# Compensatory Cephalometric Changes in Mandibular Symphysis with Different Anteroposterior Jaw Relationships

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## ABSTRACT

**Objective:** The purpose of this study was to determine whether cephalometric symphysis morphology could be used as a predictor of the anteroposterior skeletal relationship and to assess compensatory changes of the symphysis different sagittal dysplasia. Cross-sectional data included lateral cephalometric radiographs of 120 adults (60 women, 60 men) with all subject within same age group. **Materials and methods:** The dimension of mandibular symphysis was evaluated with 10 cephalometric measurements that included 7 skeletal parameters SNA, SNB, ANB, LAFH, UAFH, TAFH, IMPA and 5 Mandibular symphysis parameters. The mandibular symphyseal dimensions studied were height, depth, ratio (height/depth), and angle. **Results:** Symphysis morphology was found to be associated with the direction of anteroposterior skeletal relationship, especially in male subjects with symphysis ratio having the strongest relationship. The vertical dimension of Mandibular Symphysis was significantly smaller in Class II than in Class I and Class III skeletal relationships. Inclination of alveolar part of MS toward the mandibular plane was significantly more in the Class III group than in the other two groups. **Conclusion:** The dimensions and configuration of MS in the Class I. Class II, Class III relationship were different; the alveolar part of MS compensated for the skeletal relationship in the all skeletal pattern. MS dimensions were strongly correlated to anterior facial dimensions.

**KEYWORDS: Mandibular Symphysis; Anteroposterior Jaw Relationships, Digital Cephalometrics**

## INTRODUCTION

The mandibular symphysis has received a great deal of attention from anatomists, human biologists, paleontologists, and orthodontist. In current scenario research mostly focused on symphyseal shape variation in humans and hominoids based on the functional interpretation. This is due to, anthropologist and human biologist, focusing much on the complex biomechanical stresses placed on the mandible during mastication,[1] wide diversity of symphyseal forms present, [2] frequent preservation of mandibular specimens in the mammalian fossil record, [3] and finally, an anthropocentric interest in the unique morphology of the human chin.[4]

Also for the clinical orthodontist, the symphysis region is one of the most important regions of the craniofacial complex. For determining the esthetic aspect of the lower third of the face, mandibular symphysis used as a primary a reference. Furthermore, a vertical and sagittal position of the mandibular incisor and mental protuberance are important determinants in planning occlusal and skeletal relation for orthodontic treatment and orthognathic surgical procedures. An understanding of the structure and function of basal and alveolar bone, which ultimately requires description and explanation of ontogenetic

variation in symphyseal morphology is, therefore, essential in order to develop a differential diagnosis. [5]

Hence, we study the two-dimensional symphyseal morphology of mandibular symphysis in a cephalometric attempt to identify factors that influence variations in mandibular shape with different anteroposterior skeletal patterns.

## MATERIAL AND METHODS

One hundred and twenty lateral cephalographs for adult subjects including 60 females with mean ages of 21.3 ± 2.5 years and 60 males with mean ages of 20.5±2.1 years were retrospectively selected from the pretreatment orthodontic records of patients undergoing fixed orthodontic treatment at the Department of Orthodontics and Dentofacial orthopedics at the Saraswati Dhanwantari Dental College and Hospital, Parbhani. Ethical approval, to access patient's files was granted by the Institutional Research Board at Saraswati Dhanwantari Dental College and Hospital, Parbhani.

Lateral cephalographs were taken for the study was,

*How to cite this article:*
*Bangar C, Wagh S, Murthy KK, Parhad S. Compensatory Cephalometric Changes in Mandibular Symphysis with Different Anteroposterior Jaw Relationships. Int J Oral Health Med Res 2015;2(3):3-7.*

Frankfort Plane Horizontal according to the natural head position by using an ORTHOPHOS XG with cephalostat, lips in a relaxed position and centric occlusion. The potential used is 80 kVp (kilovolt potential), current used is 12 mA (milliampere) and the exposure time was 1.0 sec for all the cephalograms taken.

