Reliabiltiy of Occlusal Plane: Determinant of Dentoskeletal Framework in Western Uttar Pradesh Population

C Munish Reddy*, Shivangi Gupta**, Akshi Rathee**, Tarun Phull*, Tarun Rana*, Shalu Jain*

Introduction

The conventional cephalometrics has been playing a major role in determining the facial skeletal and soft-tissue relationships and estimating their growth statuses. Lateral cephalograms have been widely used to evaluate ones facial form thereby aiding in diagnosis and treatment planning.

The reason behind the occurrence of abnormal growth is still hidden. However, the various factors that seem to be involved can be cranial base flexion, eruption, vertical dimension, occlusal plane, intrinsic maxillary and mandibular growth, genetics, environment, and their interactions[1].

To be precise, the effect of inclination of occlusal plane in determining and establishing the mandibular position is still questionable. **Tanaka and Sato**[1] stated that the occlusal plane is the effect, not the cause of the anatomic relationships attributing condylar growth as the key to the changes of the occlusal plane.

It is important to mention the work of **Sato**[2] who emphasized on the importance of occlusal plane and introduced denture frame analysis in 1987. *The Denture Frame is a triangle formed by the palatal plane (PP), the A–B plane (AB), and the*

*Professor, **PG Student, Department of Orthodontics and Dentofacial Orthopedics, Subharti Dental College, Meerut

Address for Correspondence:
*Dr Shivangi Gupta, Department of Orthodontics and Dentofacial Orthopedics, Subharthi Dental College, Meerut
e-mail: guptshivangi@gmail.com

mandibular plane (MP), and assesses the position of teeth in terms of a maxillary occlusal plane related to this triangle.

Sato and Suzuki[3], **Sato et al[4]**, and **Sato[5]** assessed patients with severe dental and skeletal malocclusions for planning orthodontic treatment using the DFA as an adjunctive cephalometric evaluation. These patients underwent successful orthodontic therapy, although their skeletal discrepancies showed a significant open bite or a reverse incisal relationship.

As per best of our knowledge the Denture Frame Analysis has been used only in the Japanese and the Caucasian population and the distribution of malocclusions was found to be different in a Japanese and Caucasian population. Moreover, the significance of the occlusal plane inclination as a primary determinant in establishing the mandibular position is still a subject to be explored.

So, the aim of the present study is to validate the application of the DFA to a randomized Western UP population sample and to determine if the DFA is able to describe malocclusions and to compare the cephalometric measurements with that of Caucasians.

Materials & Method

The data for this study was gathered from the Department of Orthodontics and Dentofacial Orthopaedics, Subharti Dental College, Meerut, Uttar Pradesh over a period of 12 months. The data was collected from patients selected for orthodontic treatment. From all patients examined, 100 individuals were randomly selected.

The sample size consisted of 100 Western Uttar Pradesh patients (56 males, 44 females) aged from 12 to 30 years; with a mean age of 21±5.67 years. Each patient was examined and the records comprised of: a lateral cephalometric head-film, intra-oral photographs, and dental casts which were taken as standard records for orthodontic treatment.

The patients were assigned to groups according to the Angle classification. Open and deep bites were the added groups evolving as zero or negative vertical incisal relationship.

The standard cephalometric measurements and DFA measurements were made as done by **Celar et al[6]** for all the five sub groups.

Result

Table I: Results of standard linear and angular cephalometric measurements of Western Uttar Pradesh population

	Class 1	Class 2	Class 3	OPEN BITE	DEEP BITE	P-value[@]
	Mean±S.D.	Mean±S.D.	Mean±S.D.	Mean±S.D.	Mean±S.D.	
SNA	81.96±4.49	80.83±4.01	81.90±3.16	78.06±4.90	82.44±1.72	0.038*
SNB	77.96±3.90	75.93±3.23	82.55±4.44	74.17±5.47	77.39±3.13	0.000***
ANB	4.00±2.88	4.90±1.95	-0.65±2.03	3.89±2.59	5.06±2.21	0.000***
BJORK SUM	389.73±6.64	390.60±6.36	387.10±9.54	392.11±11.78	387.33±6.05	0.306#
U1 INCLINATION TO SN	116.54±10.33	118.60±8.16	116.00±8.67	112.28±7.23	109.61±18.95	0.094#
L1 INCLINATION TO MP	102.38±7.78	101.80±9.60	94.75±8.40	97.39±8.45	102.50±9.73	0.048*
U1 – N-PG	13.46±4.37	13.57±3.81	7.20±6.89	13.83±6.19	11.56±5.40	0.015*
LI – N-PG	6.27±4.39	3.97±3.11	5.10±3.21	7.33±4.27	2.78±3.04	0.003**
UL-EP	1.35±3.31	0.40±2.46	-1.25±3.09	0.22±3.41	-0.50±3.40	0.065#
LL-EP	4.19±3.83	1.57±3.33	3.05±2.67	2.94±2.71	2.56±4.05	0.075#
WITS	1.96±4.20	3.67±2.80	-3.90±2.49	2.78±3.19	3.50±4.18	0.000***
OVERJET	6.12±3.24	8.87±3.53	2.20±3.79	7.50±3.79	6.78±4.32	0.000***
OVERBITE	4.08±2.12	5.03±1.40	3.45±2.04	-4.44±2.15	7.94±1.26	0.000***
FACIAL HEIGHT RATIO	67.49±5.37	63.36±2.78	66.96±4.30	63.35±3.76	69.34±2.39	0.000***
FH-PP	1.00±2.90	-0.43±4.59	1.05±4.17	-0.78±4.17	0.22±3.49	0.405#

