Correlation of Symphyseal Angle and Various Skeletal Patterns in Skeletal Class I Malocclusion

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Abstract
Introduction: Skeletal growth pattern is an important parameter used in orthodontics for diagnosis and treatment planning. Lateral cephalogram is commonly used to evaluate skeletal growth pattern. Orthopantamogram (OPG) can also be used to evaluate skeletal growth pattern with parameters like gonial angle and symphyseal angle (SA). This study deals with symphyseal angle and its correlation with skeletal growth patterns. Objective: To correlate symphyseal angle with different skeletal growth patterns in skeletal Class I sample. Materials and Methods: The study was a cross-sectional, observational study including 60 patients of age 15 - 49 years with skeletal Class I pattern selected from ANB angle. Samples were divided into horizontal, vertical and normal skeletal growth patterns according to Jarabak ratio (JR). The symphyseal angle was measured and compared among various skeletal growth patterns using one-way ANOVA test. Pearson's correlation test was performed to correlate symphyseal angle with Jarabak ratio. Results: The mean and standard deviation of symphyseal angle in horizontal, normal and vertical growers were 155.5±9.25, 147.2±6.7, 141.9±6.4 respectively. Significant difference of symphyseal angle was found among different skeletal growth patterns using one-way ANOVA and subsequently post-hoc tests showed significant difference between the groups (p value < 0.05). High positive correlation was found (r=0.70) between symphyseal angle and Jarabak ratio. Prediction equation was derived using linear regression analysis as SA=JR(1.071)+78.80. Conclusion: Symphyseal angle and Jarabak ratio has high positive correlation in skeletal Class I subjects.

Keywords
Skeletal growth patterns; Jarabak ratio; Symphyseal angle

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ABSTRACT

Introduction: Skeletal growth pattern is an important parameter used in orthodontics for diagnosis and treatment planning. Lateral cephalogram is commonly used to evaluate skeletal growth pattern. Orthopantamogram (OPG) can also be used to evaluate skeletal growth pattern with parameters like gonial angle and symphyseal angle (SA). This study deals with symphyseal angle and its correlation with skeletal growth patterns.

Objective: To correlate symphyseal angle with different skeletal growth patterns in skeletal Class I sample.

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Conclusion: Symphyseal angle and Jarabak ratio has high positive correlation in skeletal Class I subjects. Taiwanese Journal of Orthodontics 2023;35(4):158–163

Keywords: Skeletal growth patterns; Jarabak ratio; Symphyseal angle

INTRODUCTION

Orthodontists have a common interest in studying skeletal growth pattern which influences extraction versus non-extraction decision, intrusion and distalization of teeth, and assessment of overall facial morphology. It is usually evaluated by lateral cephalometric tracings with the help of different analyses. Among the different analyses, Jarabak ratio is commonly used to find the skeletal growth pattern of the patient; it is defined as the ratio of posterior facial height/anterior facial height that multiplied by 100. Jarabak used measurements of anterior and posterior facial heights, determining the Jarabak ratio while also establishing the correlation between the Y-axis, mandibular plane, and S–N plane. Nahidh et al. reported that the vertical skeletal relation can be measured more precisely with the help of Jarabak ratio. The Jarabak ratio also assesses the role of posterior facial height in contributing to skeletal dysplasia. Therefore, it is essential to calculate this ratio for each patient to minimize diagnostic errors.

Orthopantamogram (OPG) is a commonly used radiograph in the diagnosis of skeletal and dental disharmony. OPG has an indispensable use in orthodontic screening as it provides information on tooth angulations and about surrounding supporting tissues. Habets and Levandowski were among...
the pioneers to introduce the analyses of panoramic radiograph.9–13

Researches on growth assessment using OPG have been done previously, as they have interpreted different anatomical landmarks in OPG as an alternative to landmarks in lateral cephalogram.14–17 Most of the studies have focused on gonial angle in OPG with respect to its counterpart on lateral cephalogram. Comparison of gonial angle of OPG and lateral cephalogram has been done to evaluate the skeletal growth pattern.15–17

Ajmera et al. in 2014 suggested symphyseal angle as another adjunct to find the skeletal growth pattern in OPG. The symphyseal angle is constructed from two tangents drawn at the most prominent point on the inferior border of the mandible, meeting at the midsagittal plane, drawn passing through the anterior nasal spine and between the two central incisors.18

This alternative method of using OPG serves in interpreting skeletal growth patterns when the facility of lateral cephalogram is scarce. Thus, this study aims to correlate symphyseal angle in different skeletal growth patterns using OPG.

