A Photographic Approach Studying the Orientation of the occlusal plane of the Malaysian Population. A Proposal for an Orienting Device

LAITH MAHMOUD ABDULHADI AL-SAMAWI, HANAA ABBAS MOHAMMED, HUMAM LAITH
Department of Prosthetic Dentistry
Mahsa University
Jalan SP 2, Bandar Saujana Putra, Selangor,
MALAYSIA

Abstract:- The occlusal plane is crucial in prosthodontic reconstructive treatment as it affects the most important factors for the proper functioning of the artificial prostheses. The achievement of correct occlusal plane position offers maximum aesthetic, phonetic, mastication, and patient's satisfaction. An incorrectly oriented occlusal plane interferes with denture stability and retention, in addition to more vital functions of the teeth and oral cavity. This study used a photographic approach to determine the occlusal plane inclination in relation to some anatomical references. 95 young volunteers of Mahsa University College, aged between 20 and 25 years, were selected for this study. The participants were selected according to specific inclusion criteria. A standardized digital profile and front images were taken for each participant using a digital camera that is fixed on a tripod with the fox bite plane placed on the occlusal surfaces of the maxillary teeth. The angle amplitude of the reference planes in relation to the occlusal plane was measured using a digital protractor on the screen display. The results revealed that the least mean angle difference was with the AT1, while higher variability was found using the Frankfort plane. In addition, there were no significant differences between the two genders or among the three ethnic groups. It is concluded that the photographic method can be used successfully to study the occlusal plane, and the lowest point of the tragus is the best posterior reference point to determine the ideal location of the occlusal plane.

Key-Words:- Orientation of the occlusal plane, Camper plane, Frankfort plane, Mandibular plane, Orienting device

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1 Introduction

The occlusal plane is "an imaginary surface that is related anatomically to the cranium and that theoretically touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth. It is not a plane in the true sense of the word but represents the mean curvature of the surface" [1]. The height of the lower canine, which nearly lines up with the mouth commissure, determines it anteriorly, as does the height of the retromolar pad, which defines it posteriorly. One of the elements in both natural and artificial tooth occlusion is the occlusal plane. It offers an important role in oral and dental rehabilitation and is essential for restoring the stomatognathic system's function and aesthetics [2].

1.1 Reference and Anatomical Landmarks

In studying and analyzing the components of the stomatognathic system, some references (anatomical and imaginary) should be well defined to understand the relation and configuration of the system when rehabilitation of occlusion in edentulous patients is addressed. Therefore, some important references are defined in this section.

1.1.1 Frankfort plane

Is a horizontal plane established on the cranium by joining the orbitale, which is the lowest point in the margin of the bony orbit (the lowest point on the inferior edge of the orbit) and the highest point in the margin of the external auditory meatus (the porion; the superior surface of the external auditory meatus). In craniometry, the porion is identified as

the margin of the bony canal on the skull. This plane is used as a reference for most of the anatomical parts of the skull. It orients the skull parallel to the horizontal plane. It forms a variable angle with the occlusal plane (Fig. 1).

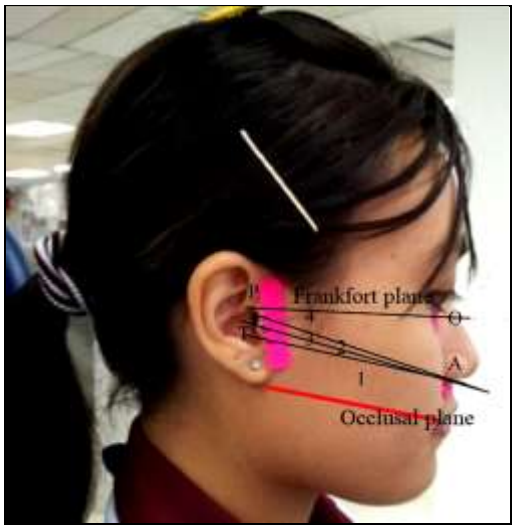

Fig. 1: Some facial landmarks and reference lines or planes
P; porion, T; tragus, O; orbitale, A; ala of the nose, 1; lower limit of tragus, 2; middle point of tragus, 3; upper limit of tragus,T-A; ala-tragus or Camper line, P-O; Frankfort plane or line.