Individuals with a history of previous orthodontic treatment, orthognathic surgery, craniofacial anomalies with gross facial asymmetry, or a history of traumatic injuries to the mandible were excluded from the study. All subjects had average growth pattern with a maxillary to mandibular plane angle that was within normal limits for Indians (25.5±5.3).[6]

The radiographs were divided into three group based on their skeletal AP jaw relationship (Class I, Class II, or Class III relationship). When ANB angle was $3^0 \pm 1^0$ Then Class I skeletal relationship was considered, Class II skeletal relationship was considered when ANB angle was s>$4^0$, and Class III skeletal relationship was considered when ANB angle was <$2^0$.[6] The three groups had similar age and gender distribution (Table 1).

| | Females | Males | Total |
|---|---|---|---|
| Class I | 20 | 20 | 40 |
| Class II | 20 | 20 | 40 |
| Class III | 20 | 20 | 40 |
| Total | 60 | 60 | 120 |

Table 1. Sample Distribution according to gender and anteroposterior skeletal jaw relationship

**DIGITAL TRACING BY NEMOCEPH:** The 120 cephalometric radiographs were directly taken from the cephalostat to the computer through LAN (Local Area Network) or by CD burning and will be measured for landmarks, angulations and planes at Saraswati Dhanwantari Dental College, and postgraduate research institute, Parbhani.

An indicator was used (Nemoceph® radiographic film calibration ruler) to determine the amount of magnification and to establish a proportion for cephalometric images. The images which were received from the cephalostat were stored in TIFF format in the software itself with maximum quality. All the cephalometric landmarks traced in digital method were also traced with the computerized method and were then digitized in Nemoceph ® software.

**COMPUTERIZED CEPHALOMETRIC ANALYSIS:** In the preparation for cephalometric landmark identification, linear and angular measurements of these radiographs, a digital cephalometry approach is used and computerized cephalometric analysis carried out with NEMOCEPH program. In Nemoceph ® software a new cephalometric analysis is created which includes addition of some new points (Table 2), linear measurement (Table 3), Angular Measurement (Table 4) and skeletal parameters (table 5). Nemoceph ®. During modification of software end, user license was not violated (Fig 4).

| Cephalometric Variables | Definition |
|---|---|
| Nasion (N) | The intersection of the internasal and frontonasal sutures, in the midsagittal plane. |
| Gonion (Go) | The most posterior inferior point on the outline of the angle of the mandible. |
| Incision inferius (Ii) | The incisal tip of the most labially placed mandibular incisor. (Unilateral) |
| Point B | The most posterior point on the profile of the mandible between the chin point and the alveolar crest |
| Pogonion (Pog) | The most anterior point of the mandibular symphysis in the midline |
| Gnathion (Gn) | The most anterior inferior point of the mandibular symphysis in the midline |
| Menton (Me) | The lowermost point of the mandibular symphysis in the midline |
| Point B1 | A point formed by the intersection between a perpendicular line dropped from point B to the tangent drawn on the inner contour of mandibular symphysis at the shortest distance from point B |
| Point Id | The most anterior superior point of the labial mandibular alveolar crest, situated between the lower central incisors |

Table 2: Definition of the cephalometric Points for cephalometric analysis (Figure 1)

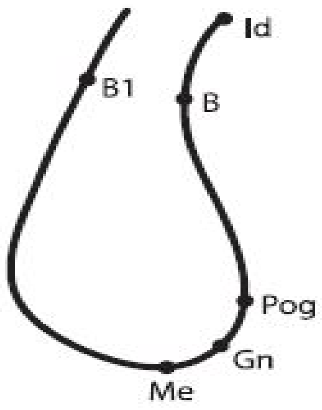


Figure 1: Cephalometric Points for cephalometric analysis

| Cephalometric Variables | Definition |
|---|---|
| Id-B | The linear distance from Id to point B |
| B-Pog | The linear distance from point B to Pogonion |
| Pog-Me | The linear distance from Pogonion to Me |
| Id-Me | The linear distance from Id to Me, representing the total length of MS |
| Perpendicular distance from Pog to B-Me line | The perpendicular distance from Pogonion to the line connecting point B and Menton to represent the anterior prominence of MS |

Table 3: Definition of the cephalometric linear parameters for cephalometric analysis (figure 2)

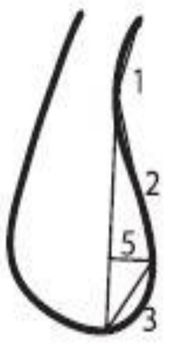


Figure 2: cephalometric linear parameters for cephalometric analysis

| Cephalometric Variables | Definition |
|---|---|
| B-B1-Gn | The angle between point B, point B1, and Gnathion; It gives an indirect reflection of the vertical dimension of the mandibular symphysis. |
| B-Pog-Me | The angle formed between point B, Pogonion, and Menton; It reflects the convexity of the mandibular symphysis. |
| Id-B-Pog | The angle between point Id, point B, and Pogonion; It reflects the concavity of the mandibular symphysis. |
| Id-B/Md | The angle between a line connecting Id to Point B and the mandibular plane; It reflects the inclination of the alveolar part of the mandibular symphysis in relation to the mandibular plane. |
| B-Pog/Md | The angle between a line connecting Point B to Pogonion and the mandibular plane; It reflects the inclination of the skeletal part of the mandibular symphysis in relation to the mandibular plane. |