[@] Kruskal-wallis test
*** Very Highly Significant difference (P-value≤0.001)
** Highly Significant difference (P-value≤0.01)
* Significant difference (P-value≤0.05)
# Non- Significant difference (P-value>0.05)

Table II: Results of linear and angular measurements of DFA of Western Uttar Pradesh population

	Class 1	Class 2	Class 3	OPEN BITE	DEEP BITE	P-value
	Mean±S.D.	Mean±S.D.	Mean±S.D.	Mean±S.D.	Mean±S.D.	
FH-MP	25.15±6.74	22.47±7.89	22.15±6.49	38.22±4.99	21.89±7.36	0.000***
PP-MP	25.42±5.80	23.13±8.13	23.70±6.81	40.44±5.73	20.67±7.75	0.000***
SN-MP	31.27±7.07	29.40±7.64	27.20±6.70	30.78±8.29	27.00±6.32	0.235#
SN-PP	7.00±3.06	7.07±2.95	6.55±2.96	8.50±4.54	8.56±3.47	0.455#
OP-MP	14.96±7.11	15.53±5.61	16.45±11.21	22.56±9.16	14.89±4.38	0.039*
OP-MP/PP-MP	0.61±0.30	0.68±0.29	0.68±0.41	0.54±0.18	0.78±0.29	0.056#
AB-MP	75.58±5.54	80.07±7.57	66.50±6.50	71.67±10.20	85.11±4.61	0.000***
A'P'	51.00±2.97	52.43±5.98	51.90±4.46	49.89±3.16	53.00±4.03	0.194#
A'6'	25.88±3.36	26.00±5.21	26.65±2.54	24.11±2.65	27.56±3.22	0.015*
A'6' / A'P'	0.51±0.06	0.49±0.08	0.51±0.03	0.48±0.04	0.52±0.04	0.055#
U1 INCLINATION TO AB	45.23±12.60	52.03±15.40	28.20±11.62	43.67±12.87	42.11±14.40	0.000***
L1 INCLINATION TO AB	26.08±9.23	21.23±6.24	29.75±7.14	28.22±3.25	13.89±4.40	0.000***
U1 PROTRUSION TO AB	12.35±3.44	15.10±9.13	8.10±4.54	12.89±4.97	11.11±4.31	0.002**
L1 PROTURSION TO AB	5.50±3.67	3.80±2.81	6.30±2.45	6.00±2.38	1.17±1.62	0.000***
INTERMOLAR ANGLE	170.42±4.84	169.30±8.70	170.95±5.64	170.67±7.24	167.56±5.90	0.367#

[@] Kruskal-wallis test
*** Very Highly Significant difference (P-value≤0.001)
** Highly Significant difference (P-value≤0.01)
* Significant difference (P-value≤0.05)
# Non- Significant difference (P-value>0.05)

Table III: Comparison between the calculated values of the Caucasians and the Western Uttar Pradesh population