1.1.2 Camper's line

A line from the lower border of the ala of the nose to the upper border of the tragus of the ear. The camper line becomes a plane when the imaginary lines connect the two alae of the nose anteriorly and the tragus posteriorly. Approximately, it is parallel to the occlusal plane (Fig. 1).

1.1.3 Interpupillary line

An imaginary line that passes between the centers of the pupils of the two eyes is parallel to the horizontal plane. The anterior part of the maxillary occlusal plane should be parallel to the interpupillary line. It should be 2mm below the upper lip line or smile line [2]. This line is indispensable to validating the parallelism between the anterior tooth edges and the eyes (Fig. 2).

1.1.4 The curve of Spee

It is the antero-posterior curve line that extends from the tip of the lower canine and follows the buccal cusps of the mandibular posterior teeth (Fig. 3) [2].

1.1.5 The curve of Wilson

It is a mediolateral curve that touches the buccal and lingual cusps of molars on both sides of the dental arch (Fig. 4) [2].

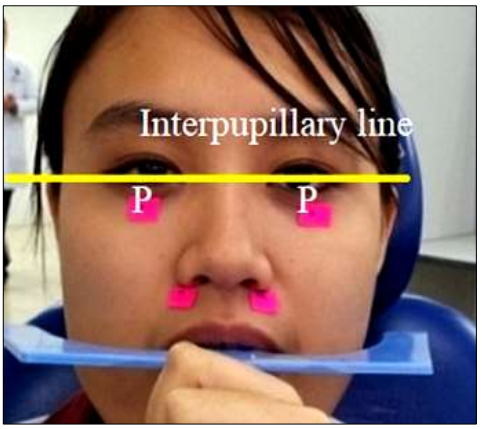

Fig. 2: Interpupillary line
P; centre of the pupil of the eye

Fig. 3: Curve of Spee

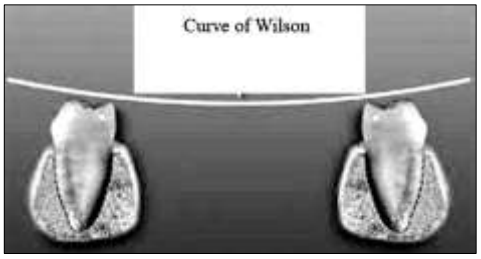

Fig. 4: The curve of Wilson

1.1.6 The importance of the occlusal plane

Clinicians have recognized that the occlusal plane should be at a right angle to the occlusal forces for stability of the occlusion, head, and neck musculature and the maximum benefits of occlusion forces that minimize muscle fatigue and promote a healthy functioning system [2], [3], [4]. The path of mandibular closure depends on the head and cervical neck postural angle and inclination and

should be perpendicular to the long axis of occlusal forces produced by an optimal cervical posture and an optimized mandibular closing path [3].

The inclination of the occlusal plane (IOP) is one of the key factors governing occlusal balance. Studies using cephalometrics have shown that the occlusal plane inclination during craniofacial growth relative to various facio-cranial reference lines varied in anterior rotation during growth. The most significant changes in the occlusal plane inclination were from the maxillary base, Frankfort horizontal, and cranial base reference lines. Small but significant correlational changes have been reported with these reference lines. It has also been reported that no significant differences according to sexes have been Occlusal plane inclination and angle are important factors that harmonize the morphology and function of the stomatognathic system [4].

