95%.

Results: The results showed that there were no statistically significant differences in the mean angle values between mandibular occlusal plane and maxillary occlusal plane. There was a statistically significant effect of patient's age on maxillary occlusal plane in females ($P=0.010$), while there was no statistically significant effect of the patient's age on maxillary occlusal plane in males and in the whole research sample ($P=0.783, 0.064$ respectively).

Conclusions: The mandibular occlusal plane can be used to determine the maxillary occlusal plane in complete dentures. The use of retromolar pad, the lateral borders of the tongue and the commissure of the lips as intraoral reference points to determine the occlusal plane is a reliable landmark. The impact of patient's age must be taken into account while determining the occlusal plane in this technique.

Keywords: Occlusal plane, maxilla, mandible, age, denture, complete

Introduction

According to the Glossary of Prosthodontic Terms "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 these surfaces^[1]. The orientation of occlusal plane (OP) is one of the most indispensable clinical procedures in prosthodontic rehabilitation for edentulous subjects^[2]. The ideal position, of the teeth in complete dentures is the same as that of the natural teeth^[3]. Facial harmony is achieved when teeth are set in their proper relation^[4]. The position of the occlusal plane of orientation forms the basis for ideal tooth arrangement. It should fulfill the necessary mechanical, esthetic, and phonetic requirements, and aid respiration and deglutition^[5]. While, natural teeth and normal tonus of muscles manipulating the masticatory system are lost when the individuals become completely edentulous, orientation of (OP) should be as close as possible to the plane previously occupied by the natural teeth to harmonize with the normal functions of the cheek and tongue muscles^[6, 7]. Usually (OP) is oriented anteriorly to fulfill esthetic and phonetic requirements and posteriorly parallel to Ala-Tragus line^[8].

Developing an occlusion that is compatible with functional movements of the stomatognathic system is one of the key factors in determining the prognosis of the completely edentulous patients [9]. The location of occlusal plane in complete denture construction is incredibly subjective and it is widely variable depending upon the uncertainty of reference landmarks and the individual judgment [10]. The precise location of occlusal plane for edentulous patients is a controversial matter. There appears to be a lack of agreement on how it should be orientated for patients [11]. Occlusal plane could be oriented using landmarks in the mandibular arch as well as in the maxillary arch. In the mandibular arch there are few landmarks which could be used to orient the occlusal plane like the retromolar pad, corner of the lips (lower lip length) whereas the maxillary arch has a number of landmarks, of which the Ala-Tragus line is the most commonly used and the same being the most controversial [12]. Some dentists establish the occlusal plane by constructing the maxillary occlusion rim to approximately 1 to 3 mm. below the resting upper lip anteriorly and parallel to the Ala-Tragus line posteriorly. Then, when arranging the teeth, the occlusal plane is slightly modified according to patient needs to achieve balanced occlusion [13, 14]. Some dentists position the occlusal plane parallel to and midway between the maxillary and mandibular residual ridges, to fulfill the theory that food is controlled on the occlusal table by the tongue [3, 15, 16], others suggest orienting the occlusal plane on the same level as the lateral border of the tongue [16, 17]. Still other dentists recommend placing the occlusal plane terminating posteriorly at the medial two thirds of the retromolar pad [8, 18]. While others orienting the occlusal plane with the buccinator grooves and the commissure of the lips [19-21]. Boccaletti orients the occlusal plane according to its relation to the inclination of the condylar path as well as according to the individual requirements of the kinematics of the lower jaw [13]. Swenson says that the relative size and shape of the bearing area of the maxillae and mandible influence the decision as to the position of the occlusal plane [22]. The leverage is reduced for the denture having the more unfavorable ridge size by placing the plane closer to that ridge [16, 22].

To analyze the level of Ala-Tragus line, various instruments and tools have been devised and used. Fox plane is the simplest and most widely used instrument for determining OP. It is also less bulk than other instruments. Furthermore, it is the most commonly used instrument for establishing OP in completely edentulous cases [23]. Bite plane leveler [24], J plane [25], Campers plane indicator [26], and more recently, OP analyzer [27], and OP orientor [28] have been used to determine Ala-Tragus line.

