

Comparison of the occlusal plane in dentulous and edentulous patients: A cephalometric study

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Establishing the correct occlusal plane after loss of natural teeth, is an arduous task. So a study was done with the following objective: To establish the occlusal plane in the edentulous patient and also to relate the occlusal plane to the maxillo-mandibular space length and height with the aid of cephalometrics. **MATERIALS AND METHODS:** In this study the subjects were divided into two categories (a) Dentulous having Angle's class 1 occlusion (b) Edentulous with conventionally fabricated complete dentures. Lead foils were placed at predetermined positions on the mandibular dentures and then lateral cephalograms were taken. Cephalometric analysis was done and different angular measurements were recorded. After that depending upon average values of the height and length of the maxillary-mandibular space, all the subjects in each category were again divided into four groups. **RESULTS:** Our results indicated that there is significant correlation between occluso-maxillary plane and maxillo-mandibular space length and height. **CONCLUSION:** This study can prove helpful for extensive oral rehabilitation cases.

Key words: Maxillary plane, mandibular plane, maxillo-mandibular space, occlusal plane

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With the increase in life expectancy in the last few decades the number of people in need of complete denture fabrication has risen considerably. Fabrication of complete denture prosthesis places a large number of important factors under the control of the operator. Most textbooks advise that artificial teeth should be placed in the position previously occupied by the natural teeth. This is particularly true of the plane of occlusion: a feature that plays an important role in fulfilling the criteria of both function and esthetics. There appears to be a lack of agreement on how it should be oriented for individual patients. Some of the concepts include:

1. Establishing the occlusal plane 1-3 mm below the resting lip anteriorly and parallel to the alaragus line posteriorly.
2. Positioning the occlusal plane parallel to and midway between the residual ridges.
3. Positioning it at the level of lateral border of the tongue.
4. Terminating the occlusal plane posteriorly at the middle or upper 3rd of the retromolar pad.
5. Orienting the occlusal plane with the buccinator grooves and the commissure of lips.

In all these concepts, references used for locating the occlusal plane are soft tissue landmarks which are liable to change with aging as well as with the judgment of the individual operator.

Cephalometrics is a technique based on reliable hard

tissue cranio-facial structures. Hence, an attempt was made in this study to establish the plane of occlusion using cephalometrics.

The objectives of the present study were:-

1. To determine the location of the occlusal plane using hard tissue references
2. To relate the angulation of the occlusal plane to the maxillary plane and to the height and length of the max-mand space.

The primary hypothesis in this study was that the angulation and vertical height of the occlusal plane are predictable from an assessment of the maxillo-mandibular space as seen on a lateral skull radiograph recorded with the opposing teeth in the intercuspal position.

MATERIALS AND METHODS

Sample selection of subjects

For the present study, 52 subjects were selected and equally divided into two groups:

- Dentulous
- Edentulous

Dentulous - All the 26 subjects were of the age group 20-30 years. All of them had complete or nearly complete dentitions with Angle's Class 1 molar relation with normal overjet and overbite. They had not undergone any orthodontic treatment.

Edentulous - Here the age group selected was between 45-76 years. For all these subjects complete dentures

were fabricated using conventional techniques.

METHODS

Lateral cephalograms of all subjects were obtained by using "Universal Cephalometric machine" at 10 mamp and 65 KVP. Focus-film distance was 60 inches. Developing and fixing of the films were done and data were obtained from these radiographs with the teeth in the intercuspal position. For the edentulous group, before taking cephalograms lead foils were placed at upper and lower right central incisors, the apex of the mesiobuccal cusp of the lower right 1st molar and the outline of the right retromolar pad [Figure 1]. Lateral cephalograms of each of the edentulous and dentulous subjects are shown in Figures 3.

All the X-rays were then traced.

Cephalometric analysis

The majority of points, planes and angular measurements were made in accord with certain definitions. These were:

(A) Points

- 1) Anterior nasal spine (a)
- 2) Posterior nasal spine (p)
- 3) Gonion (g)
- 4) Menton (m)

Some arbitrary labeled points were:

1. T- point where the occlusal plane meets the most lingually placed incisor tooth.
2. U- the point where the occlusal plane meets the shadow of the posterior pharyngeal wall.
3. J -Tongue base: taken as the deepest point in the concavity between the posterior part of the base of the tongue and anterior border of the epiglottis [Figure 1].