It also influences the masticatory closing pattern in the sagittal plane. Anterior convex closure patterns dominate when the occlusal plane is inclined in the anterior direction. In contrast, the majority of posterior convex closure patterns were induced by the posteriorly inclined occlusal plane. The appearance of these types seemed to reflect a harmonious relationship between the inclination of the occlusal plane, tooth guidance, and other central and peripheral controls. The correlation between the inclination of the occlusal plane and masticatory closing movement serves as a functional background to the significance of the occlusal plane inclination [5].

The determination of OP is an important step before the construction of full-arch restorative, orthodontic, and full-denture-type cases. Evaluating and assessing the bilateral occlusal plane of the maxillary arch for symmetry, balance, and form is desirable to meet the demands of function and appearance. The IOP often reflects occlusal dysfunction along with often-associated periodontal problems as well as temporomandibular disorders. The determination of OP inclination has been found to be valuable during the diagnostic and rehabilitation treatment phases. It is the opinion of many that the right- and left-side antero-posterior OP angle should be evaluated before any major treatment or rehabilitation program, whether prosthetic or orthodontic, is undertaken.

It was reported that occlusal level alteration and masticatory imbalance have effect on the cervical spine. It may result in displacement of the cervical spine; in contrast, a chopping or more vertical-type closure pattern was observed predominately in cases with an anterior inclining occlusal plane. The importance of the inclination of the occlusal plane during masticatory movement in the excursive functional movement is much greater and of significance through the closing phase, except near the terminal intercuspal position. So, an anterior occlusal plane inclination or slope is important and significant in order to optimize the masticatory function in prosthodontic replacements. In contrast, a chopping or more vertical-type closure pattern was observed predominately in cases with an anterior inclining occlusal plane. So, an anterior occlusal plane inclination or slope is important and significant in order to optimize the masticatory function in prosthodontic replacements.

1.1.7 General importance of OP in dentistry

During the tooth arrangement of artificial teeth, the occlusal plane acts as a crucial guide for optimum placement and inclination of the teeth on the denture bases. It constitutes an important factor with the other constituents of occlusion for occlusal harmony during centric and eccentric mandibular movements. This relationship of harmony (H) was described as quints of Hanau. The factors include condylar inclination (CG), incisal guidance (IG), occlusal plane inclination (OP) , the compensating curve (CC), and cuspal inclination (CI). This harmony (H) is represented in equation:

$H = CG \times IG/OP \times CI \times CC$ [6].

1.1.8 Importance of OP in oral rehabilitation

The level and orientation of the occlusal plane are the most important factors in prosthetic restorations. In fact, the occlusal plane must ensure a perfect distribution of occlusal forces on abutment teeth during intercuspation, preserve prosthetic stability in eccentric movements and contribute to restore aesthetics and phonetics. Distortions in the occlusal plane may be due to malpositioning of the remaining teeth: versions, regressions, and rotations, in addition to malformation of hard and soft tissues in dentulous or edentulous areas. Restoring balance may appear complicated, for it concerns the four following factors: the sagittal orientation, the frontal orientation and the occlusal curvature radius: frontal (curve of Wilson) and sagittal (curve of Spee).

1.1.8.1 Stabilizing Role

The occlusal plane contributes to stabilizing the removable prosthesis during centric as well as during eccentric movements. During centric relation, occlusal forces stabilize the complete prosthesis when transmitted forces are perpendicular to the abutment surface. During eccentric movements, a bilaterally balanced occlusion

depends on an adequate orientation of the occlusal plane.

1.1.8.2 Functional Role

Aesthetics; anterior upper and lower mal-positioned teeth affect aesthetics. The position of incisal edges could be corrected according to aesthetic criteria and phonetic elements. However, the occlusal correction of maxillary natural teeth should be always carried out carefully without altering the patient's aesthetics. On the other hand, it is often easier to correct the incisal edge of mandibular teeth [7].