MATERIALS AND METHODS

A cross-sectional comparative study was conducted using lateral cephalogram and OPG of patients visiting Department of Orthodontics, Kantipur Dental College and Hospital, Kathmandu. The lateral cephalogram and OPG of the subjects of age range 15–49 years were included. The exclusion criteria were gross mandibular asymmetry, previous orthodontic treatment, inferior image quality and history of craniofacial trauma that might hamper the growth. The study conducted was during July to August 2022. Ethical clearance was obtained from the Institutional Review Committee (IRC Ref. No 17/022).

The sample size was calculated using the data from the study done by Amatya S et al.19 using the formula:

\[
N = \frac{2 \times (Z_\alpha + Z_\beta)^2 \times \rho^2}{D^2}
\]

Where,

\[
N = \text{No. of sample calculated}, Z_\alpha = 1.96, Z_\beta = 1.65 \text{ in 95 % power, } \rho = \text{Average of standard deviation from a similar study.}
\]

Sample size \(N\) = \[2 \times (1.96 + 1.65)^2 \times (4.81)^2 / (5.77)^2 = 18.10 – 20\]

The value obtained from above equation was 20. Thus, 20 samples each for normal, horizontal and vertical skeletal growth patterns were taken with the total sample size of 60.

Secondary data were obtained from the departmental records. Manual tracing of the films were done and measurements were recorded in the data collection sheet. Lateral cephalograms with skeletal Class I relationship were selected according to ANB angle which was constructed joining Point A (A), Nasion (N) and Point B (B) (Figure 1). ANB angle from 0–4° was taken as skeletal Class I.4 The selected samples were divided into normodivergent, hyperdivergent and hypodivergent skeletal growth pattern groups according to Jarabak ratio.5

Anatomic landmarks used to determine the ratio and ANB angle included Sella (S), Nasion (N), Menton (Me), Gonion (Go), Point A (A) and Point B (B) (Figure 1). The linear measurements used were S-Go (posterior facial height) and N–Me (anterior facial height) (Figure 2).

OPGs with skeletal Class I relationship were selected and traced. Symphyseal angle was measured by tracing the bony outlines in the OPG. Two tangents AB and BC were drawn using grids of 1 cm square. Grids were placed on the OPG film to determine the mid sagittal plane and to determine maximum curvature on the lower border of the mandible to facilitate drawing the tangent on the lower border. The tangents meeting at the mid sagittal plane formed the symphyseal angle (Figure 3).18 Intra-class correlation coefficient (ICC) was used to check inter-rater and intra-rater reliability for Jarabak ratio and Symphyseal angle in 10 % of the sample size.

Figure 1. Cephalometric points and angular measurement.
IBM SPSS Statistics Version 21 was used to compute the mean symphyseal angle in different skeletal growth patterns. Shapiro–Wilk test was done to check the normality of the data distribution. One-way ANOVA followed by post-hoc Tukey test was used to compare the mean of various skeletal growth patterns. Pearson's correlation was used to correlate Jarabak ratio with symphyseal angle. Linear regression analysis was applied between the correlated values. The level of significance was set at $p < 0.05$.

RESULTS

The sample size of the study was 60 including 20 samples each of horizontal, vertical and normal skeletal patterns. ICC values for intra-rater reliability were 0.91 for Jarabak ratio and 0.90 for symphyseal angle, which were interpreted as excellent reliability. ICC values for inter-rater reliability were 0.93 for Jarabak ratio and 0.85 for symphyseal angle, which were interpreted as excellent and good reliability respectively. Shapiro–Wilk test showed that the data were normally distributed ($p$-value $>0.05$). The mean angular comparisons among the skeletal patterns are shown in Table 1.

One-way ANOVA showed significant differences between the groups ($p = 0.000$). The subsequent post-hoc Tukey test showed mean symphyseal angles were significantly different between horizontal-vertical ($p = 0.03$); horizontal-normal ($p = 0.001$) and vertical-normal ($p = 0.03$) skeletal patterns (Table 2).

There was a high positive correlation between symphyseal angle and Jarabak ratio ($r = 0.7$) (Table 3). With respect to the above findings, a liner

Figure 2. Cephalometric points and linear measurements.

Figure 3. Symphyseal angle.
A regression equation relating symphyseal angle to Jarabak ratio was derived with a linear function (Table 4 and Figure 4).

The equation for the line \( y = mx + c \) for Jarabak ratio to predict symphyseal angle was derived as:

\[
SA = JR(1.071) + 78.80
\]

Where, \( y \) (dependent variable) is symphyseal angle on OPG.

\( m \) (slope) = 1.071

\( x \) (independent variable) = Jarabak ratio from lateral cephalogram.

Linear regression analysis indicates that the change in mean Jarabak ratio by 1 percent, increases the mean symphyseal angle by 1.071.