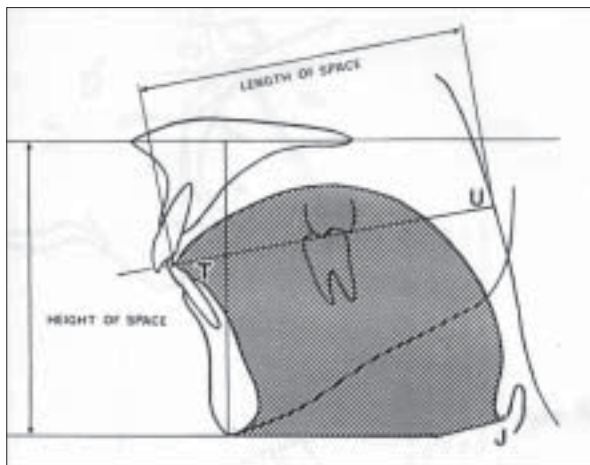


Figure 1: The length and height of the maxillo-mandibular space are outlined on a tracing of a lateral cephalometric radiograph

(B) Planes

1. **Mandibular plane:** joining gonion and menton.
2. **Occlusal plane:**
 - i. Dentulous group: A line joining the point midway between the incisal tips of maxillary and mandibular incisors to the point midway between the mesiobuccal cusp of the max. and mand. 1st molar.
 - ii. Edentulous group:- A line joining mesiobuccal cusp of lower right 1st molar and incisal edge of the mand. right central incisor.
3. **Maxillary plane:** joining a and p [Figure 2].

(C) Linear measurements

1. **Maxillo - Mandibular space length:** the distance between the point where the occlusal plane meets the lingual contour of the lower right central incisor and point U.
2. **Maxillo - Mandibular space height:** The perpendicular distance of menton (m) to maxillary plane measures anterior face height. Posterior face height is the perpendicular distance of point J from max. plane [Figure 1].

(D) Angular Measurements

1. Maxillary occlusal plane angle
2. Mandibular occlusal plane angle
3. Maxillary-mandibular angle [Figure 2]

Mean values of all were calculated.

Arbitrary mean values were taken for maxillo - mandibular space length and height. Maxillo - mandibular space heights of 70 mm or more were taken as high, while those under 70 mm were considered as low. Maxillo - mandibular space length of 80 mm or less were considered short, while those above it were considered as long. The combination of height and length of the maxillo- mandibular space was a significant morphologic feature, and based on

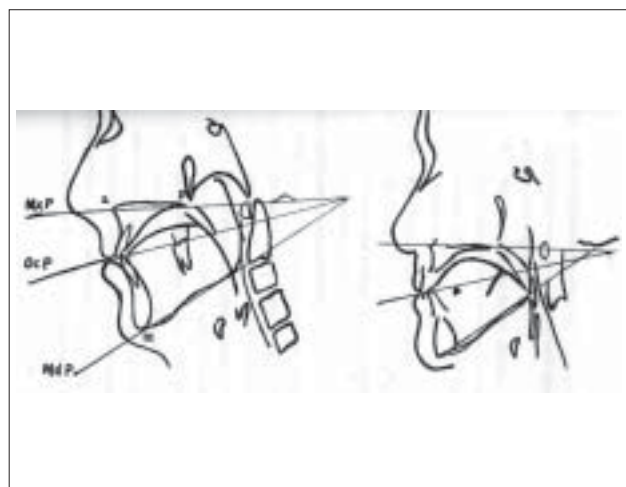


Figure 2: (Left) A tracing from a cephalometric radiograph of a dentulous subject. (Right) A tracing from a cephalometric radiograph taken from a subject in the edentulous group

that the max-mand spaces were subdivided into 4 categories.

- Category A - Short and Low
- Category B - Long and low
- Category C - Short and high
- Category D - Long and high

Statistical analysis

These measurements were recorded for every patient and the values obtained were subjected to statistical analysis, including:

- Mean
- Standard deviation (S.D)
- Coefficient of variation
- F - test (Analysis of variance)

RESULTS

Results are shown in Tables 1-6. Parametric measurements for both the dentulous and edentulous groups were shown in Tables 1 and 2.

