EC DENTAL SCIENCE
Research Article

A Cephalometric Study to Establish the Relationship of the Occlusal Plane to Various Craniofacial Structures in a Moroccan Population

El Mdaghri Meriem[1], Bennani Anas[2]*, Alfidi Jamila[3], Ait Ben Bouazza Khadija[3] and Ousehal Lahcen[4]

[1]Assistant Professor, Department of Fixed Prosthodontics, Dental College, Mohamed 6 University of Health Sciences, Casablanca, Morocco

[2]Professor, Head of Department of Fixed Prosthodontics, Dental College, Hassan II University, Casablanca, Morocco

[3]Dentist, Private Practice, Casablanca, Morocco

[4]Professor, Head of Department of Orthodontics, Dental College, Hassan II University, Casablanca, Morocco

***Corresponding Author**: Bennani Anas, Professor, Head of Department of Fixed Prosthodontics, Dental College, Hassan II University, Casablanca, Morocco.

Received: May 16, 2023; **Published:** June 20, 2023

Abstract

Objective: The aim of this study was to determine average values of profile teleradiographs of the angles between the occlusal plane and five craniofacial planes in a Moroccan population.

Methods: In this cross-sectional study, we collected 160 profile teleradiographs of adult patients (XX females and XXX males) with class I dental occlusion who underwent treatment from March, 2021 to July, 2021. Patients were divided into three groups according to vertical facial type: group I (normodivergent; n = 47), group II (hypodivergent; n = 36) and group III (hyperdivergent; n = 77).

Results: The results indicated that the mean angles between the occlusal plane and the five craniofacial structures examined were 8.6° for the Frankfort Horizontal plane, 10.6° for the Camper plane, 11.4° for the Palatine plane, 13.3° for the Axio-orbital plane and 18.6° for the Mandibular plane.

Conclusion: The comparison of global mean values with mean values for each group of patients suggested that angle mean values in hypodivergent cases were lower than the overall values and significantly higher than the overall values. With respect to normodivergent cases, a significant difference was noted only for the POPM and POPC values, which were lower than the sample's mean. To orient the occlusal plane, cephalometry, combined with other reference planes, can be used as an adjunct to position the occlusal plane; that is with profile teleradiography.

Keywords: *Occlusal Plane; Craniofacial Structures; Teleradiographs*

Introduction

Occlusal plane orientation plays a key role in the construction of a complete denture. Achieving an accurate occlusal plane orientation requires an interdisciplinary approach that involves diagnosis, planning and therapeutic procedures [1,2]. Prosthetic restoration refers to a set of procedures designed to replace a partial denture or complete occlusion; hence, the need to observe occlusal criteria for reconstruction [3]. In complex rehabilitation contexts where all occlusal reference is lost, correct orientation of the Occlusal Plane (henceforth, OP)) is an essential step [4].

Teeth repositioning must be achieved according to a reference plane, which should constitute the basis for an ideal dental arrangement. It is required to fulfill aesthetic, mechanical and physiological requirements of chewing, deglutition and breathing performed by the manducatory apparatus [5]. The position of the OP plays a critical role in achieving excellent static and dynamic equilibrium of prosthetic restorations, thus improving their long-term stability [6]. Therefore, the OP should be oriented as close as possible to the plane previously occupied by the natural teeth [7]. During the last decades, there have been multiple numerous methods to determine the position and orientation of the OP [8-10]; however, none was accurate in locating the OP [11]. Cephalometric analysis has been proposed to [5] clinically determine various craniofacial planes based a profile teleradiographs. This method is perceived as a gold-standard technique, and can be used as a reference to orient and evaluate the position of the occlusal plane in patients more precisely [12]. It is reported as adequate for many patients, and usually produces satisfactory results.

Aim of the Study

The aim of the present study was to determine mean values for profile teleradiographs of the angles between the OP and five craniofacial planes, namely, Camper's plane (CP), Frankfort plane (FP), Axio-orbital plane (AOP), Palatine plane (PP) and Mandibular plane (MP). Their location was specified by tracing cephalometric landmarks on profile teleradiographs of a Moroccan population in normal occlusion. The results were compared with previous studies, thus allowing for the orientation of the occlusion plane in complex prosthetic rehabilitation cases that involve the loss of all occlusal reference.