Materials and Methods

The research sample

Forty subjects (20 men and 20 women) ranging between 41 and 84 years of age, from the patient who attended the Removable Prosthodontics Department, Faculty of Dentistry, Hama University.

Input criteria

1. The last extraction was done for a period of at least (6 months) ago.
2. The patient does not suffer from any general systemic diseases.
3. The patient enjoys good oral health in the absence of oral infections.

4. Normal size and shape of the dental arch: The residual alveolar ridges are of good shape (Class CI I, Class CI II) according to the (Moses) classification [29].
5. That the jaw relationship of the alveolar ridges is a first class according to Angle.
6. Moderate salivation, and the patient is not treated with radiation or chemical treatments.
7. That the patient has good neuromuscular harmony.
8. The patient does not suffer from any disorder in the temporomandibular joint.

Patients were divided into three groups according to their age:

1. Midlife (from 40 to less than 60 years).
2. The Young Elderly (from 60 to less than 75 years).
3. The Old Elderly (from 75 to 85 years) [30, 31].

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed. Preliminary alginate impressions were taken and poured into plaster (Cavex Impressional, Cavex, Netherland). The final impressions were taken with individual acrylic trays, with the border were molded by the impression compound (Impression compound Type 1, Kerr, USA), and zinc oxide-eugenol paste was used as the final impression material (Impression Paste, S.S.White, England). Auto polymerizing acrylic resin (Respal, S.P.D, Italy) was used to made acrylic record bases on master casts for the maxillary and mandibular. The record bases have anterior wax rims (Modelling Wax, B.M.S. Dental, Italy) that extend from the canine to the canine only in the maxillary and mandibular. The record bases were checked in the patient's mouth for extension, retention and stability. The height of the maxillary occlusion rim in the anterior region was positioned about (1 to 2 mm) below the resting upper lip, and parallel to the interpupillary line (Frankfurt Horizontal Plane), and provided the verbal and aesthetic aspects [8, 13, 14, 18]. (Fig 1).



Fig 1: Shows posterior maxillary wax rim

The OVD (Occlusal Vertical Dimension) was determined by the combination of (Niswonger) method and the closest speaking space (Silverman) [32] and the height of the mandibular occlusion rim was adjusted to match the suitable occlusal vertical dimension of the patient. (Figure 2)



Fig 2: Shows posterior mandibular wax rim

Retromolar pad was drawn on the master cast of the mandibular, and it was divided into three parts (upper, middle, and lower).

On the master cast of the mandibular had been determined the posterior occlusal plane at both sides, in line with the convergence of the middle third with the upper third of the retromolar pad and the posterior waxy height of the mandibular was constructed according to this plan [8, 13, 18, 28]. The posterior lower wax height was adjust to modify in accordance with the lateral borders of the tongue [16, 17, 33] and located above the commissure of the lips (corner of the mouth) by (1-2 mm) [19, 20]. (Figure 3).



Fig 3: Shows mandibular wax rim

Layers of modelling wax were placed in the posterior maxillary record base and raised from the anterior plane (3 mm) and the centric occlusion relation was recorded.

Metal determinants were placed in the position of the first premolar and the first molar on both sides of the mandible wax rims, and layers of modeling wax were placed in the posterior part of the maxillary, so that they rise from the anterior maxillary occlusal plane height (3 mm) (Figure 5). To lead the patient's mandible to the centric relationship position, the upper record plate is fixed on the maxillary inside the patient's mouth. The lower record plate is fixed inside the patient's mouth by pressing down and forward with the index fingers on the vestibular wings of the lower plate on either side of the at the same time in the premolar region. The patient should relax the jaw muscles as much as possible, and slowly and quietly close his back teeth, while the doctor's

thumb gently presses the chin to stimulate (not push) the mandibular towards the centric relationship, and in this way the centric relationship is recorded [34, 35]. The side appendages were removed from the posterior wax height of the maxillary to remain completely flat. (Figure 4).



Fig 4: Shows resulting maxillary wax rim

The relationship of the posterior mandibular occlusal plane to the Ala-Tragus line was examined using a double-level ruler specially designed for this purpose. (Figure 5).



