Research Article

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Relationship between Vertical Facial Morphology and Overbite: A Cephalometric Study

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ABSTRACT

Aim: The aim of this study was to investigate varying degree of overbite and their relationship with morphological differences in maxilla and mandible.

Materials and Method: The sample of 120 untreated subjects was divided into 4 groups of 30 subjects each; Control Group and 3 Experimental Groups. Control group subjects had Class I occlusion, normal (0-2 mm) overbite and overjet, no crowding or spacing and balanced facial profile. Based on overbite status, the 3 Experimental Groups were: open bite, deep bite and severe deep bite. Four Surface Area measurements, 6 Linear measurements and 4 angular measurements were made for every subject on their lateral cephalogram. Surface Area measurements were made by means of an electronic Planimeter (Koizumi Placom KP-90N, Japan). Linear and Angular measurements were made by using Nemoceph software (Nemotec,Version 6.0). The data so obtained was subjected to detailed statistical analysis.

Results: Results were assessed by means of unpaired t-test for each parameter under study and p-value less than 0.05 was considered significant. Protruding Chin Area (PCA) expressed as a % value, Gonial Angle (GA), Lower Gonial Angle (LGA), SN-PP angle (SNPPA), Maxillary Posterior Alveolar and Basal Height (Mx-PABH), Mandibular Posterior Alveolar and Basal Height (Md-PABH), Maxillary Anterior Alveolar and Basal Height (Mx-AABH), Ramal Height (RH) and Corpus Length (CL) exhibited significant changes in some of the groups studied. Six other parameters studied exhibited no significant correlation.

Conclusion: Patients belonging to hyperdivergent or hypodivergent facial types deserve definitive changes in the treatment approach.

Keywords: Overbite; Maxillary and mandibular morphology; Cephalometrics.

INTRODUCTION

The aim of this study was to investigate varying degree of overbite and their relationship with morphological differences in maxilla and mandible. **Method:** The sample of 120 untreated subjects was divided into 4 groups of 30 subjects each; Control Group and 3 Experimental Groups. Control group subjects had Class I occlusion, normal (0-2 mm) overbite and overjet, no crowding or spacing and balanced facial profile. Based on overbite status, the 3 Experimental Groups were: open bite, deep bite

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MATERIALS AND METHODS

Lateral cephalograms of 120 patients aged 14 to 30 years were randomly selected and analyzed for preassigned skeletal and dental parameters as detailed later.

Inclusion Criteria:

- Healthy, untreated subjects.
- Absence of anomaly of size, shape and number of teeth.

Exclusion Criteria:

- History of orthodontic treatment.
- Syndromic cases/Craniofacial disorders

Overbite was measured as the distance between the incisal tips of the maxillary and mandibular central incisors perpendicular to the occlusal plane. Positive values for overbite indicated normal or deep bite, whereas open bite was indicated by negative values.

Subjects were divided into following groups each comprising of 30 subjects.

❖ **Control Group**: Consisted of orthodontically untreated subjects without previous orthodontic treatment having neutral occlusion, normal (0-2 mm) overbite and overjet, absence of crowding or spacing and a balanced facial profile.

❖ **Experimental Groups**

Group I OB: Overbite less than 0 mm.
Group II DB: Overbite 2.1 mm to 4 mm.
Group III SDB: Overbite more than 4 mm.

The three different experimental groups were then compared with control group for the following parameters:

➢ **Surface Area (SA):** Surface area measurements, in mm^2, were obtained by means of an electronic planimeter. Digital Planimeters are excellent area measuring tools to measure irregular shaped areas on plans or drawings. Pointer followed the outline of the area to be measured, the reading on the digital display corresponds to the circumscribed area. Each area was measured successively three times by same operator and the mean value was computed (Fig.1), following surface area measurements were made.