Materials and Methods

To conduct this cross-sectional study, a total of 160 participants were recruited. They were identified through Casablanca University Dental Hospital (See table 1) and a private clinic in Casablanca in Morocco. The participants were included in the study, if they fulfilled the following criteria:

- Had complete set permanent teeth, with a skeletal class I dental occlusion.
- Received no current or recent orthodontic/orthopaedic treatment.
- Had no supraclusion, overlap or dental space.

We collected 160 profile teleradiographs of adult patients with a class I dental occlusion from March, 2021 to July, 2021. The sample was divided into three groups: group 1 normodivergent (n = 47), group 2 hypodivergent (n = 36), and group 3 hyperdivergent (n = 77), based on values obtained on the Frankfort Mandibular Plane (FMA) angle.

All cephalograms were traced on an acetate tracing sheet of five microns' thickness using a 0.5 mm lead pencil on a view box. A single operator, with 24 years of clinical experience in orthodontics, performed the tracings to avoid errors due to intra-operator variability. In accordance with the standard technique, the participants' profile faced right, and the film was oriented to place the SN line horizontally. Using a protractor, angle measurements were obtained between the OP and the FP, OP and AOP, the OP and the CP, the OP and the PP and the OP and the MP (Figure 1).

To trace the Camper's plane, the upper edge of the tragus as a posterior landmark and the subnasal point as an anterior landmark were used. Table 1 summarizes the different methods used to draw the Camper's plane [11]. In the present study, all tracings were performed by experienced investigators, and were repeated at two-week intervals to ensure intra-observer reliability. Approval for conducting the study was obtained from the Institutional Review Board of Casablanca School of Dentistry at Hassan II University in Morocco, and all participants provided oral informed consent. The T-test was used to determine if there was a significant difference between the means of the overall distribution and the mean of each group of participants.

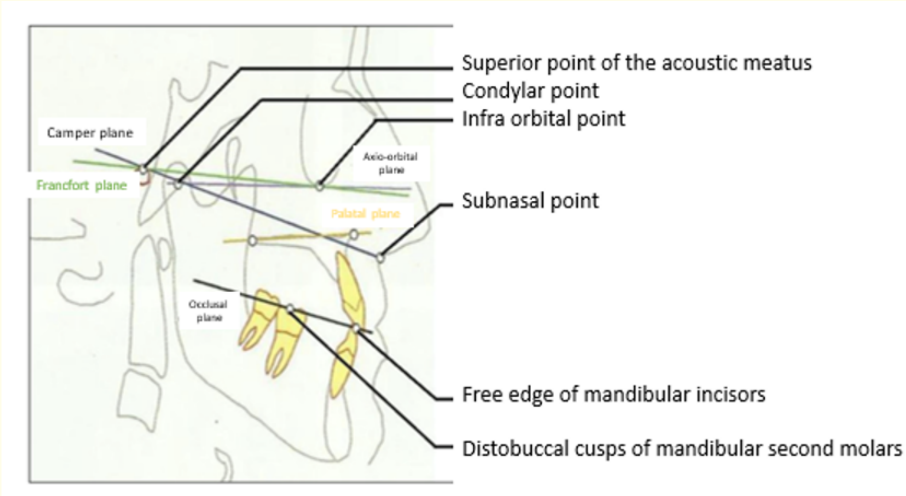

Figure 1: *Tracing showing the different measurement points used.*

Authors	Posterior references	Anterior references
Dalby	Lowest point of the external auditory meatus	Lowest point of ala
Clap and Trench	Upper border of the external auditory canal	Ala of the nose
Prothero	Tragus	Ala of the nose
Landa	Midpoint of the tragus	Ala of the nose
Hartono	Lower margin of the tragus	Lowest point of ala of the nose
Nikzad Javid	Miiddle of the tragus	Under ala of the nose
Niekerk, Miller, Bibby	Lower Border of the tragus	Ala of the nose
Winkler, Heartwell	Upper Border	Lower Border of ala
Xier, Zhao	Middle of the tragus	Ala of the nose
MCGergor	External auditory meatus of the ear	Lower Border of ala of the nose
Glossary of Prosthodontics term	Tip of the tragus (ala-tragus line) Upper border of tragus Camper line	Lower Border of ala
Sharry	Tragus	Ala of the nose
Cie Boucher	Upper Border	Lower border of the nose
In part	Center of the tragus	Center of the wing of the nose
Hickey Zarb, Bolender	No information on the exact part of the tragus	Ala of the nose
Neil and Narin	Center of the tragus	Ala of the nose

Table 1: *Different reference points of Ala-tragus as reported by different authors.*