Phonetics; the arrangement of the anterior teeth will affect phonetics as well as aesthetics. The proximity of the upper and lower anterior teeth during protrusive movements, for example, will determine the 'c','s', and't' sounds. The relationship between the upper anterior teeth and the lip will affect the 'f' and 'v' sounds. As well as facilitating interpersonal communication, there is a social expectation that phonetic patterns will be affected in a specific way. Thus, the absence of anterior teeth (anterior part of the occlusal plane) can affect self-image as well as speech [3],[4].

Excessive lateral deviation around posterior teeth to develop socially acceptable speech patterns will require adaptation of the jaw neuromuscular system. Exceeding the physiological 'adaptability' of one or more of these components may result in pain and dysfunction. The length of incisors, the degree of horizontal and vertical overlaps, the angle of condylar inclination, and the curve of the occlusal plane will influence anterior tooth approximation during protrusion. These factors, except condylar inclination, may be modified by restorative procedures. Tooth form and tooth arrangement should therefore ensure the absence of posterior contacts during protrusive jaw movements, and this will be facilitated by developing a correct occlusal plane level and inclination. Thus, restorative procedures, which influence phonetics, may also affect the patient's psychological and physiological well-being [8].

The masticatory system as a whole forms a functional unit, which consists of the dentition, the periodontium, the jaws, the temporomandibular joints, the muscles involved in moving the mandible, the lip-cheek-tongue system, the salivary system, and the neuromuscular and nutritive (vascular) mechanisms involved in the maintenance of proper function.

For tooth replacement, the most important factors that have to be taken into account are the inclination of the occlusal plane and the vertical distance.

A faulty orientation of the occlusal plane will jeopardize interaction between the tongue and the buccinator muscle. Where the occlusal plane is too high, the tongue cannot rest on the lingual cusp of the mandibular denture teeth and prevent its displacement. There is also a tendency for the food to accumulate in the buccal and lingual sulci [9].

An occlusal plane that is too low or too high could lead to tongue and cheek biting and difficulty swallowing as well [10].

2 Problem Formulation

The orientation of occlusal plane needs a fixed reference or anatomical landmarks that ensure fixity , repeatability and reliability for proper reproduction. Therefore, due to the variability of the references used and the complexity of the proposed methods, this research was conducted to find an easy, reliable method to teach and to apply in daily practice in Malaysian people (Malay, Chinese, and Indians). With the perpetual progress in artificial intelligence and simulation models application in medical, teaching and research fields, this work can be included as a small routine to achieve a correct OP when digital occlusal and oral rehabilitation systems are designed for diagnosis and patient treatment [11]. Usually, teeth replacement and rehabilitation of edentulous patients are done either using the classical manual method or the digital-oriented technique. The next procedure after making an impression of the residual ridges is to record the maxillomandibular relationship. The record includes the determination of the OP inclination, the registration of vertical dimension height [12], the recording of centric and eccentric relations, and finally the arrangement of artificial teeth. Therefore, a reliable reference landmark should be used to transfer the maxillomandibular relationship to a simulation dental device.

2.1 The gathering of data

Data were collected from MAHSA University students. 95 healthy students aged 20–25 years participated in the study. Ethical approval was gained, and consent forms were signed. Each participant had the following criteria: full, healthy dentition; absence of attrition or extensive restorations; absence of orthodontic treatment; healthy temporomandibular joint.

The following anatomical landmarks were marked on each participant's face (Fig. 1).

To ensure the reliability of the reference line measurements on the patients using printed photos or digital images, 30 patients were selected

randomly, and the reference points were marked off on the face and then photographed using a digital camera fixed to a tripod. Profile and frontal photos were taken while the subject was sitting in an upright position with his or her head supported vertically by the head rest of the dental chair. The distance, magnification, level, and height of the camera were fixed (Fig. 5, Fig. 6).