Fig 5: Shows the tool that was designed especially for this research

Angle measurement method

The Ala-Tragus line was drawn using a special liner (Extra Fine Tip) with the help of a flexible plastic ruler from the inferior border of the Ala of the nose to the middle part of the tragus of the ear [1, 13, 20, 21, 36, 37]. The lower ruler was placed in the patient's mouth, so that the intra-oral portion corresponds to the occlusal plane of the maxillary wax.

The upper ruler was moved so that its front part was at the same level with the inferior border of the Ala of the nose, and its position was fixed using nuts. One of the two movable arms was moved (the upper if the maxillary occlusal plane is located below Ala-Tragus line, and the lower in the opposite case), and the angle was measured using the ruler's protractor. (Figure 6).



Fig 6: Shows measuring the angle between mandibular occlusal plane and Ala-Tragus line

To ensure the accuracy of the measurement, three examiners measured the angle, and the mean is taken for the measured

angles. The angle was assigned a positive value if the upper arm was used (maxillary occlusal plane is located below Ala-Tragus line), a negative value if the lower arm was used to measure the angle (maxillary occlusal plane is located above Ala-Tragus line), and a zero value if applicable.

Results

Data related to the group of patients with the age group (from 75 to 84 year) were deleted, when studying the effect of the age group due to the small number of patients belonging to the mentioned age group (only two patients). Data were analyzed using SPSS V.25 (IBM; CORP., ARMONK, USA). The level of the P value was set at 5%, and the level of confidence was set at 95%. The values of the Pearson correlation coefficients were calculated to study the nature of the relationship between the values of the angle magnitude between the Ala-Tragus line and the maxillary occlusal plane (degrees) and the patient's age (in years) in the research sample, according to the patient's gender (Table 1).

Table 1: Pearson correlation coefficients to study the relationship between the values of the angle magnitude between the Ala-Tragus line and the maxillary occlusal plane and the values of the patient's age in the research sample, according to the patient's gender

The variable	Patient's gender	Sample volume	Correlation coefficients	P value
Patient's age (In years)	Male	20	-0.164	0.491
	Female	20	-0.394	0.068
	The research sample	40	-0.258	0.108

It is noted in the above table that the value of the significance level is greater than the value 0.05 regardless of the patient's gender and in the whole research sample. That is, at the level of confidence of 95% there is no statistically significant correlation between the values of the angle between the Ala-Tragus line and the maxillary occlusal plane (In degrees) and the values of the patient's age (in years), whatever the gender

of the patient, and in the whole research sample. Descriptive results including mean, standard deviation, standard error, minimum and maximum values of the angle between Ala-Tragus line and the maxillary occlusal plane (by degrees) in the research sample according to patient's age (Table 2).

Table 2: Descriptive results of the Independent T test regarding the values of the angle measurements between Ala-Tragus line and the maxillary occlusal plane (By degrees) between the two age groups in the research sample

Patient's gender	Age group	Sample volume	Mean	Standard deviation	Standard error	Minimum	Maximum	P value
Male	(from 40 to less than 60 years)	13	2.00	1.35	0.38	0	4	0.783
	(from 60 to less than 75 years)	6	1.83	0.75	0.31	1	3	
Female	(from 40 to less than 60 years)	11	2.18	0.87	0.26	0	3	0.010
	(from 60 to less than 75 years)	8	1.13	0.64	0.23	0	2	
The research sample	(from 40 to less than 60 years)	24	2.08	1.14	0.23	0	4	0.064
	(from 60 to less than 75 years)	14	1.43	0.76	0.20	0	3	

Independent T test showed statistically significant differences in the mean values of the angle measurements between Ala-Tragus line and the maxillary occlusal plane (in degrees) between patients from the age group (from 40 to less than 60 years), and patients from the age group (from 60 to less than 75 years), in the female group (P=0.010). Since the algebraic indication of the difference between the two averages is positive, we conclude that the values of the angle between the Ala-Tragus line and the maxillary occlusal plane (degrees) In the group of patients with the age group (from 40 to less than 60 years), it was greater than in the group of patients with the age group (from 60 to less than 75 years) in the research sample.

Independent T test showed no statistically significant differences in the mean values of the angle measurements between Ala-Tragus line and the maxillary occlusal plane (in degrees) between patients from the age group (from 40 to less than 60 years), and patients from the age group (from 60 to less than 75 years), in the male group and in the whole research sample (P=0.783, 0.064 respectively).