Results

The sample comprised 160 patients; XXXXX were males (%) and XXX were females (%). Of the 160 patients included, 47 (29.4%), 36 (22.5%), and 77 (48.1%) presented as normodivergent, hypodivergent, and hyperdivergent patterns, respectively. The results of the angular measurements made for each group are summarized in table 2-4. Table 5 provides the overall results of the average angle measurements for the whole sample. Statistical differences between the angle values of the overall sample and the cephalometric values of each group indicated that: OPFP

- Only the OPMP ($p = 0.0006$) and OPCP ($p = 0.00003$) angle values in normodivergent patients (group I) were significantly lower compared to the overall sample (Table 5).
- The angle values of OPMP ($p < 0.05$), OPCP ($p = 0.028$), OPFP ($p = 0.037$), OPPP ($p = 0.0009$) and OPAOP ($p = 0.000008$) in hypodivergent patients (group II) were significantly lower than those of the overall sample (Table 5).
- The angle values of OPMP ($p = 0.05$), OPCP ($p = 0.00004$), OPFP ($p = 0.056$), OPPP ($p = 0.003$) and OPAOP ($p = 0.0007$) in hyperdivergent patients (group III) were significantly higher than those of the overall sample (Table 5).

	OP-MP	OP-PP	OP-AOP	OP-CP	OP-FP
Mean	15,936	10,478	12,782	8,223	8,127
Minimum	10	1	6	2	1
Maximum	23	14,5	22	14	14
Standard deviation	3,177	2,851	3,051	2,802	2,671

Table 2: *Angular measurement results for group 1.*

	OP-MP	OP-PP	OP-AOP	OP-CP	OP-FP
Mean	13,44	9,27	10,40	8,73	7,54
Minimum	10	5,5	5	3	4
Maximum	20	13,5	14	14	14
Standard deviation	2,60	2,07	2,71	2,04	1,83

Table 3: *Angular measurement results for group 2.*

	OP-MP	OP-PP	OP-AOP	OP-CP	OP-FP
Mean	22,70	12,88	14,90	13,23	9,46
Minimum	17	4	9	4	0
Maximum	30	23	29	24	14
Standard deviation	3,13	3,91	3,21	3,56	3,37

Table 4: *Angular measurement results for group 3.*

	OP-MP	OP-PP	OP-AOP	OP-CP	OP-FP
Mean	18,63	11,368	13,270	10,75	8,637
Median	19	11,5	13,25	10,5	8,5
Minimum	10	1	5	2	0
Maximum	30	23	29	24	14
Variance	25,39	12,992	12,475	15,059	8,924
Standard deviation	5,04	3,604	3,532	3,88	2,987

Table 5: *Overall results of the angular measurements of our sample.*

Discussion

Sample size

The study sample consisted of 160 participants, broken down into three groups: normodivergent (n = 47/29.4%), hypo divergent (n = 36/22.5%) were and hyper divergent (n = 77/48.1%) were. This sample is considered larger than that reported in previous studies. For example, the Sinobad's study (1988) included only 140 patients [13]. To determine the angulation of the occlusal plane, Siefert., *et al*. (2000) [14] and Gandhi., *et al*. (2017) [7] divided their sample into three groups based on facial patterns (normodivergent, hypodivergent, hyperdivergent). Other studies, however, classified their sample according to the sagittal direction based on the relationship between the maxillary and mandibular skeletal bases (Skeletal Classes 1, 2 and 3). Shergil (2018) [15] examined also the angulation of occlusal plane according to different skeletal bases.

Lahori., *et al*. [16] examined the relationship between the occlusion plane and different anatomic reference planes and their use as a guide to determine the OP, and Kumar., *et al*. [17] investigated the reliability of anatomical reference planes in determining the OP based on the same skeletal classification. Subhas., *et al*. (2016) [8] compared the relationship between the occlusion plane and the three Ala-Tragal lines, namely the superior, middle and inferior lines, in individuals having different head forms (mesocephalic, dolichocephalic and brachycephalic). While the research presented above investigated the relationship between the OP and all the craniofacial planes addressed in this work, one unaddressed gap was the relationship between the OP and the Axio-orbital reference plane. The present study attempted to fill this gap.