Fig. 5: Profile imaging of the patient

Fig. 6: patient frontal photo-shooting

The anatomical landmarks that were used as reference points were marked directly on the face using different marking colors. Profile and front photos were taken from a fixed distance and position, while the Fox bite was fixed on the occlusal surfaces and incisal edges of the maxillary teeth, supported by the fingers of the examiners.
Thirty profile photos were printed on paper. Angle measurements were done indirectly (on papers) and directly (on the screen) for the same cases to check the reliability of records by three examiners.
The decision was to do the photo analysis directly on the personal computer screen after approving the reliability and coincidence of the measurements on the screen and the photos.
The reference landmarks that were marked on the face (Fig. 1, Fig. 2) are:
Left and right orbitales (LO, RO)
Three locations on each ear tragus: lower, middle, and upper (T1, T2, T3)
Lower border of the ala of the nose (A)
The reference planes and lines that were used in this study are:
Frankfort plane (FP): from the upper border of the tragus to the left orbitale
Ala-Tragus lines from three posterior reference points on the tragus:
LAT1: left ala-tragus line from the lower border of the tragus to the lower border of the ala of the nose
LAT2: left ala-tragus line from the middle border of the tragus to the lower border of the ala of the nose
LAT3: left ala-tragus line from the upper border of the tragus to the lower border of the ala of the nose
RAT1: right ala-tragus line from the lower border of the tragus to the lower border of the ala of the nose
RAT2: right ala-tragus line from the middle border of the tragus to the lower border of the ala of the nose
RAT3: right ala-tragus line from the upper border of the tragus to the lower border of the ala of the nose
Occlusal line on left side (LOP) and right side (ROP):
All the information was transferred to the case sheet designed for this study.
As mentioned before, three examiners analyzed the photos and measured the angulation of each line or plane in relation to references independently. The results were compared to those on the computer screen using digital ruler software (MB ruler) [13].

2.2 Data analysis

Descriptive statistics were used to explore the features of the sample (composition, standard deviation, mean age and angle, variance, maximum and minimum records, and normal distribution). Inter-examiner reliability tests were performed using Pearson correlation for the three examiners who calculated the angle variability of the lines and planes in relation to the occlusal plane on the photos and computer screen independently. The difference between right and left side records in relation to sex and ethnicity was tested using paired t-tests. The fixity of each reference line was tested in relation to the occlusal plane using the coefficient of variability to advise on the best one for clinical daily use.

3 Problem Solutions

3.1 Reliability of the measurements

3.1.1 Inter-examiner reliability

Three examiners measured a group of data independently to ensure the reliability and precision of the measurements. The results were highly positive at p<.001, Table 1, Table 2.

	1 examiner	2 examiner
2 examiner	P=.996*	-
3 examiner	P=.972**	P=.971***
*Significant, (DF = 28), p<.001, (2-tailed)		
**Significant, (DF = 28), p<.001, (2-tailed)		

***Significant, (DF = 28),p<.001,(2-tailed)

Table 1. The inter-examiner reliability of the 3 examiners for LAT1 records. P; Pearson correlation

	1 examiner	2 examiner
2 examiner	P=.935**	-
3 examiner	P=.982**	P=.919**
*Significant, (DF= 28), p<.001, (2 -tailed)		
**Significant, (DF= 28), p<.001, (2 -tailed)		
***Significant, (DF= 28), p<.001, (2 -tailed)		

Table 2. The inter-examiner reliability of the 3 examiners for LAT2 records. P; Pearson correlation

3.1.2 Inter-media reliability

The angles between some assigned reference planes or lines were recorded on the computer monitor using software (MB-Ruler), and on printed photographs manually, and they were compared to estimate the dependability by three examiners. The results were linear, highly significant, and positive (P = 0.995, DF = 28, at p<.001), Fig. 7.