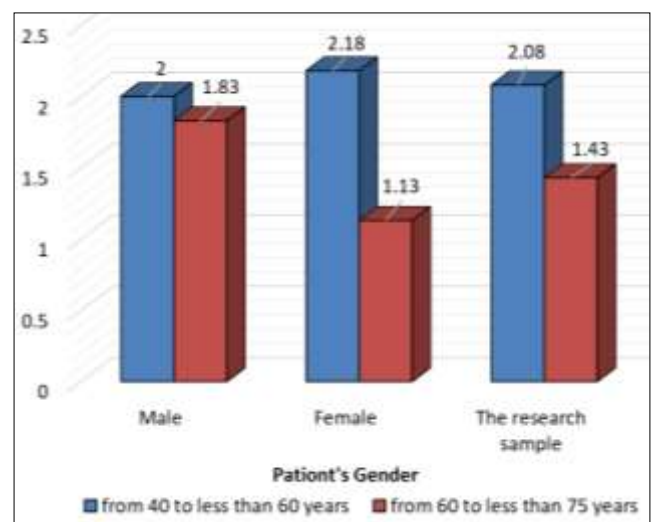


Fig 7: Means the values of the angle magnitude between the Ala-Tragus line and the maxillary occlusal plane in the research sample, according to the patient's gender and patient's age

Discussion

The orientation of the occlusal plane is one of the most important steps needed in determining maxillo-mandibular relationship and, eventually in the arrangement of the artificial teeth during complete denture fabrication. This could be achieved by contouring the maxillary occlusal rim to achieve an occlusal plane, which lies parallel with facial guides, interpupillary and Camper's (Ala-Tragus) plane [38]. Although the determinants for the location of the occlusal plane have varied among authors [13, 19, 33, 36, 39], most dentists determining the posterior plane of occlusion by Camper's line [40]. Some reported a close relationship between the Ala-Tragus line and the occlusal plane [41]. According to surveys, occlusal plane orientation differs considerably among schools in Japan, the US, and Canada; however, the most commonly used and widely taught method in determining the plane of occlusion was the Ala-tragus line method, which means a line drawn from the lowest point of the Ala of the nose to the middle part of the tragus [19, 20, 36, 37, 40, 41]. There are another intra-oral and extra-oral landmarks that suggested to clinically determine the position of the occlusal plane as commissure of the lips [19, 20], lateral border of the tongue [16, 17, 33], two-thirds of the height of the retromolar pad [13, 18]. This study assessed the relationship between maxillary occlusal plane that determined by intra-oral landmarks resisting in the mandible and Ala-tragus line, in order to maintain the possibility of using the mandibular occlusal plane for determining the maxillary occlusal plane in complete dentures.

Apart from these landmarks, the influences of other factors like age, gender, ethnicity to the position of the occlusal plane is also questionable [42]. The effect of age was studied in this research. The age of patients ranged between 41 and 84 years, with an average age of 58 years. In order to study the possibility of using the mandibular occlusal plane to determine the maxillary occlusal plane, the method of measuring the angle between the occlusal planes was used to determine the relationship between them in this study. This method is used in many studies such as studies (D'Souza and Bhargava 1996; [43] Saquib Ahmed Shaikh and Mathur 2015; [44] Ravi Shankar Y 2016; [45] Tantray *et al.*, 2017; [46] Mehta and Chhetri 2019; [42] Tippashetty *et al.*, 2020 [47] Most of the previous studies relied on a comparison between the occlusal plane in a group of individuals with complete number of teeth, and the artificial occlusal plane used while teeth arrangement in a group of edentulous patients. With the exception of the study (Ismail and Bowman 1968) [13] which relied on comparing the occlusal plane of a group of individuals before Tooth extraction and after. As for this study, it was based on a comparison between the maxillary occlusal plane defined using the mandibular occlusal plane, with (Ala-Tragus) line in the same group of patients (meaning that the studied patient group is the same as the control sample). This may allow obtaining more realistic results, as a result of excluding the occurrence of differences due to age and other personal differences (race, face shape, mandibular measurements).