	CLASS I			Class II			Class III			OPEN BITE		
	Karnataka	Western Uttar Pradesh	P-value	Karnataka	Western Uttar Pradesh	P-value	Karnataka	Western Uttar Pradesh	P-value	Karnataka	Western Uttar Pradesh	P-value
SNA°	82.7±4.7	81.96±4.49	0.545	82.6±4.2	80.83±4.01	0.08	80.6±6.1	81.90±9.16	0.414	82.7±7.6	78.06±4.90	0.037*
SNB°	79.9±3.9	77.96±3.90	0.065	77.9±3.7	75.95±3.23	0.029*	80.8±5.3	82.55±4.44	0.289	78.4±4.4	74.17±5.47	0.015*
ANB°	2.9±2.5	4.00±2.88	0.125	4.7±2.6	4.90±1.95	0.725	-0.1±2.8	-0.65±2.03	0.499	4.5±6.1	3.89±2.59	0.698
Björk sum°	392.4±7.3	389.73±6.64	0.155	390.8±6.7	390.60±6.96	0.9	396.5±6.7	387.10±9.54	0.002**	398.1±7	392.11±11.7	0.072
U1 inclination to SN°	102.4±5.9	116.54±10.93	0.000***	109.4±12.6	118.60±8.16	0.000***	101.1±9.9	116.00±8.67	0.000***	103.7±10.4	112.28±7.23	0.007**
L1 inclination to MP°	91±6.5	102.98±7.78	0.000***	95.3±6.5	101.80±9.60	0.001**	83.1±8.4	94.75±8.40	0.000***	88.4±7.7	97.99±8.45	0.002**
Protrusion U1 to N-Pg mm	5.4±3.6	19.46±4.57	0.000***	8.3±3.4	19.57±3.81	0.000***	2.5±3.1	7.20±6.89	0.016*	8.1±4.4	19.83±6.19	0.003
Protrusion L1 to N-Pg mm	2.5±3.4	6.27±4.99	0.001**	2.3±2.9	3.97±3.11	0.024*	1.8±3	5.10±5.21	0.009**	3.1±3.6	7.33±4.27	0.003**
UL-EP mm	-3.5±3.2	1.95±3.31	0	-1.2±3.4	0.40±2.46	0.039*	-3.7±2.2	-1.25±3.09	0.014*	-3.7±3.9	0.22±3.41	0.003**
LL-EP mm	-1.8±2.9	4.19±3.83	0	-0.4±3	1.57±3.33	0.012*	-0.9±2.1	3.05±2.67	0.000***	-1.6±3.4	2.94±2.71	0.004**
Denture Base (Wits, mm)	-2.5±2	1.96±4.20	0	1.8±2.6	3.67±2.80	0.005**	-5.8±2.7	-3.90±2.49	0.095*	0.9±5.7	2.78±3.19	0.231
Overjet mm	2.7±1.4	6.12±3.24	0	5.2±2.9	8.87±3.53	0.000***	0.6±1.6	2.20±3.79	0.124	3.5±3	7.50±3.79	0.001***
Overbite mm	2.8±1.7	4.08±2.12	0.013	3.2±2	5.03±1.40	0.000***	0.8±1.9	3.45±2.04	0.000***	-2.5±2	-4.44±2.15	0.008**
Facial height ratio (%)	64.9±5.7	67.49±5.57	0.083	66.2±5.3	63.36±2.78	0.010**	63.2±4.3	66.96±4.90	0.014*	63.2±5.9	63.95±3.76	0.928
FH-PP°	-1.5±2.4	1.00±2.90	0.001	-2.2±6.4	-0.49±4.59	0.203	-2.2±3.5	1.05±4.17	0.018*	-1.8±5.3	-0.78±4.17	0.525
FH-MP°	25.3±5.4	25.15±6.74	0.925	22.9±6.4	22.47±7.89	0.802	25.1±9.3	22.15±6.49	0.271	30.2±5.9	38.22±4.99	0.000***
PP-MP°	26.3±5.9	25.42±5.80	0.572	25.9±5.7	23.19±8.19	0.098	29±3.8	23.70±6.81	0.009**	31.5±6.7	40.44±5.73	0.000***
SN-MP°	32.8±6.9	31.27±7.07	0.41	31.1±6.4	29.40±7.64	0.315	35.5±5.6	27.20±6.70	0.000***	36.9±6.6	30.78±8.29	0.020*
SN-PP°	6.8±3.7	7.00±3.06	0.826	6.8±3.2	7.07±2.95	0.094	7.5±7.3	6.55±2.96	0.599	6±5.2	8.50±4.54	0.194
OP-MP°	14.9±5.3	14.96±7.11	0.971	15.7±4.8	15.59±5.61	0.892	17.9±3.6	16.45±11.21	0.623	22.2±5	22.56±9.16	0.885
OP-MP to PP-MP ratio	0.56±0.16	0.61±0.90	0.42	0.62±0.2	0.68±0.29	0.315	0.62±0.12	0.68±0.41	0.576	0.71±0.1	0.54±0.18	0.001***
AB-MP°	71.8±4.9	75.58±5.54	0.008**	78±5.6	80.07±7.57	0.193	69.4±5.2	66.50±6.50	0.19	67.9±6.3	71.67±10.20	0.191
A-Pg (mm)	48.6±3.3	51.00±2.97	0.006**	50.2±3.6	52.49±5.98	0.057	46.7±3.7	51.90±4.46	0.001***	49.9±4.1	49.89±3.16	0.994
A-6 (mm)	26.2±3.1	25.88±3.96	0.708	26.9±3.1	26.00±5.21	0.371	23.4±4	26.65±2.54	0.006**	25.5±5.3	24.11±2.65	0.327
A6/A'P ratio	0.54±0.06	0.51±0.06	0.014*	0.54±0.07	0.49±0.08	0.007**	0.53±0.09	0.51±0.03	0.957	0.52±0.1	0.48±0.04	0.124
U1 inclination to AB°	26.7±5.5	45.23±12.60	0.000***	34±8.6	52.03±15.40	0.000***	25.4±13.4	28.20±11.62	0.507	32.4±8	43.67±12.87	0.003**
L1 inclination to AB°	19.2±6.3	26.08±9.23	0.001***	17.6±5.9	21.29±6.24	0.015*	19.4±7.1	29.75±7.14	0.000***	19.2±7	28.22±9.25	0.000***
U1 protrusion to AB (mm)	5.4±2.3	12.35±3.44	0.000***	7.8±3	15.10±9.13	0.000***	9.6±2.1	8.10±4.54	0.000***	7.4±2.7	12.89±4.97	0.000***
L1 protrusion to AB (mm)	2±2	5.50±3.67	0.000***	1.6±2.9	3.80±2.81	0.001***	2.9±2	6.90±2.45	0.000***	2.6±2.9	6.00±2.98	0.000***
Intermolar angle°	169.5±5.5	170.42±4.84	0.507	162.5±28.8	169.90±8.70	0.216	170.4±6.4	170.95±5.64	0.786	164.7±19.6	170.67±7.24	0.109