Methods of occlusal plane determination

Rehabilitating a defective occlusion plane is a major esthetic challenge for the restoring dentist. Placing the prosthetic teeth in a correct occlusion plane is fundamental to obtain adequate stability, function and aesthetics [18]. Various methods utilize extra-oral, static intra-oral and dynamic intra-oral landmarks for determining the occlusal plane position and orientation. Establishing the occlusal plane according to aesthetic and phonetics requirements involves setting the beading of the maxillary model in order to achieve a harmonious and natural labial support, and positioning the OP parallel to the bipupillary plane. These techniques are represented by Fox's plane and the Ditramax system suggested by Margossian., *et al*. [19]. The Ditramax system allows straightforward casting of the interpupillary line, the median sagittal plane and the camper plane which guides fixed and/or adjoining prosthetic reconstruction. Labio-dentals such as "Fe" and "Ve" are pronounced to refute or confirm the position of the free edge of the model. During the pronunciation of these, the posterior part of the bead should be parallel to Camper's plane.

The use of anatomical landmarks as guides for locating the occlusion plane has been suggested in a number of studies. For example, Gysi [20] and Ackerman [21] maintained that a parallelism between the OP and the curve of the mandibular ridge was achieved when masticatory forces were perpendicular to the occlusal plane. Walker [22] however, pointed out that the parallelism between the OP and the curve of the mandibular ridge was achieved with the maxillary ridge. Other authors located the occlusion plane in the intercostal space. For example, Cooperman [23] opined that the hamular notches located between the tuberosity and the hamulus of the medial pterygoid (HIP) plate could be useful in establishing the occlusal plane. This plane should be parallel to the HIP plane.

Piezography as a physiological technique is principally used to record muscular activity of oral structures (tongue and buccinators, in particular) by means of pressure exerted during oral functions. The term was first used by Klein in 1974, and it means 'a shape formed by pressure' [24]. The occlusal plane is normally established according to mandibular registration, a technique appropriate for difficult cases such edentulous teeth, significant resorption of ridges, and facial paralysis [24].

A simplified technique for determining the occlusal plane is the 'Broadrick flag technique', designed to identify the location of the Curve of Spee [25]. It is based on the work of Wadsworth, Wilson, Monson and Villain. Monson proposed that the Spee curve is inscribed in a sphere whose centre is the Crista galli apophysis. The determination of the occlusal plane is performed in the laboratory, after mounting the components on an articulator in centric relation. In this technique, a vertical, flag-shaped component is attached superiorly to the upper member of an articulator. The distance recorded on the flag is transferred by drawing two intersecting arcs with 4-inch radius (104 mm) [26], the centers of which are, successively, the condyle and the canine tip. The point of bisection of the two arcs determines the center of a sphere whose surface corresponds to an ideal sagittal plane of occlusion [27]. The 'Broadrick flag technique' has been criticized on the basis of its inability to consider the skeletal type of patients due to its delicate or sometimes imprecise implementation [28]. Nevertheless, this geometric technique remains a relatively simple and rapid method for identifying disturbances of the OP, and thus suggesting therapeutic measures [29].

In an attempt to identify the OP, a number of studies have related it to various anatomic reference planes. Karkasis and Polysois [30] used Camper's plane, while Seifert [14] used Frankfurt's horizontal plane as a guide to correctly orient the OP. Originally, Camper's plane was oriented using bony landmarks, passing through right and left Tragus and Subnasal landmarks [31].

Locating Camper's plane has proven to be more difficult. If the anterior determinant is always located at the level of the inferior edge of the wing of the nose, the posterior determinant varies according to different studies. In fact, there are differences in the literature concerning which part of the tragus to use, since some researchers believe that using the lower border of the tragus is more effective, while others believe in the appropriacy of using the lower part [32] or the upper part [33].

In the Anglo-Saxon literature, Camper plane is often referred to as the "ALA-Tragus line", and the occlusal plane is expected to be more parallel to the ala-tragus line posteriorly [34,35]. There exists a debate over the exact reference points for the Camper line. In fact, there is consensus as to which part of the Ala-Tagus line should be used for determining the occlusal plane. Al Quran., *et al*. [36] suggested that the most accurate Ala-Tragus line for orienting the OP was passed through the lower edge of the nose wing and the upper edge of the Tragus. van Niekerk., *et al*. [10] constructed the plane of occlusion according to esthetics, function, and comfort criteria, and showed a parallel relationship between the OP and the Ala-Tragus line when it passed through the lower edge of the tragus. However, many comparative studies have shown that the Ala-Tragus line is variable and quite different from the real OP [37-40].

Against this background, it was therefore necessary to have a useful method that can determine the OP. Profile teleradiography offers an ideal cephalometric approach to determine the orientation of the occlusal plane, relative to the craniofacial mass [41] in totally or partially edentulous patients, by locating different craniofacial planes.