- Maxillary Surface Area[1] (MxSA) [fig 2 A] : The total area of the maxilla.
- Mandibular Surface Area[1] (MdSA) [fig 2 A] : The total area of the mandible.
- Symphysis Surface Area (SSA) [fig 2 A] : The total area of the symphysis. (fig. 1)
- Protruding Chin Area (PCA)[2] [fig 2 B] : Expressed in Percentage (fig. 2B)

protruding portion of the chin was divided by total symphysial area

➢ **Linear and Angular Measurements** done with Nemoceph software were :

- Gonial Angle (GA)[3] [fig 3], Upper Gonial Angle (UGA)[3] [fig. 4] and Lower Gonial Angle (LGA)[3] [fig 5]
- Angle between SN plane and Palatal Plane[4] (SNPPA) [fig. 6].

Linear measurements done with Nemoceph software were:

- Maxillary and Mandibular Anterior and Posterior Alveolar and Basal Height[1]. (Fig. 10)3

1. Maxillary Anterior Alveolar and Basal Height (MxAABH) : Measured in mm, the distance between midpoint of alveolar meatus of maxillary central incisor and intersection point between the palatal plane and long axis of the maxillary central incisor.

2. Maxillary Posterior Alveolar and Basal Height (MxPABH) : Measured in mm, the perpendicular distance between midpoint of alveolar meatus of maxillary first molar and the palatal plane.

3. Mandibular Anterior Alveolar and Basal Height (Md-AABH) : Measured in mm, the distance between midpoint of alveolar meatus of mandibular central incisor and intersection point between the mandibular plane and long axis of the mandibular central incisor.

4. Mandibular Posterior Alveolar and Basal Height (Md- PABH, mm) : Measured in mm, the perpendicular distance between midpoint of the alveolar meatus of mandibular first molar and the mandibular plane.

- Ramal Height (RH) [fig 8] and Corpus Length (CL)[3] [fig 9].

➢ Posterior to Anterior Facial Height Ratio[3] / Jarabak ratio (JR) [fig 7].

The data so obtained was subjected to statistical analysis.

Fig 1: Area measurement using Planimeter.

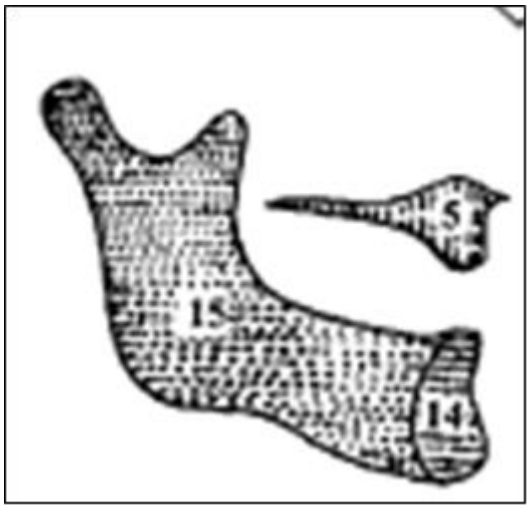

Fig 2a: MxA: Surface area maxillary; TmdA: Surface area mandibular; SSA: Symphysis area.

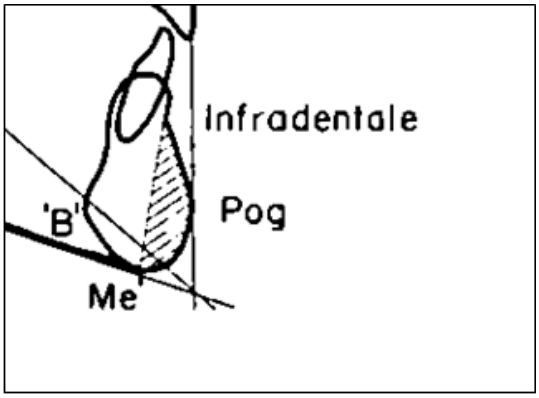

Table 2b: Percentage of protruding chin area.

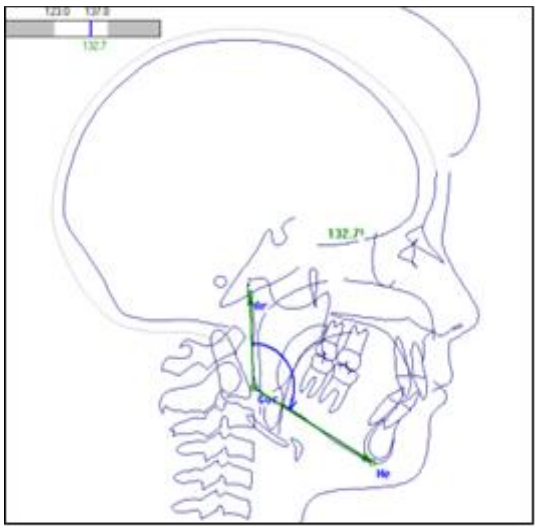

Fig 3: Gonial Angle.