Unpaired or Independent t-test
*** Very Highly Significant difference (P-value≤0.001)
** Highly Significant difference (P-value≤0.01)
* Significant difference (P-value≤0.05)

Discussion

The sagittal maxillo-mandibular relationship, the angles SNA and SNB and AB–MP showed a statistical difference between the groups. In contrast to the findings by Jacobson in 1975, the angles SNA, SNB and ANB showed significant intergroup differences in the present study. The ANB measurement is based on the variability of factors other than jaw relationship itself[8,9]. The perpendicular projections of points A and B to the occlusal plane as they are used for assessment of the denture base relationship in the sagittal plane showed highly significant intergroup differences in the present study.

As concluded by **Celar**[6], the A–B plane represents the denture base and is independent of the structure, size, and position of the hard-tissue chin as represented by pogonion. According to **Schudy**[10] and **Nanda**[11], pogonion appears to be important only in determining the facial profile. Referenced to the Frankfort Horizontal plane, the inclination of MP was significantly different in all groups, whereas with reference to the S–N plane, there was no difference found statistically. Therefore, the angle AB–MP also indicates the *vertical sagittal relationship*.

Kim[12] used the overbite depth indicator to assess the tendency towards open bite. According to **Sassouni** and **Nanda**[13], vertical dysplasias influence the anteroposterior position of the denture bases. While the angle AB–MP was significantly different between the investigated groups, the measurement AB–MP itself cannot provide sufficient information on the maxillo-mandibular relationship.

Vertical relationships between maxilla, mandible, and dentition are represented by the angular measurements PP–MP, OP–MP, and their ratio OP–MP/PP–MP, too. The angle PP– MP was significantly different between the five groups of this study. The Class II and Class III groups showed similar means, whereas the Class I and open bite groups showed higher values and deep bite group revealed less values for this angle.

In the present study there were no significant differences between the groups in the SN–PP, FH–PP, and intermolar angle measurements. The Björk sum demonstrated no significant intergroup differences. Significant difference was found in this investigation when testing the facial height ratio. These findings do not agree with those of **Nanda**[14] who found that the posterior face height and ramal height did not differ significantly between open and deep bite patients and those with the **Celar et al**[6].

The occlusal plane and its significance

In the present study the open bite group showed the steepest occlusal plane which is agreement with **Sassouni** and **Nanda**[13] and **Celaret al**[6]. The angles OP–MP and PP–MP were significantly different between the groups ($p<0.01$).

The angular relationship between the cranial base and the maxilla (SN–PP) was not significantly different between the groups. This differs from the findings of **Kerr et al**, but is in agreement with **Bacon et al**[15] and **Celar et al**[6] whose cranial base measurements could not account for the Class II relationship. The maxillary base lengths of the Denture Frame triangle (A′P′, A′6′) showed the highest values in the deep bite group.