Several methods of orienting the occlusal plane have been proposed in the literature (e.g. Tweed and Ballard), but the ones which have gained the widest acceptance are those of Ricketts and Downs [42,43]. The determination of the correct orientation of the OP by teleradiography is based on the work of Ricketts. Ricketts [44] defined a point (Xi) in the center of the ramus, created by geometric construction and located at the level of the center of the mandibular ramus. It is obtained by first assimilating the ascending ramus to a rectangle constructed by drawing four points determined on the mandibular contour with the Frankfurt plane as a reference, then tracing the diagonals of this rectangle. their intersection constitutes the point Xi. The occlusion plane would pass over point Xi at 8 years, through point Xi at 10 years and slightly below at 12 years [44].

Lejoyeux [28] stated that the OP passed through point Xi posteriorly and 2 mm above the lower lip anteriorly. This technique is indicated in total or partial denture in cases of bi-maxillary Kennedy C1 edentulism. Other researchers have relied on purely typological data that do not require any angular value. On two teleradiographs of the face and profile, they examined the facial structures in relation to arcs of circles centred on a point as the centre of convergence of a plane tangent to the base of the skull, the palatal plane, occlusion plane and the mandibular plane. The OP runs from the middle of the incisive overlap to the middle of the first overlapping molars and should normally converge to point OP [45].

Gibert and Cretot [46] investigated the angle between the OP and the bony camber plane, related to the degree of opening of the mandibular angle for each individual, as it slightly varies according to gender. Using the angle between the OP and the Frankfurt plane, Downs [43] defined the OP as a line bisecting the midpoint of the overlapping cusps of the first molars and the incisal overbite.

Our study proposed teleradiography as an accurate and objective method to determine the OP, with the aim of comparing our findings with the results of other studies conducted on various populations.

The predominance of hyperdivergent cases in our sample can be explained on the basis of Moroccan patients' predisposition to hyperdivergence compared to hypodivergence. Our results are similar than the results reported in the Ousehal., *et al*. study (2012) [47] and (2016) [48]. A comparison of the different measurements obtained with other studies showed (Table 6):

	Our Study			Other Studies				
	Mean	**Total**	**Population**	**Authors**	**Mean**	**Total**	**Population**	**P value**
OP-MP	18,63 ± 5,04	160	Morocco	Siefert., *et al*.	13,32 ± 3,85	60	Croatia	0
OP-MP	18,63 ± 5.04	160	Morocco	Shergil	17,35 ± 2,95	25	India	0,186
OP-PP	11,36 ± 3,604	160	Morocco	Siefert., *et al*.	7,58 ± 3,18	60	Croatia	0
OP-PP	11,36 ± 3,604	160	Morocco	Shergil	6,70 ± 0,80	25	India	0,000225
OP-PP	11,36 ± 3,604	160	Morocco	Kumar., *et al*.	6,00 ± 1,90	20	India	0,002539
OP-CP	10,75 ± 3,88	160	Morocco	Siefert., *et al*.	5,37 ± 3,44	60	Croatia	0
OP-CP	10,75 ± 3,88	160	Morocco	Shergil	6,95 ± 3,44	25	India	0,000007
OP-CP	10,75 ± 3,88	160	Morocco	Subhas., *et al*.	3,12 ± 4,47	25	Saudi Arabia	0
OP-CP	10,75 ± 3.88	160	Morocco	Ghandhi., *et al*.	7,46 ± 4,65	100	India	0
OP-FP	8,63 ± 2,987	160	Morocco	Siefert., *et al*.	11,42 ± 4,62	60	Croatia	0
OP-FP	8,63 ± 2,987	160	Morocco	Shergil	11,70 ± 1,87	25	India	0,011
OP-FP	8,63 ± 2,987	160	Morocco	Kumar., *et al*.	10,60 ± 1 ,68	20	India	0,042
OP-FP	8,63 ± 2,987	160	Morocco	Subhas., *et al*.	11.04 ± 1,53	25	Saudi Arabia	0,156