Angulation of occlusal plane to the maxillary plane

Dentulous group: Analysis of variance within and between the four categories of max-mand space showed significant differences in the angles of occlusal-max planes associated with the combined effect of the height and length of the max-mand space [Table 3]. The mean of the occluso-maxillary plane angles for all the dentulous subjects was $6.9 \pm 4.03^\circ$. A comparison of the means of the high and low types of the max- mand space indicated that long and low types tend to have the occlusal plane more parallel to the maxillary plane (mean 4.8°) while short and high types tended to have the occ- max plane angle more steeply angulated (mean 13°) [Table 3]. The other two groups had values near to the mean of the whole

group, which was $6.9 \pm 4.03^\circ$.

Edentulous Group: In all the categories of the maxillo-mandibular space, there has been marked parallelism of the occlusal plane and the maxillary plane. Mean value for the entire sample was (7.6 ± 3.7) [Table 4].

Angulation of occlusal plane to the mandibular plane

Dentulous Group: The measurements did not indicate any significant relationship between the occluso- mand plane angle and max-mand space characteristics. The mean for the sample was $15.2 \pm 4.5^\circ$.

Edentulous Group: The findings were similar to the dentulous group. The mean for the entire sample in this group was $12.2 \pm 3.2^\circ$.

Tables 5 and 6 depict the comparison of the angles of the occ- max and occ- mand planes. It indicated that in all dentulous subjects, occ- max plane angle was less than that of the occ- mand plane angle. Similar results were obtained for all edentulous subjects except 3 [Line Diagrams 1 and 2].

Results showed that for the dentulous group, significant correlation was found between the angulation of occlusal- max plane and height and length of the maxillo- mand space.

1. In long and low - value is lowest.
2. In short and high - value is highest.
3. Mean of occluso- maxillary plane angle was less than that of occluso - mandibular plane angle in nearly all the subjects.



Figure 3: Lateral cephalogram of edentulous subject

Table 1: Parametric measurements for the dentulous group

Parameter	Mean	Min	Max	S.D.	Coefficient of variation %
Maxillo-Mand. Angle	17.6°	2.5°	26.0°	7.9	44.88
Angle of occluso-max plane	7.6°	-5.0°	13.5°	3.7	49.33
Angle of occluso-mand. plane	12.2°	7.5°	18.0°	3.2	26.23
Ant. M.S.H. = L.F.H. (mm)	66.8	54.5	79.0	6.6	9.91
M.S.L. (mm)	81.7	71.5	107.0	8.5	10.41
Post. M.S.H. (mm)	65.0	47.5	81.5	8.4	12.92

M.S.H. - Maxillo-mandibular space height, L.F.H. - Lower facial height, M.S.L. - Maxillo-mandibular space length.

Table 2: Parametric measurements for the edentulous group

Parameter	Mean	Min	Max	S.D.	Coefficient of variation%
Maxillo-Mand. Angle	17.6°	2.5°	26.0°	7.9	44.88
Angle of occluso-max plane	7.6°	-5.0°	13.5°	3.7	49.33
Angle of occluso-mand. plane	12.2°	7.5°	18.0°	3.2	26.23
Ant. M.S.H. = L.F.H. (mm)	66.8	54.5	79.0	6.6	9.91
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DISCUSSION

In the present study an attempt is made to establish a special relationship between the various parts of the facial and dental structures through cephalometric analysis. We considered using hard tissue landmarks which are fixed or remain unchanged with age so they can be used reliably. The study comprised two groups:

Dentulous group

Significant correlations were found between the angulation of the occlusal plane to the maxillary plane and the max- mand space dimensions. Since the mean angulation of the occ-max plane angle for the whole group was $6.9 \pm 4.03^\circ$ and in addition, the long and high and short and low types of max- mand space had means that were less than 1 S.D from the mean of the total sample, the mean value of 6.9° is considered to be an acceptable starting point. However in long and low and short and high types (i.e. when the height and the length of max- mand space diverge from each other within the individual) the divergence is seen to be approximately 1 S.D less for the long and low types (2.87°) and 1 S.D more for short and

high types (10.03°) [Table 3]. Thus as length of the space increases, the maxillary plane becomes more parallel to the occlusal plane. Similar results were obtained when the height of the space decreased. In other words, when the height and length of the maxillo-mandibular space tended to be towards the opposite extremes of the normal range, the occlusal plane deviated away from the mean angulation to the maxillary plane as in short and high and long and low cases.