In the maxilla, the axial inclination and anteroposterior position of the incisor were significantly different in the DFA (referenced to the A–B plane), while the inclination referenced to the S–N plane showed no significant difference. These findings are found in agreement with those by **Celaret al**[6].

In respect to the A–B plane, the axial inclination of the upper incisor indicated variable trends: smaller values in Class III group, similar values in class I, open bite and deep bite groups and highest values in Class II group. This finding does not agree with **Battagel**[16] who showed that the Proclined upper incisors of the Class III malocclusions were as far forward within the face as in the Class I controls. Lower incisor protrusion showed statistically significant differences between the groups along with their inclinations, both in the standard and DFA measurements.

The Denture Frame and the occlusal plane determine a rough estimate for the required tooth movement in the sagittal and vertical planes according to the individual pattern. The dentition of a patient should be aligned within the existing skeletal framework of that patient and neither to a statistical mean of a population[12] nor'any set of magic numbers'[17].

The development of an open bite is estimated by the OP–MP/PP–MP ratio. The higher the ratio, the more severe the open bite. The ratio A′6′/A′P′ indicates the space occupied by the maxillary teeth anterior to the first molar in relation to the entire maxilla. A high ratio determines the need for extraction or non-extraction of molars or premolars.

Conclusion

The following conclusions can be drawn from the study:

- The Denture Frame sets the boundaries within which the teeth can

be moved for the correction of a malocclusion in accordance with the resultant effect on the occlusal plane.

•   The OP-MP/PP-MP ratio was highest for the deep bite group whereas it was calculated to be the lowest for the open bite group. On comparison with the Caucasian population, only open bite group demonstrated significant differences.

•   This study gives the norms for the DFA for Western Uttar Pradesh population.

References

1. Tanakaa EM and Sato S.Longitudinal alteration of the occlusal plane and development of different dentoskeletal frames during growth. Am J OrthodDentofacOrthop 2008;134:602.e1-602.e11

2. Sato S. Alteration of occlusal plane due to posterior discrepancy related to development of malocclusion—introduction to Denture Frame Analysis. Bulletin of Kanagawa Dental College 1987; 15: 115–123.

3. Sato S, Suzuki Y. Relationship between the development of skeletal mesio-occlusion and posterior tooth to denture base discrepancy. Journal of Japanese Orthodontic Society 1988 ;47: 796–810

4. Sato S, Motoyanagi K, Suzuki T, Imasaka S, Suzuki Y. Longitudinal study of the denture frame and its relationship with the development of skeletal malocclusions. Journal of Japanese Orthodontic Society 1988;47: 186–196

5. Sato S, Takamoto K, Suzuki Y. Posterior discrepancy and development of skeletal Class III malocclusion: its importance in orthodontic correction of skeletal Class III

malocclusions. Orthodontic Review, pp. 1988;16–29

6. Celar AGC, Freudenthaler JW, Celar RM, Jonke E and Schneider B. The Denture Frame Analysis: an additional diagnostic tool. Eur J Orthod 1998; 20: 579–587

7. Jacobson A. The 'Wits' appraisal of jaw disharmony. Am J Orthod 1975; 67: 125–138

8. Järvinen S. Floating norms for ANB angle as guidance for clinical considerations. Am J Orthod Dentofac Orthop 1986;90: 383–387

9. Järvinen S. Relation of the Wits appraisal to the ANB angle: a statistical appraisal. Am J Orthod Dentofac Orthop 1988; 94: 432–435

10. Schudy FF. The vertical dimension. J Clin Orthod 1992; 26: 463–472

11. Nanda RS, Merrill RM. Cephalometric assessment of sagittal relationship. Am J Orthod Dentofac Orthop 1994;105: 328–344

12. Kim YH. Overbite depth indicator with particular reference to anterior open-bite. Am J Orthod 1974; 65: 586–611

13. Sassouni V, Nanda S. Analysis of dentofacial vertical proportions. Am J Orthod 1964; 50: 801–823

14. Nanda S. Patterns of vertical growth in the face. Am J Orthod Dentofac Orthop 1998; 93: 103–116

15. Bacon W, Eiller V, Hildwein M, Dubois G. The cranial base in subjects with dental and skeletal Class II.Eur J Orthod 1992; 14: 224–228

16. Battagel JM. Identification of Class III malocclusion.Eur J Orthod 1994; 16: 70–80

17. Baumrind S, Miller D, Molthen R. The reliability of head film measurements. 3. Tracing super-imposition. Am J Orthod 1976; 70: 617–644