Table 4: Definition of the Angular parameters for cephalometric analysis (figure 3)

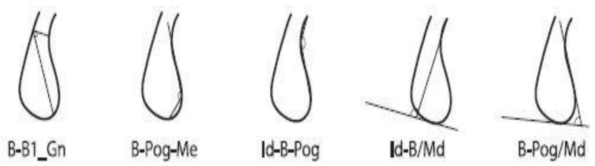


Figure 3: Angular parameters for cephalometric analysis

| Cephalometric Variables | Definition |
|---|---|
| SNA | Angle formed by intersection of Sella-Nasion and Nasion-A point |
| SNB | Angle formed by intersection of Sella-Nasion and Nasion-B point |
| ANB | Angle formed by intersection of Nasion-B point and Nasion-A point |
| IMPA | Angle formed by intersection of long axis of the most prominent mandibular incisor and mandibular plane |
| UAFH | The distance from Nasion to Anterior nasal spine |
| LAFH | The distance from Anterior nasal spine to Menton point |
| TAFH | The distance from Nasion to Menton |

Table 5. Definition of the Craniofacial and Dentoalveolar Cephalometric Parameters

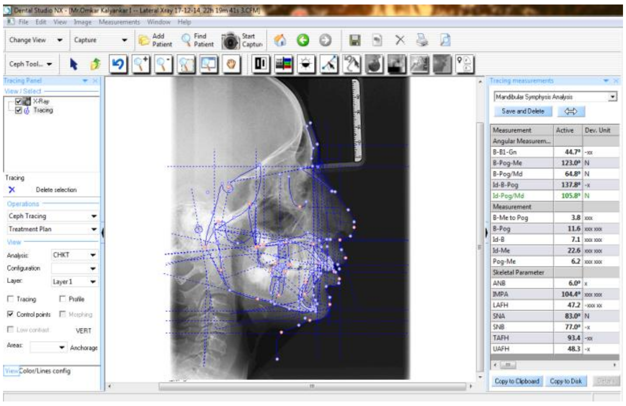

Figure 4: Software

**Statistical Analysis:** Mean and standard deviations for the cephalometric parameters and those describing MS were calculated. For all statistical analysis, the Statistical Package for the Social Science (SPSS version 21, Chicago, Ill) was used. To investigate differences between the measured MS parameters in the three AP groups the General linear model analysis was employed. The Pearson correlation coefficient was calculated to assess the relationship between the MS parameters on one hand and craniofacial and dentoalveolar parameters on the other hand. The level of significance was set at P<0.05.

## RESULTS

Mandibular symphysis (MS) configuration changes with different anteroposterior jaw relationship which clearly indicates MS compensate for anteroposterior jaw relationship. Mean, standard deviations, and mean differences of all measured MS parameters for the three AP groups are shown in **Table 6**.

| Mandibular Symphysis Parameters | Class I, Mean ±SD | Class II, Mean ±SD | Class III, Mean ±SD |
|---|---|---|---|
| B-B1-Gn | 54.61±2.89 | 44.42±2.88 | 62.53±2.46 |
| B-Pog-Me | 129.08±9.39 | 128.22±8.12 | 127.32±7.5 |
| B-Pog/Md | 64.61±6.11 | 67.04±5.77 | 65.49±4.9 |
| Id-B-Pog | 139.26±9.6 | 143.71±7.7 | 145.52±8.4 |
| Id-B/Md | 105.66±8.55 | 103.42±8.66 | 99.78±10.14 |
| Id-B | 10.68±1.5 | 9.45±2.5 | 8.3±1.2 |
| B-Pog | 11.98±2.3 | 13.30±2 | 12.92±1.95 |
| Pog-Me | 9.81±1.8 | 9.62±1.5 | 9.78±1.34 |
| Id-Me | 27.66±3.7 | 29.91±3.5 | 28.56±2.5 |
| Dist.Pog to B-Me | 5.5±1.1.9 | 4.67±1.02 | 6.22±8.77 |

Table 6. Definition of the Craniofacial and Dentoalveolar Cephalometric Parameters

**Compensatory changes in Class II MS:** The angle B-B1-Gn, which indicates the vertical dimension of MS was significantly smaller in Class II than in Class I and Class III skeletal relationships. The perpendicular distance from Pog to B-Me line was significantly smaller in Class II than in Class I and Class III groups.