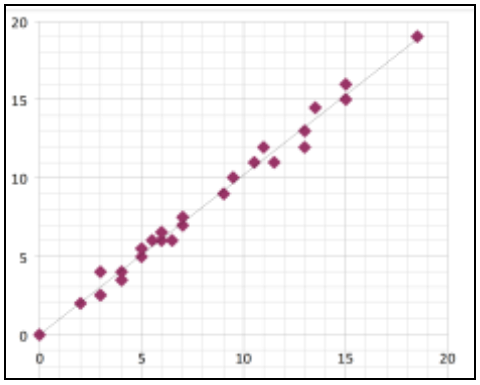

Fig. 7: Inter-media Reliability for records on paper and computer monitor

3.2 The composition of the sample

The sample was composed of 33 Malays, 32 Chinese, and 30 Indians (Fig. 8).

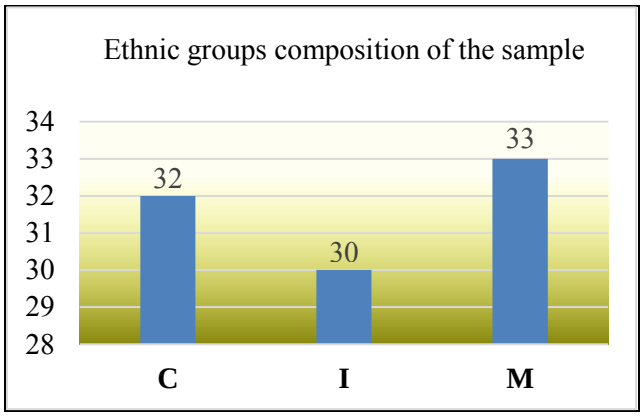

Fig. 8: Ethnic composition, C; Chinese, I; Indians, M; Malays

While, for the gender composition of the sample, the females constitute two times the males.
(Fig. 9).

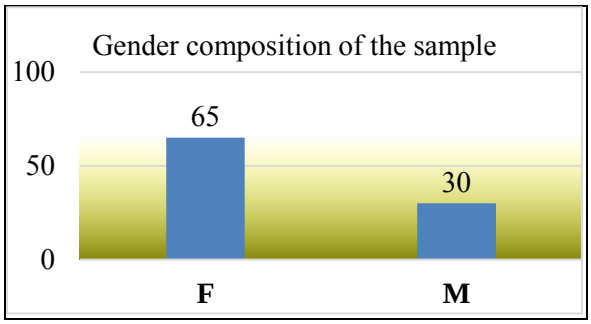

Fig. 9: Gender inclusion of the sample
F; females, M; males

3.3 The other features of the sample

3.3.1 The mean angle between the OP and reference lines on the two facial sides in relation to gender

The mean angles between the different reference lines, the occlusal plane on the two sides of the face and the Frankfort plane are shown in Table 3 . No statistical difference was found between the males and females on the two facial sides.

Table 3. The records of the differences in angle degrees between the occlusal plane and different reference lines on the two sides of the face in males and females

G;gender, N;number, M.A; mean angle, P-val.; p-value, RAT1-ROP; right lower ala tragus line-right occlusal plane, RAT2-ROP; right middle ala-tragus line-right occlusal plane, RAT3-ROP; right upper ala-tragus line-right occlusal plane, ROP-FP; right occlusal plane-Frankfort plane, LAT1-LOP; left lower ala tragus line-left occlusal plane, LAT2-LOP; left middle ala-tragus line-left occlusal plane, LAT3; left upper ala-tragus line-left occlusal plane, LOP-FP; left occlusal plane-Frankfort plane.

3.3.2 The mean angle between the OP and RL in relation to ethnic groups of the sample

The differences between the records on the right and left sides of the face were not significant at p<0.00 for the different ethnic groups (Table 4).