Analysis of variance within and between the four groups showed a significant difference in the angles of the occluso-maxillary plane associated with the combined effect of the height and length of the maxillary-mandibular space.

The difference between occlusal -max and occlusal-mand planes [Table 5] indicates the closer angular relationship of the occlusal plane to the maxillary plane as compared with that of the occlusal and mandibular planes.

Table 3: Dentulous group – comparison of angles of occlusal plane and maxillary plane, in relation to height and length of maxillo-mandibular space

Angle (Degrees)			
Short and Low	Long and Low	Short & High	Long and High
10	11	13	7.5
9	9	•	9
10	2.5	•	10
5	3	•	-
6	2.5	•	-
4.5	1	•	-
11	1.5	•	-
14.5	10.5	•	-
2	1	•	-
6	8.5	•	-
9	2	•	-
Mean 7.9	4.8	13	8.8

Table 4: Edentulous group - comparison of angles of occlusal plane and maxillary plane, in relation to height and length of maxillo-mandibular space

Angle (Degrees)			
Short and Low	Long and Low	Short & High	Long and High
10	12.5	5	6.5
6	11	7	7
12	10	15	4
8.5	1	5	3.5
13.5	10.5	9	-
1	12.5	7	-
4.5	10	•	-
-5	10.5	•	-
Mean 6.3	9.75	8	5.25

Table 5: Dentulous group - comparison of the angles of the occluso-maxillary and occluso-mandibular planes

Subject	Angle (Degrees)		
	Occluso-maxillary angle	Occluso-mandibular angle	Difference between the two
1	10.0	15.0	5.0
2	9.0	14.5	5.5
3	10.0	15.0	5.0
4	5.0	15.0	10.0
5	11.0	14.0	3.0
6	9.0	13.0	4.0
7	6.0	15.0	9.0
8	4.5	8.0	3.5
9	7.5	25.0	17.5
10	13.0	25.0	12.0
11	9.0	14.0	2.0
12	10.0	20.5	10.5
13	8.5	17.5	9.0
14	2.5	8.5	6.0
15	11.0	15.0	4.0
16	14.5	23.5	9.0
17	2.0	15.0	13.0
18	3.0	19.0	16.0
19	2.5	13.0	10.5
20	1.0	14.5	13.5
21	1.5	14.5	13.0
22	6.0	8.0	2.0
23	2.0	16.0	14.0
24	10.5	11.5	1.0
25	9.0	11.5	2.5
26	1.0	13.0	12.0
Mean	6.9	15.2	8.2

Table 6: Edentulous group - comparison of the angles of the occluso-maxillary and occluso-mandibular planes

Subject	Angle (Degrees)		
	Occluso-maxillary angle	Occluso-mandibular angle	Difference between the two
1	6.5	8.5	2.0
2	5.0	13.0	8.0
3	12.5	13.0	0.5
4	10.0	15.0	5.0
5	7.0	11.0	4.0
6	15.0	15.5	0.5
7	5.0	17.0	12.0
8	6.0	18.0	12.0
9	9.0	10.0	1.0
10	12.0	12.5	0.5
11	7.0	15.5	8.5
12	7.0	7.5	0.5
13	8.5	9.5	1.0
14	11.0	9.5	-1.5
15	13.5	11.0	2.5
16	10.0	12.0	2.0
17	1.0	10.0	9.0
18	4.0	12.0	8.0
19	1.0	9.0	8.0
20	10.5	7.5	-3.0
21	4.5	8.5	4.0
22	3.5	17.5	14.0
23	12.5	13.0	0.5
24	-5.0	16.0	11.0
25	10.0	15.0	5.0
26	10.5	11.0	0.5
Mean	7.5	12.2	4.25