**DISCUSSION**

Present study showed significant difference in symphyseal angle among vertical, horizontal and normal skeletal growth patterns. Symphyseal angle was found greater in sample with horizontal skeletal growth pattern followed by normal skeletal growth pattern and least in vertical skeletal growth pattern. Previous study measured symphyseal angle only in normal skeletal growth pattern.18

Previous literatures on predicting skeletal growth patterns from OPG mainly focused on gonial angle. The studies compared cephalometric and OPG measurements of gonial angle and suggested that OPG can be used as an adjunct to lateral cephalogram for the evaluation of skeletal growth pattern.17,20,21 Shababi et al. in 2009 and Rajak et al. in 2021 suggested that there was no significant difference between the gonial angle measured from lateral cephalogram and OPG, therefore OPG can be used to assess skeletal growth pattern using gonial angle.17,22 In the present study, symphyseal angle has been used in OPG to evaluate the skeletal growth pattern. Turp et al. suggested inaccuracy of vertical linear measurement in OPG.9 Similarly, Larheim et al. also suggested that horizontal linear measurements from OPG were unreliable.23 Therefore angular measurements were taken from OPG. This justifies the use of OPG utilizing angular parameter in the present study.

Aki et al. conducted a study which related symphysis morphology with growth and suggested mandibular growth having a significant role in symphyseal morphology. They found that horizontal growers had increased angle of symphysis whereas vertical grower had decreased angle of symphysis.24 Similarly, Bjork in 1969 concluded that there was pronounced apposition below the symphysis leading to backward mandibular rotation tendency.25 In the present study, the vertical skeletal growth pattern cases had decreased symphyseal angle suggestive of increased bone apposition below the symphysis.

Ajmera et al. showed a significant positive correlation between Jarabak ratio and symphyseal angle. This indicates increased symphyseal angle in horizontal skeletal growth pattern. Similar result was derived from the present study as Jarabak ratio had high positive correlation with symphyseal angle. The study also showed negative correlation of symphyseal angle with Frankfort mandibular plane angle and maxillo-mandibular angle. These findings suggested that the symphyseal angle was increased in horizontal skeletal growth pattern and decreased

| Table 1. Mean symphyseal angle of different skeletal growth patterns. |
|------------------------|-----------------|-----------------|
| Parameter              | n   | Mean ± SD (Degrees) |
| Horizontal skeletal growth pattern | 20  | 155.5 ± 9.2 |
| Vertical skeletal growth pattern | 20  | 147.2 ± 6.7 |
| Normal skeletal growth pattern | 20  | 141.9 ± 6.4 |

| Table 2. Post-hoc (Tukey) of different variables. |
|------------------------|---------|---------|
| Skeletal Growth Pattern (I) | Skeletal Growth Pattern (J) | Mean Difference (I-J) | Significance |
| Horizontal Normal | Vertical | 8.3 | 0.003* |
| Normal Horizontal | Vertical | -8.3 | 0.003* |
| Vertical | 6.2 | 0.032* |

a Significant at \( p < 0.05 \).

| Table 3. Correlation between symphyseal angle and Jarabak ratio. |
|------------------------|-----------------|-----------------|
| Variable                | Jarabak Ratio Correlation | Symphyseal angle Correlation |
| Jarabak Ratio Pearson Correlation | 1 | 0.000* |
| Sig. (2-Tailed)         | 0.000* |
| N                       | 60 |

a Significant at 0.01 level (2-tailed).

| Table 4. Linear regression analysis to establish the relationship between symphyseal angle and Jarabak ratio. |
|------------------------|-------------------|-------------------|-------------------|-------------------|
| Variable              | Unstandardized Coefficients (B) | Standardized Coefficients (Beta) | t-value | p-value |
| (Constant)            | 78.80 | - | 8.67 | 0.00a |
| Jarabak ratio         | 1.071 | 0.70 | 7.63 | 0.00a |

a Significant at \( p < 0.05 \).
in vertical skeletal growth pattern, which is in accordance to the present study. As present study showed high positive correlation between symphyseal angle and Jarabak ratio, the equation derived from linear regression can be used to predict Jarabak ratio. Hence, the skeletal growth pattern can be evaluated in places of limited facilities with the availability of OPG only.

The sample size of the present study does not represent the whole population. Thus, the result cannot be generalized. The symphyseal dimensions continue to change until adulthood, therefore, a longitudinal study with a larger sample size is recommended.

CONCLUSION

Following conclusions can be drawn from the study:

- Jarabak ratio increases when symphyseal angle increases and vice versa.
- Symphyseal angle values are different for normal, vertical and horizontal skeletal growth patterns.
- Symphyseal angle from OPG can be used as adjunct to assess the skeletal growth pattern using the prediction equation $SA = JR \cdot (1.071) + 78.80$.

FUNDING

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ETHICAL APPROVAL

This study was approved by the Institutional Review Committee of Kantipur Dental College Teaching Hospital & Research Center, Kathmandu, Nepal (IRC Ref. No 17/022).

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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