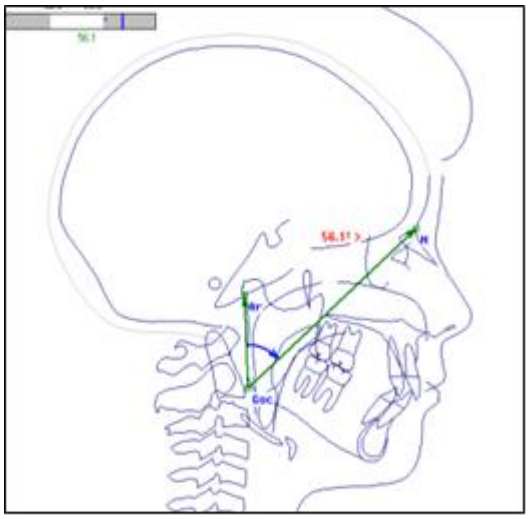

Fig 4: Upper Gonial Angle.

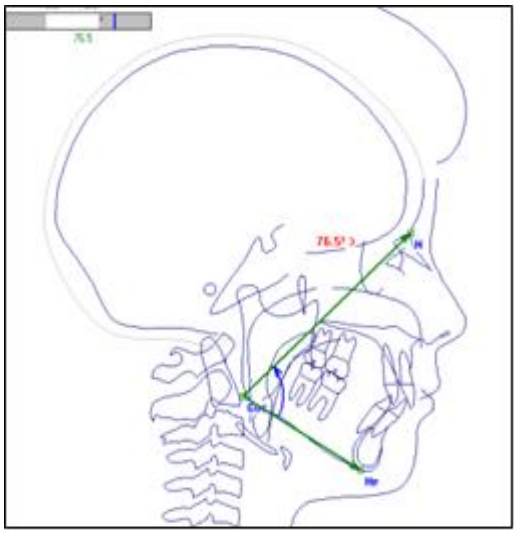

Fig 5: Lower Gonial Angle.

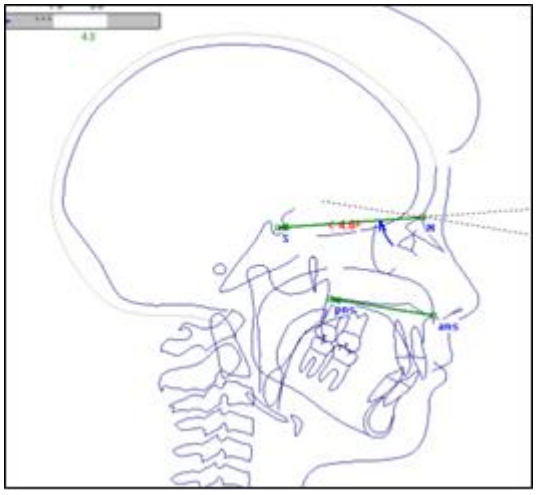

Fig 6: Angle between anterior cranial base and palatal plane.

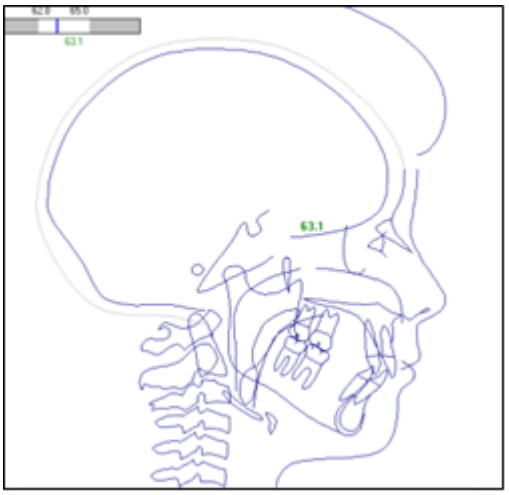

Fig 7: Posterior to anterior facial height ratio.