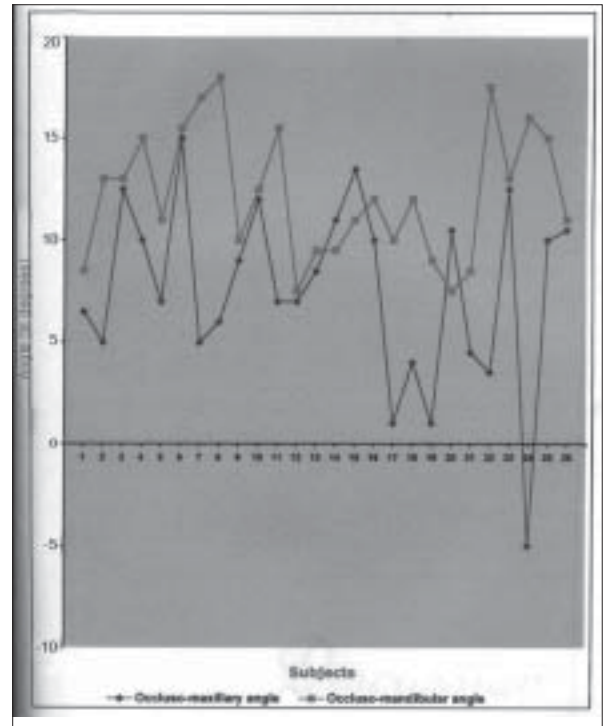


Diagram 2: Comparison of the angles of the occluso-maxillary and occluso-mandibular planes in edentulous subjects

Edentulous group

The findings for this group were similar to those for the dentulous group regarding the angulation of the occlusal plane to the maxillary plane and mandibular planes [Table 6]. In all except 3 subjects the occluso-mandibular angle was greater than the occluso-maxillary angle.

As with the dentulous group, the angulation of the occlusal plane to the maxillary plane for each of the four categories of the maxillo-mand spaces was within 1 S.D of the mean angulation for the edentulous group. Since tooth loss and subsequent prosthetic reconstruction in no way affects the maxillary plane it is considered preferable to relate the occlusal plane to the max-plane rather than to the mandibular plane. Also, the mobile nature of the mandibular renders the orientation of the mandibular plane infinitely variable in relation to cranio-facial landmarks.

The clinical implication of the study is that when extensive oral rehabilitation is undertaken, the dimensions of the max-mandibular space, recorded at optimal occlusal vertical and horizontal jaw relationship, are factors which can influence the angle at occlusal plane and should always be taken into consideration.

CONCLUSIONS

The present study was undertaken to determine

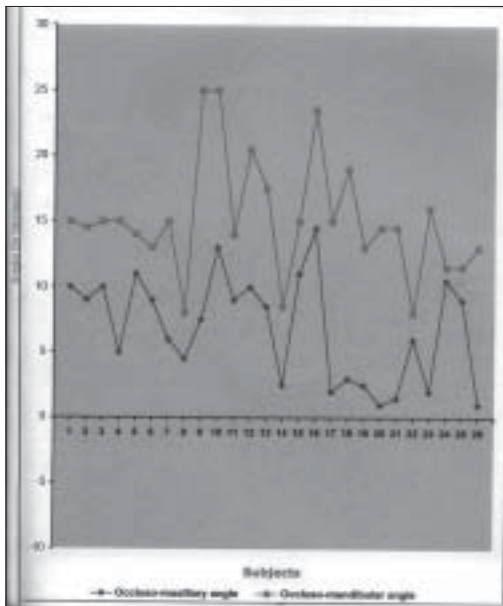


Diagram 1: Comparison of the angles of the occluso-maxillary and occluso-mandibular planes in dentulous subjects

the location of the occlusal plane on the basis of cephalometric criteria since these provide reliable and stable landmarks. All the observations were analyzed and the following conclusions were drawn.

1. There exists a close angular affinity between the occlusal and maxillary plane in both dentulous and edentulous subjects.
2. In the dentulous subjects, significant associations were found between occ-max plane and dimensions of the max-mandibular plane, i.e.
 - a. In long and low types the occluso-max angle is least.
 - b. In short and high types, the occ-max plane angle is most steeply angulated.
 - c. In short and low and long and high types, the occ-max plane angle is close to the mean of the entire sample.
3. In the edentulous group, there was no significant correlation between occlusal- max plane and dimensions of max - mand space.

Thus, as length and height of the max-mand space diverge from each other, the occlusal plane deviated away from the mean angulation to the max-plane. In the edentulous group, the occlusal plane showed marked parallelism of the max-plane although values of the occ-max plane angle in all the four groups were close to the mean of all subjects. Thus, from the present study, we have found enough evidence for the importance of cephalometry in prosthodontics to establish the occlusal plane of edentulous patients

for proper functions of chewing and mastication, and to restore esthetics of the patient.

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