The traditional method of registration the centric relationship was not used because drilling a V-shaped gutter within the wax height into which the softened wax from the opposite wax height would enter will lead to the formation of two waxy protrusions in the upper wax height, which will impede the necessary measurements for this study. This method was replaced by the design of metal determinants to stabilize the centric relationship that are placed in the first premolars and first molars area, and leave a negative impression in the

maxillary wax, which enables us to stabilize the centric relationship without any influence on the required measurements. In this study, a ruler was specially designed to compare occlusal planes, and it is a simple and easy-to-use tool that is characterized by giving results directly without waiting for the results of image analysis, and without the need to use a computer or expose the patient to radiation. The results of this study showed that there were no statistically significant differences in the mean angle values between the Ala-Tragus line and the maxillary occlusal plane between the two studied age groups in the male group and in the entire research sample. The results of this study concluded the possibility of using the mandibular occlusal plane for determining the maxillary occlusal plane in complete dentures. This was consistent with Ismail and Bowman, [13] Curtis *et al.*, [48] Nissan *et al.*, [49] and Mohamed *et al.*, [18] studies, which confirmed the possibility of using the mandibular occlusal plane resulting from the retromolar pad and lateral border of the tongue, and Commissure of the Lips serves as a reliable reference guide for determining the occlusal plane.

This study was disagreed with the results of a Gupta *et al.*, [21] study, which considered the buccinator groove to be the most reliable intra-oral reference guide for determining the occlusal plane, while it considered that retromolar pad cannot be considered a reliable reference for determining the occlusal plane. The reason for this may be due to the patients in their study was young patients, whose muscular activity is large, and they have teeth. Consequently, determining retromolar pad is difficult and far from accuracy, which increases the error range in that study. In this study, determining retromolar pad was performed for edentulous patients, which is much easier and more accurate. This study was also disagreed with Acharya [50] study, which found that the use of soft tissues and intra-oral landmarks is unreliable, he preferred the use of cephalometric study, and it is possible that he preferred that method because radiological studies help to know the effect of ethnic differences on the craniofacial reference levels. Given that, he compared the occlusal planes of two different ethnic groups, while this study did not focus on the effect of race on the occlusal planes. While this study revealed statistically significant differences in the average values of the angle magnitude in the female group. The values of the angle magnitude in the group of patients with the age group (from 40 to less than 60 years) were greater than in the group Patients with the age group (from 60 to less than 75 years). There wasn't any correlation between the patient's age and the amount of angle, whether it is a direct relationship (increasing the patient's age requires increasing the amount of angle values), or inversely (decreasing the patient's age requires a decreasing in the amount of angle values). Results of this study are in agreement with the study (Nirav Rathod 2017) [51] that there was no effect of age on determining the occlusal plane. It is partly in agreement with the study (Saquib Ahmed Shaikh and Mathur 2015) [44], which stated that the tendency of the occlusal plane in young individuals is greater than the tendency of the occlusal plane in older individuals, and that of the female group in this study, and it differs with it in the male group and the entire research sample. And it is possible that this is due to the fact that the study of (Saquib Ahmed Shaikh and Mathur 2015) [44] did not include the effect of gender, and that ethnic differences, and differences in the methods used for measurement (the use of digital images in their study) may have a role in this difference. The small number of studies conducted to find out the effect of age, and

the limitation of most studies that included its effect on individuals from small age groups, makes the results of these studies inaccurate.

Conclusion

Based on the results of this study, it can be concluded that:

1. Using the mandibular occlusal plane (two-thirds of the height of the retromolar pad, lateral border of the tongue, commissure of the lips) for determining the maxillary occlusal plane in complete dentures can be considered a reliable method.
2. There is an effect of the patient's age on the maxillary occlusal plane determined using the mandibular occlusal plane in females, as the degree of inclination of this plane from the Ala-Tragus line in the age group (from 40 to less than 60 years) is greater than in the age group (From 60 to less than 75 years).
3. The patient's age had no effect on the maxillary occlusal plane determined using the mandibular occlusal plane in males.
4. There is no correlation between the patient's age and the amount of inclination of the occlusal maxillary occlusal plane determined using the mandibular occlusal plane than the Ala-Tragus line.

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