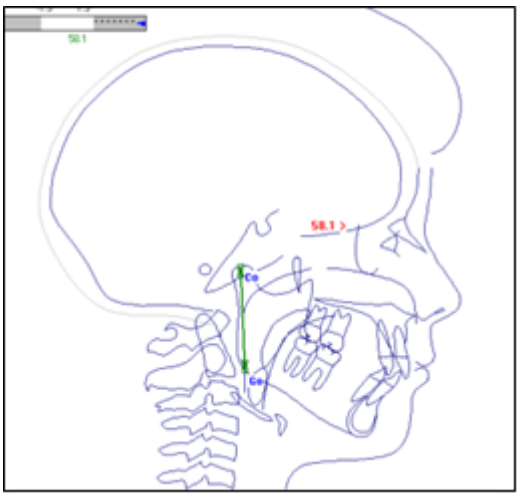

Fig 8: Ramal height.

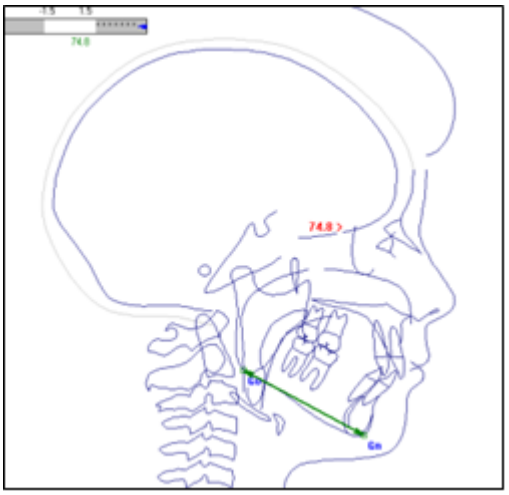

Fig 9: Corpus length.

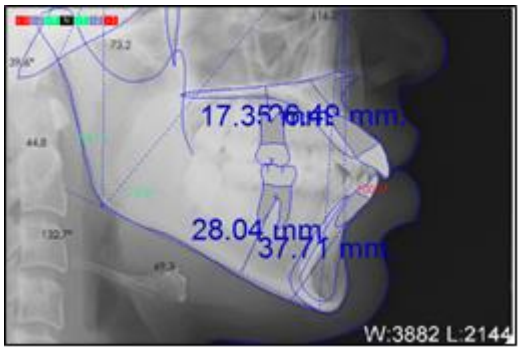

Fig 10: Posterior and Anterior Alveolar and Basal Height measurement.

RESULTS

Data analysis was carried out using descriptive and inferential statistics. The descriptive statistics permitted understanding of the basic data distribution to draw suitable interpretations. The study then compared Control Group with Group I, Group II and Group III. The data was analyzed using Statistical Package for the Social Sciences (SPSS) 16, IBM. The comparison between the groups was carried out using unpaired t-test for each parameter under study. The p-value less than 0.05 was considered significant.

Table 1: Comparison of means.

	Control Group	Open Bite	Deep Bite	Severe Deep Bite
MxSA (mm^2)	324.33	313.67	321.00	301.67
MdSA (mm^2)	2794	2747	2708	2667
SSA (mm^2)	268.67	297.67	254.00	282.67
PCA (%)	34.56%	28.48	37.08	43.29
GA (°)	126.93	128.38	127.05	122.88
UGA (°)	52.65	53.12	54.00	52.73
LGA (°)	73.95	75.20	72.83	70.48
SNPPA (°)	6.85	7.57	6.88	9.61
Mx-PABH (mm)	16.62	16.16	17.94	18.44
Md- PABH (mm)	25.00	24.62	28.79	28.30
Mx-AABH (mm)	22.89	22.47	21.16	19.15
Md-AABH (mm)	32.33	32.05	32.00	30.85
RH (mm)	55.80	52.02	55.99	55.63
CL (mm)	65.61	67.10	67.18	68.78
JR(%)	67.20	66.63	68.84	68.75

DISCUSSION

Great emphasis is being placed on the vertical dimensions of facial morphology. However vertical dysplasias are difficult to describe within the framework of traditional anteroposterior classifications[5]. Opdebeeck[6] also found such dysplasias may often be associated with, and may indeed be at origin of the anteroposterior discrepancies'. Evaluation of parameters used in the present study can help in early diagnosis and prompt treatment of associated malocclusion and thus may aid in correction or reduction in severity of the same.