**Compensatory changes in Class III MS:** The angle Id-B-Pog, which reflects concavity of MS was significantly larger in Class III subjects. In comparison to class I and class II subjects, increased inclination of the alveolar part of MS towards the mandibular plane was observed in class III subject which was indicated by smaller Id-B/MP angle.

Linear cephalometric parameter such as the distances from Point Id to point B (Id-B) and point B to Pogonion (B-Pog) were significantly larger in the Class III than in the Class II group. Total length of MS (Id- Me) was larger in the Class III group than in the other two groups. Angular parameter indicating the convexity of MS (B-Pog-Me) and inclination of the skeletal part of MS (B-Pog/MP) however, showed no significant difference between the three groups.

## DISCUSSION

To overcome the underlying AP skeletal discrepancy dentoalveolar compensation is usually observed clinically. Mandibular symphysis morphology is mostly affected by changes in inclination of the lower incisors, reason being the AP relationships might cause surface remodelling of MS.[7] Accordingly, this study evaluated some of the characteristics of MS in the three AP relationships and investigation compared with the compensatory changes in the morphology of MS.

The age group considered in this study was females and males with mean ages of 21.3 ± 2.5 years and 20.5±2.1 years, respectively which represented a stable period in the growth and development of the cranio-facial complex. Skeletal malocclusions were classified according to ANB angle and standardization for digital cephalometrics was strictly followed.

Results from the present study showed correlation with Yamada et al.[8] in which the concavity of MS is decreased in class III subjects, it was clearly observed that inclination of alveolar part of the MS to mandibular plane is increased in Class III subjects. It indicates that retroclination of mandibular incisors in Class III subject act as compensatory mechanisms to compensate skeletal discrepancy. These compensatory mechanisms provide good occlusion along with acceptable facial balance related to various skeletal apical bases.[8] It has been observed that retroclination of the lower incisors would result into surface remodeling of the outer surface of the dentoalveolar part of MS.[9,10] Such retroclination of the alveolar part of the symphysis would result in less concavity of the anterior contour of MS. Which was reflected as a compensatory change on lateral cephalograms.

Angular and linear parameters were used to evaluate the convexity of the contour of the skeletal part of MS, angular measurement B-Pog-Me was smaller in class III group than class II group, but difference between group but statistically less relevant. All the linear measurement, however, was significantly larger in the Class III group which show that MS have larger vertical dimension as compared class I and class II group. Class II group Showed the smallest distance. This finding demonstrates a compensatory increase in chin prominence in Class III skeletal relationship. The general increase in mandibular size in Class III discrepancy could be one explanation for that.[11]

On interpreting the results of the study, is was observed that vertical dimension of MS were largest in the Class III group as compared to the class I and Class II group. These results coincide the results from other studies [11–13] which showed mandibular size is larger in Class III groups as compared to Class I and Class II groups.

Sexual dimorphisms were observed in the results from this study, males exhibited larger MS longer dimensions than females. Sexual dimorphism has been reported.[14] between males and females with regards to different aspects of the craniofacial complex.

Mandibular symphysis morphology is affected by several factors which include genetic and racial factors. During this study, a strong correlation was found between skeletal anteroposterior relationship and vertical dimension of mandibular symphysis. This type of correlation may be reflected the underlying dentoalveolar compensation in vertical dimension justified by the class III malocclusion and lower and facial height is increased an upper and lower anterior teeth attempt to maintain positive overbite, bringing their bony support with them, resulting in an increased mandibular symphysis length.

There was a significant correlation between the lower incisor inclination and mandibular symphysis inclination. But as compared to other studies it was weaker. But in those studies conventional cephalometric method was used as compared to our digital method which produced a value of 0.001 unit. Therefore, the values showed weak correlation.

Although the symphysis morphology and dimension were relatively small as compared to the whole of the dentofacial structures. But clinically, chin level has no significant roll on aesthetics of lower face. It also contributes to the anteroposterior skeletal relationship and their treatment outcomes. Hence, mandibular symphysis should be considered during other cephalometric findings and mandibular growth prediction relating to the size and direction.

The results of the present study are limited to a small number of cross-sectional data. The long-term studies with larger sample size are needed to evaluate the mandibular symphysis compensation with the different anteroposterior skeletal relationship.

## CONCLUSION

It is concluded from the result of the study, The Class III skeletal jaw relationship exhibits a decreased concavity of anterior contour of MS as compared to other groups. Also observed that MS compensate the underlying skeletal jaw relationship by an increased in its vertical dimension and inclination of the alveolar part towards the mandibular plane than any other AP relationships, reflecting compensation for the skeletal pattern of the jaws. Larger dimensions and area of MS are found in Class III than in Class I and Class II part of MS.

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Source of Support: Nil
Conflict of Interest: Nil