Table 6: *Comparing of the mean of our sample and the mean of others studies.*

- For the OPMP angle, while in our study the average value of OP angle measurement was found to be 18.6°, Shergil [15] reported an average value of 17.3° for the Indian population while Siefert., *et al*. [14] suggested 13.3° as the average for the Croatian population.
- For the OPPP angle, we found an average value of 11.4° in the Moroccan population. Siefert., *et al*. [14] reported a value of 7.5° for the Croatian population; in contrast, Shergil [15] confirmed a value of 6.7° for the Indian population while Kumar., *et al*. [17] indicated an average value of 6.0° for the Indian population.
- For the OPCP angle, an average value of 10.7° was obtained in our study, 7.4° in Ghandi., *et al*. [7] for the Indian population, 6.9° in Shergil [15] for the Indian population, 5.3° in Siefert., *et al*. [14] for the Croatian population, and 3.1° in Subhas., *et al*. [8] for the Saudi population.
- Regarding the OPFP angle, an average value of 8.6° was confirmed in our study, 10.6° in Kumar., *et al*. [17] for the Indian population, 11.4° in Siefert., *et al*. [14] for the Croatian population, and 11.7° in Shergil [15] for the Indian population.

Statistical comparison of means for the entire sample with those previously reported in the literature on different populations showed significant differences between the OPCP angle and those of the Croatian, Indian and Saudi populations ($p < .05$); between the OPPP and OPFP angles and those of the Croatian and Indian populations; and between the OPMP angle and the Croatian population, exclusively.

These differences could be explained by the high hyperdivergence rates found in the Moroccan population, with average values recording higher than those reported in the literature (Table 7). It is important to stress the effect of diversity in the definition of the points through which the planes studied pass. For example, in the present study, Camper's plane ran through the subnasal point and the superior point of the tragus. In Shergil's study [18], it passed through the anterior nasal spine and porion, while in Gandhi., *et al's* study [8], Camper's plane ran from the inferior border of the ala of the nose to the superior border of the tragus.

OP-MP	18,63° ± 5,04	13,444° ± 2,607
OP-PP	11,36° ± 3,60	9,277° ± 2,078
OP-AOP	13,27° ± 3,53	10,402° ± 2,711
OP-CP	10,75° ± 3,8	8,736° ± 2,047
OP-FP	8,63° ± 2,98	7,541° ± 1,837

Table 7: *Comparing the mean of the overall distribution and the mean of group 2.*

Our findings, however, are in accordance with previous studies (e.g. the OPMP angles for the Indian population [15] and the OPFP angles for the Saudi population [8]).

Comparison of means for the entire sample with those for each group also showed significant differences. Mean values were significantly lower in the hypodivergent cases and higher in the hyperdivergent cases compared to the global sample's mean. This could be explained by the fact that the orientation of the OP in this study was done according to the facial typology: the OP is directed downwards in case of hyperdivergence and upwards in case of hypodivergence. For normodivergent cases, the mean values were lower than the overall means. This difference was only statistically significant for the OPMP and OPCP angles. The problem with cephalometric standards lies in applying the same standards to different populations. Applying American standards to African or Asian populations is challenging. This is the reason why the orthodontic literature includes studies of cephalometric norms specific to each population [49,50]. Therefore, using the cephalometric method based on foreign standards can be misleading. Ideally, the norms specific for each population should be used. Sahoo., *et al*. [11] carried out a systematic review on the OP's orientation, and confirmed a correlation between facial types and the OP's location. They further highlighted the orientation of the OP with the sagittal shifts of the face (class I, class II or class III skeletal). Conducting a similar study in class II and III skeletal Moroccan patients can be very useful and would further support our results.

Conclusion

The orientation of the OP is an essential step in prosthetic rehabilitation. Given the important effect of accurately establishing the location and inclination of OP on function, esthetics and speech, a method to conform it to the OP that existed in the natural teeth seems necessary. The use of the cephalometric method facilitates the task of orienting the OP, especially when several reference planes are used. This is made possible with profile teleradiography; an effective method which can be implemented in the dental practice setting.

This study investigated the relationship between the OP and the five craniofacial planes, namely Camper's plane, Frankfort's plane, palatal plane, mandibular plane and axio-orbital plane in a class I patient population from Casablanca, distributed according to facial typology in the vertical direction.

Mean angles found between the OP and the planes studied were 8.6° for the Frankfort plane, 10.6° for the Camper plane, 13.3° for the axio-orbital plane, 11.4° for the palatal plane and 18.6° for the mandibular plane.

Locating the OP in relation to the craniofacial planes studied, using the mean values found, should allow practitioners to place the OP as close as possible to the plane previously occupied by the natural teeth. However, the comparison between the angle means obtained in the present study and those reported in previous studies showed significant differences. As a result, this method should be used with caution, taking into account the specific characteristics of each population. Further carefully-designed studies are needed to replicate our results, and extend the investigation to patients with skeletal Class II patients.