Angles	Ethn	No	Mean	SD±
RAT1-ROP	M	33	0.63	3.9
	I	30	-1.30	4.7
	C	32	-0.82	4.2
RAT2-ROP	M	33	3.15	4.0
	I	30	2.01	4.8
	C	32	1.09	4.3
RAT3-ROP	M	33	6.27	4.0
	I	30	3.99	4.4
	C	32	3.80	4.8
ROP-FP	M	33	8.31	4.3
	I	30	8.22	4.9
	C	32	10.39	4.5
LAT1-LOP	M	33	0.71	3.7
	I	30	-1.14	5.6
	C	32	-0.98	5.1
LAT2-LOP	M	33	3.15	4.0
	I	30	2.08	5.2
	C	32	1.26	4.2
LAT3-LOP	M	33	6.17	4.2
	I	30	4.84	5.4
	C	32	3.52	4.3
LOP-FP	M	33	9.83	4.3
	I	30	10.08	5.5
	C	32	12.46	4.2

Angles	G	N	M.A	SD±	P- val
RAT1-ROP	M	30	-0.58	3.79	.856
	F	65	-0.42	4.54	
RAT2-ROP	M	30	1.64	4.02	.456
	F	65	2.31	4.65	
RAT3-ROP	M	30	4.08	4.67	.334
	F	65	5.02	4.41	
ROP-FP	M	30	9.63	4.23	.355
	F	65	8.68	4.80	
LAT1-LOP	M	30	0.36	4.47	.255
	F	65	-0.82	5.02	
LAT2-LOP	M	30	2.41	4.04	.796
	F	65	2.16	4.67	
LAT3-LOP	M	30	4.83	4.92	.97
	F	65	4.87	4.64	
LOP-FP	M	30	10.44	3.98	.577
	F	65	10.96	5.09	

Table 4. The mean angles between occlusal plane and reference lines in relation to ethnic groups in the sample

RS	P value	LS	P- value
M \ I	.08	M\ I	.124
I \ C	.66	I\ C	.907
M \ C	.154	M \ C	.130

Ethn; ethnicity, No; number, SD; standard deviation
M; Malays, C; Chinese, I; Indians
RAT1-ROP; right lower ala tragus line-right occlusal plane, RAT2-ROP; right middle ala-tragus line-right- occlusal plane, RAT3-ROP; right upper ala-tragus line- right occlusal plane, ROP-FP; right occlusal plane-Frankfort plane, LAT1-LOP; left lower ala-tragus line-left occlusal plane, LAT2-LOP; left middle ala-tragus line-left occlusal plane, LAT3; left upper ala-tragus line- left occlusal plane, LOP-FP; left occlusal plane-Frankfort plane.

3.3.3 Records comparison on the two sides of the face for the whole sample

The statistical analysis of the mean records on the two sides of the face for the whole sample, showed no difference except for the angle between the occlusal plane to Frankfort plane, Table 5.

Table 5. Difference between the mean records on right and left sides of the face in different ethnic groups for the whole sample.RS; right side,LS; left side,

M; Malays, I; Indians, C; Chinese

3.3.4 The variability of the mean angle measurements for the whole sample (right and left sides)

The coefficient of variability between the sample records of the OP in relation to the reference lines and plane is shown in Table 1. The least variable record was OP to FP; hence, the Frankfort plane may be considered the most reliable and least variable reference when used to orient the occlusal plane compared to the Camper line (Table 6).

Table 6 The variability coefficient of the used reference lines and plane in relation to occlusal plane

Angle	No	Mn	Mx	M	SD±	CV%
AT1-OP	95	-11	+13	-0.41	4.56	1112
AT2-OP	95	-7	+16	+2.25	4.51	200
AT3-OP	95	-9	+17	+4.75	4.61	97
OP-FP	95	-3	+21	+10.2	4.53	44

Mn; minimum record, Mx; maximum record, M; mean record, SD; standard deviation, CV; coefficient of variability
AT1; ala-tragus lower point, AT2; ala-tragus middle point, AT3; ala-tragus upper point,OP-FP; occlusal plane-Frankfort plane.