The results of the present study can be discussed under the following headings:

Surface Area (SA) [Table no: 1,2] [Graph no. 1]:

Measured in mm^2 in the present study, surface area determination was done for MxSA, MdSA and SSA. The afore mentioned did not show significant correlation with overbite. This was in agreement with findings of Ceylan I, Eröz UB[1], as far as MxSA and MdSA are concerned. They claimed that the areas of the maxilla and mandible did not show significant correlation with overbite; whereas the SSA in the open-bite group was greater than in the other groups but was not significant.

Protruding Chin Area (PCA) [Table no: 1,2][Graph no. 2] :

In the present study PCA was found to be significantly increased in SDB and reduced in OB this was in agreement with findings of Haskell[2]. The possible explanation for changes in area could be a reduced functional mandibular stress due to a lack of incisal biting in the open bite subjects which correlates with the diminution of a protruding chin[2].

As the vertical skeletal relationship increases, the lower incisors compensate by retroclining and by increasing their heights thus reducing the tendency for an open bite[7]. Those who have a deep bite seem to have a slight protrusion of their mandibular incisors leading to larger mandibular alveolar and basal area.

Gonial Angle (GA) [Table no: 1,2] [Graph no. 3]:

In the present study Gonial Angle was found to be increased in Group I and Group II but this was not statistically significant. However Group III showed significant reduction in gonial angle. Trouten JC, Enlow DH, Rabine M, Phelps AE and Swedlow D[8] also found that in open bite, the GA is inclined into a more open position during development. In deep bite, the GA assumes a more closed relationship.

Results obtained in present study were in agreement with those of Nahoum[9]**.** He reported that anterior facial height is greater relative to posterior facial height because of an open GA, steep mandibular plane and vice versa.

Upper Gonial Angle (UGA) [Table no: 1,2] [Graph no. 3]:

No significant differences were found in upper gonial angle when study groups were compared with Control Group. However in Group II upper gonial angle was increased slightly that suggested saggital direction of madibular growth.

Lower Gonial Angle (LGA) [Table no: 1,2] [Graph no. 3]:

In the present study LGA was found to be increased in Group I and decreased in Group II. However these findings were not statistically significant. Statistically significant reduction in LGA was seen in Group III. This strongly suggested saggital direction of mandibular growth.

SN-PP Angle (SN-PPA) [Table no: 1,2] [Graph no. 3]:

In the present study only Group III showed significant correlation with Control Group and was found to be increased. Thus results obtained are in agreement with findings of Trouten JC, Enlow DH, Rabine M, Phelps AE and Swedlow D[8].

Nahoum[9] observed increased total face height in relation to the upper face. He noticed a more upward cant of the anterior part of the palate related to short upper face height which further contributed to height of lower face.

Maxillary Posterior Alveolar and Basal Height (Mx-PABH) [Table no: 1,2][Graph no. 4]:

In the present study Mx-PABH in Group II and Group III was found to be significantly increased when compared to control group. Group I did not show significant changes. Janson GR, Metaxas A, Woodside DG[10] noted that in nasally impaired cases, the mandible may be postured open to allow mouth breathing. Upper molars then erupt. This then allows the palate to remodel further downward thus increasing the upper face height and decreasing the UPDH (Upper Posterior Dental Height).

Schendel SA, Eisenfeld J, Bell WH, Epker BN, Mishelevich D[11] also observed that shorter posterior maxillary dental height relationship was observed with a shorter RH in open bite group and vice versa for deep bite.

Mandibular Posterior Alveolar and Basal Height (Md- PABH) [Table no: 1,2] [Graph no. 4]:

Group I did not show any significant correlation to control group. In contrast in Group II and Group III, **Md- PABH** was increased significantly. This was in agreement with findings of Anwar N and Fida M[7]. Who observed that GA showed a negative linear relationship with posterior dental heights.