Bibliography

1. Dawson PE. "Evaluation, diagnosis and treatment of occlusal problems". CV Mosby, Saint Louis (1989).
2. Schillinburg HT., *et al*. "Bases fondamentales en prothèse fixée". Edition CdP, Initiatives Santé, Paris (1998).
3. Latino H and Rozencweig D. "Ajustement occlusal pré prothétique". Cah. Prothèse 28 (1979): 129-147.
4. N'dindin AC., *et al*. "Apport de la téléradiographie dans la détermination du plan d'occlusion référentielle chez l'édenté totale". *Odontostomatologie Tropicale* (2000): 91.
5. Bitty MJ., *et al*. "Recherche du plan d'occlusion prothetique chez le sujet negro-africain: Intérêt du point XI de Rickett". *The Journal of Forensic Odonto-Stomatology* 13.1 (2011): 36-43.
6. Shetty S., *et al*. "Occlusal plane location in edentulous patients: a review". *The Journal of Indian Prosthodontic Society* 13.3 (2013): 142-148.
7. Gandi N., *et al*. "Étude céphalométrique de la position de la ligne Ala-tragus par rapport au plan horizontal de Francfort et au plan occlusal parmi la population de Ludhiana". *Indian Journal of Dental Sciences* 9.5 (2017).
8. Subhas S., *et al*. "A cephalometric study to establish the relationship of the occlusal plane to the three different ala-tragal lines and frankfort horizontal plane in different head forms". *Journal of Stomatology, Oral and Maxillofacial Surgery* 118.2 (2017).
9. Boucher CO. "Occlusion in prosthodontics". *Journal of Endodontics* 3.5 (1953): 633-656.

10. Van Niekerk FW., *et al*. "Ligne Ala tragus dans les prothèses dentaires complètes". *Journal of Endodontics Dent* 53.1 (1985): 67.

11. Sahoo S., *et al*. "Systematic assessment of the various controversies, difficulties, and current trends in the reestablishment of the lost occlusal planes in edentulous patients". *Annales de la recherche en sciences médicales et de la santé* (2014): 3.

12. Neslihan Ebru Sxenısxık and Selcan Hasipek. "Occlusal Cant: Etiology, Evaluation, and Management". *Turkish Journal of Orthodontics* 27.4 (2014).

13. Sinobad D. "The position of the occlusal plane in dentulous subjects with various skeletal jaw- relationships". *Journal of Oral Rehabilitation* 15 (1988): 489-498.

14. Seifert D., *et al*. "Relation of the reference planes for orientation of the prosthetic plane". *Acta stomatologica Croatica* 34 (2000): 413-416.

15. Shergil DK. "Evaluation complexe de la cohérence des différents plans de référence lors de la réorientation du plan occlusal dans les relations des mâchoires de classe 1 et de classe 2: une étude céphalométrique in vivo". *Revue internationale de recherche en santé et sciences connexes* 4.2 (2018).

16. Lahori M., *et al*. "A cephalometric study on the relationship between the occlusal plane, ala tragus and camper's lines in subjects with angles's class1, class 2 and class 3 occlusion". *The Journal of Indian Prosthodontic Society* 13.4 (2013): 494-498.

17. Kumar P., *et al*. "Reliability of anatomic reference planes in establishing the occlusal plane in different jaw relationships: a cephalometric study". *Indian Prosthodontic Society* 13.4 (2012): 571-577.

18. Zarb G. "Treatment for edentulous patients. Boucher's prosthodontic 10th edition". CV Mosby, St. Louis (1998): 296-309.

19. Margossian P., *et al*. "Communication des données esthétiques faciales au laboratoire: le système Ditramax". *Real Clinic* 21.3 (2010): 41-51.

20. Gysi A. "The Problem of articulation". Dent Cosmos 52 (1910): 1-19.

21. Ackerman F. "Le Mécanisme des mâchoires". Paris: Masson (1952).

22. Walker W Ernest. "The Facial Line and Angles in Prosthetic Dentistry D". *Cosmos* 39 (1897): 789-800.

23. Cooperman HN. "HIP plane of occlusion in oral diagnosis". *Dent Surv* 51.11 (1975): 60-62.

24. Klein P. "Les apports de la piézographie à la prothèse adjointe mandibulaire Sciences odontologiques, paris (1970): 17.

25. Jeannin C., *et al*. "Exemple d'analyse de la situation initiale avant l'élaboration d'un devis: reconstruction prospective par la technique du drapeau". Strat Prothétique 15.2 (2005): 61-69.