3.4 Discussion

Data collection and measurements on soft tissues were impossible due to the mobility of the skin and underlying tissues; therefore, the photographic technique provides the best precision and is risk-free due to the radiation hazards when radiography is used, as in many research studies. In addition, the repeatability and precision of records were excellent and within tolerable variability. The results showed that no difference is estimated for most of the records on the face profiles (right and left), due to gender and ethnic group. These findings may support the hypothesis that the occlusal plane is affected mainly by occlusion components rather than anatomical factors. The only reference that showed less variability is the Frankfort plane. Therefore, this plane is considered the best approved reference to locate the occlusal plane during rehabilitation procedures in completely and partially edentulous patients and to resolve temporomandibular problems associated with faulty occlusion. The results were applied to design a simple device that uses the Frankfort plane as a reference (Fig. 10). The device consists of two plastic straps or rulers and two ear pieces of 10mm diameter to locate the porion inside the external auditory meatus. A horizontal metallic or plastic bar attaches to the lateral straps and the ear pieces and is equipped with an anterior nasal extension to fix the device to the correct place on the face and form the Frankfort plane. The lateral straps are adjustable to fit the face parallel to the Frankfort plane. A camper plane or ala-tragus line is used in oral restoration that offers more freedom or less precision, like total rehabilitation. The tooth form and tooth arrangement should therefore ensure the absence of posterior contacts during protrusive jaw movements, and this will be facilitated by developing a correct occlusal plane level and inclination. Thus, restorative procedures, which influence phonetics, may also affect the patient's psychological and physiological well-being [14]. Rehabilitation of oral cavity procedures and practice should be carried out continuously to enhance the quality of the offered treatment service [15], [16], and [17].A simulation model can profit from this outcome in total oral rehabilitation procedures like digital construction of complete dentures [18], implant-supported dentures [19], and orthodontic diagnosis [20].

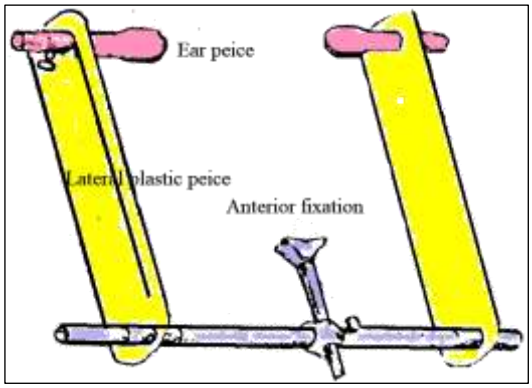

Fig.10: The proposed device for recording Occlusal plane

4 Conclusion

Studying the occlusal plane with a digital camera and computer offers safer, easier, and more accurate

recording.The ala tragus line, or Camper line, running between the lower border of the ala of the nose and the inferior border of the tragus showed the least mean difference angle (-0.41 degree) to the occlusal plane. In return, this small mean difference does not confirm its use as a suitable reference for establishing a new OP, like in cases with fully edentulous arches, due to increased variability. The high variability of CP disproves its use for occlusal plane orientation in clinical situations that imply more precise and less inconsistent errors.On the other hand, the mean angle between the Frankfort plane and the occlusal plane was +10.2 degrees, which showed less variability during the recording of OP. As a reference, the Frankfort plane offers the least variability and more repeatability among the studied references (Camper plane) at different starting points; therefore, we support the use of the Frankfort plane to study and record the occlusal plane in any future research. The outcome of this study was that a new recording device was designed for this purpose.A simple device was described to record and establish the occlusal plane in daily practice, using the Frankfort plane as a reference.Generally, no significant difference was estimated between the males and females and the three ethnic groups of Malaysians for the whole record.In the future, research work is proposed to reveal the effect of changing the inclination of the occlusal plane anterioposteriorly as well as laterally on the teeth and bone supporting the artificial replacement using the mathematical method.

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Laith Al-Samawi, Hanaa Al-Ani carried out the planning, guidance, supervision, data analysis, and writing the manuscript.

Humam has participated in data collection and supervision of the examiners.

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