Maxillary Anterior Alveolar and Basal Height (Mx-AABH) [Table no: 1,2] [Graph no. 4]:

Mx-AABH was found to be significantly reduced for both Group II and Group III. Whereas Group I did not show any significant correlation when compared to Control Group.

This was in contrast to Beckmann SH, Kuitert RB , Prahl-Andersen B, Segner D and Tuinzing DB[12]. Who observed statistically insignificant relation between the dimensions of the corresponding maxillary frontal alveolar and basal bone and the overbite.

Anwar N and Fida M[7] also noted that all dental height measurements except for upper anterior dental height to be significantly correlated with the skeletal parameters.

Mandibular Anterior Alveolar and Basal Height (Md-AABH) [Table no: 1,2] [Graph no. 4]:

Md-AABH did not show significant correlation when Study Groups were compared with Control Group.

This was contrary to the findings of Anwar N and Fida M[7] who found that, as the vertical skeletal relationship increases, the lower incisors compensate by retroclining and by increasing their height so that the tendency for an open bite is reduced and vice versa.

Janson GR, Metaxas A, Woodside DG[10] in 1994 stated that all dentoalveolar heights were significantly greater in excess LAFH persons than in normal LAFH persons.

Ramal Height (RH) [Table no: 1,2] [Graph no. 4]:

RH was found to be significantly decreased in Group I. While no significant correlation was found in Group II and Group III in comparison with Control Group.

According to Mangla R, Singh N, Dua V, Padmanabhan P, Khanna M [13], the RH was found to be significantly smaller in hyperdivergent group than hypodivergent group and significantly increased in hypodivergent and normodivergent groups when compared with hyperdivergent group, similar findings were observed in present study as far as **Group I** is concerned.

Findings of Hellman[14] also suggest that for open bite short mandibular ramus and corpus, rather than lack of vertical development in the nasomaxillary region is considered to be an etiologic factor.

Nanda SK[15] in contrast claimed that posterior face height and RH do not significantly differ between open-bite and deep-bite subjects.

Corpus Length (CL) [Table no: 1,2] [Graph no. 4]:

CL did not show any significant change in Group I and Group II when compared to Control Group; while in Group III, it was found to be increased and was statistically significant.

Jarabak Ratio (JR) [Table no: 1,2] [Graph no. 5]:

No significant correlation was found between Group I, Group II, Group III and Control Group, however JR was slightly increased in Group II and Group III suggestive of horizontal growth pattern.

CONCLUSION

Patients belonging to hyperdivergent or hypodivergent facial types deserve definitive changes in the treatment approach. This is often due to the response to mechanotherapy. Thus, diagnosis and treatment planning offer a great range of variations. Facial types could be studied with emphasis on their association with malocclusions and skeletal relationships.

The objectives of this study were to evaluate and compare association between facial morphology and vertical discrepancies such as increased or reduced overbite using aforementioned area, angular and linear measurements.

This study has established the following

1. Percentage of Protruding Chin Area showed significant reduction in open bite and was increased significantly in severe deep bite.

2. The slight increase in Gonial Angle though statistically not significant in open bite and deep bite while significant reduction was observed in cases with severe deep bite.

3. Lower Gonial Angle was significantly reduced in severe deep bites.

4. SN-PP Angle was increased significantly in severe deep bites. A smaller SN-PP Angle might reflect either a smaller upper face, a longer lower face height, or a combination of the two.

5. Mx-PABH and Md- PABH was found to be significantly increased in deep bite and severe deep bite. Mx-AABH was found to be significantly reduced in deep bite and severe deep bite while Md-AABH did not show any correlation with overbite.

6. Open Bite showed significant reduction in Ramal Height, whereas deep bite and severe deep bite did not show significant relation with overbite.

7. Corpus Length was increased significantly in severe deep bite; no other significant changes were found in other study groups; open bite and deep bite. For other six parameters studied (MxSA, MdSA, SSA, UGA, Md-AABH, JR) a significant correlation was not found between open bite, deep bite and severe deep bite when compared with Control Group.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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