26. Romerowski J. "Une bataille de titans: Ruppert Hall et Alfred Gysi". XIVème Congrès SFHAD, Caen. 23 (2004).

27. JDO. "La courbe de Spee: un impératif physiologique et prothétique". Cah Prothès 44 (1983): 89-116.

28. Orthlieb J-D., *et al*. "Application clinique d'un plan de traitement prothétique rationnel". *Infodent International* 83.23 (2001): 1715-1725.

29. Ousehal L., *et al*. "Détermination céphalométrique duplan d'occlusion". La technique du drapeau. O.S.T. - T.D.J Mars/March 35 (2012): 137.

30. Karkhazis HC and Polyzois GC. "A study of the Occlusal plane orientation in complete denture construction". *Journal of Oral Rehabilitation* 14 (1987): 399-404.

31. The Glossary, Of Prosthodontic Terms". *The Journal of Prosthetic Dentistry* 94.1 (2005): 10-92.

32. Jayachandran S., *et al*. "Occlusal Plane Orientation: A Statistical and Clinical Analysis in Different Clinical Situations". *Journal of Prosthodontics* 1.17 (2008): 572-575.

33. Nissan J., *et al*. "Relationship Between occlusal plane determinants and craniofacial structures". *Journal of Oral Rehabilitation* 30.6 (2003): 587-591.

34. Perez C., *et al*. "Application De l'analyse céphalométrique à la reconstruction prothétique de la courbe de Spee". *Stratégie Prothétique* 7.3 (2007): 175-184.

35. Saquib Ahmed Shaikh., *et al*. "Relationship Between Occlusal Plane and Three Levels of Ala Tragus line in Dentulous and Partially Dentulous Patients in Different Age Groups: A Pilot Study". *Journal of Clinical and Diagnostic Research* (2015).

36. Al Quran FA., *et al*. "La position du plan occlusal dans les dentitions naturelles et artificielles par rapport aux autres plans craniofaciaux". *Journal of Prosthodontics* 19.8 (2010): 601-605.

37. Nissan J., *et al*. "Relationship Between occlusal plane determinants and craniofacial structures". *Journal of Oral Rehabilitation* 30.6 (2003): 587-589.

38. L'Estrange PR and Vig PS. "A Comparative study of the occlusal plane in dentulous and edentulous subject". *The Journal of Prosthetic Dentistry* 33.5 (1975): 495-503.

39. Karkazis HC., *et al*. "Relationship between ala-tragus line and natural occlusal plane. Implications in denture prosthodontics". *Quintessence International* 19 17 (1986): 253-255.

40. Augsburger R. "Occlusal Relation to facial type". *The Journal of Prosthetic Dentistry* 3 (1953): 755-759.

41. Sangiuolo RA., *et al*. "Les édentations totales bimaxillaires: formes cliniques, thérapeutiques prothétiques". *François Prélat* (1980): 196.

42. Ricketts M. "The rôle of cephalometrics in prothetic diagnostic". *The Journal of Prosthetic Dentistry* 6.1 (1956): 448-502.

43. Downs WB. "Analysis of the dentofacial profile". *The Angle Orthodontist* 26 (1956): 191-212.

44. Ricketts RM. "Cephalometric analysis and synthesis". *The Angle Orthodontist* 31 (1961): 141-156.

45. Rupple L. "An apparatus to determine the position of the occlusal plane in prosthetic and orthodontic cases". *Q. Record* 40 (1920): 637-639.

46. Gilbert Y and Cretot M. "Orientation du plan d'occlusion en prothèse adjointe complète. Un pas vers la sécurité". *Chir. Dent. France* 310 (1985): 41-46.

47. Ousehal L., *et al*. "Cephalometric norms for a Moroccan population". *International Orthodontics* 10.1 (2012): 122-134.

48. Ousehal L., *et al*. "Vertical dimension of occlusion (VDO): cephalometric norms for a Moroccan population". *Journal of Orofacial Orthopedics Fortschritte Kieferorthopädie* 77.1 (2016): 39-44.

49. Obloj B., *et al*. "Cephalometric standards for Polish 10-year-olds with normal occlusion". *The Angle Orthodontist* 78.2 (2008): 262-269.

50. Hassan AH. "Cephalometric norms for Saudi adults living in the western region of Saudi Arabia". *The Angle Orthodontist* 76.1 (2006): 109-113.

Volume 22 Issue 7 July 2023