Relationship between Human Eye and Different Divergence of Skeletal Class I Pattern: A Correlative Study

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ABSTRACT

Introduction: All the systems in the body are interconnected to form a single structural unit. Scientific evaluations of potential correlations between the stomatognathic system and the eye are based on different scientific approaches. Some recent studies have shown that the various genes and growth factors involved in the eye formation play an important role in the development of the stomatognathic system also.¹,²

In this study, patterns of horizontal, average, or vertical growth were diagnosed from the lateral cephalograms. These growth patterns were correlated with the visual acuity, corneal diameter, corneal thickness, axial length, retinal nerve fiber layer thickness, and intraocular pressure of each patient.

Materials and Methods: A total of 150 samples were selected. The sample selected for the study ranged in the age group from 18 to 24 years. Individual were subjected to radiographs (lateral cephalograms) and various eye tests. The subjects were divided into horizontal, average, and vertical growth patterns on the basis of the Go-Gn-SN angle.

Results: Positive correlation was found between visual acuity and mandibular plane angle among the average growth pattern, and negative correlation was found between visual acuity and mandibular plane angle among the horizontal growth pattern. So, the present study concludes that there is a correlation between the human eye variables and the growth patterns, and thus malocclusion can be anticipated on this basis.

Keywords: Divergence, Eye, Pax-6, Pax-9, Skeletal pattern.

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INTRODUCTION

All the systems in the body are interconnected to form a single structural unit. Scientific evaluations of potential correlations between the stomatognathic system and the eye are based on different scientific approaches. Some recent studies have shown that the various genes and growth factors involved in the eye formation play an important role in the development of the stomatognathic system also.¹,²

In this study, patterns of horizontal, average, or vertical growth were diagnosed from the lateral cephalograms. These growth patterns were correlated with the visual acuity, corneal diameter, corneal thickness, axial length, retinal nerve fiber layer thickness, and intraocular pressure of each patient.

MATERIALS AND METHODS

The 150 samples were selected. Good-quality lateral cephalograms of 150 patients were obtained based on the following criteria:

Inclusion Criteria

- Subjects of age group 18–24 years having a class I skeletal pattern
- Subjects should not have any facial deformity or syndrome

Exclusion Criteria

- Subjects having class II and class III skeletal pattern
- Subjects with history of orthodontic, orthognathic, or plastic surgery
- Subjects with history of eye surgery

Sampling Method

The subjects were divided into three groups:³

- Group I—Horizontal growth pattern Go Gn-SN angle = 25–29
- Group II—Average growth pattern Go Gn-SN angle = 30–34
- Group III—Vertical growth pattern Go Gn-SN angle = 35–39

Methodology

The standardized lateral cephalogram of each patient was obtained. The cephalometric landmarks were identified: angle between point A-Nasion-point B (ANB), beta angle, and mandibular plane angle. The subjects were then referred to a renowned eye institute with academic interest. Different eye test variables were established and identified by a qualified ophthalmologist. Eye test variables taken were the following:

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Visual Acuity

During an eye test, ophthalmologists use eye charts to measure how well you see in the distance, compared with other human beings. The standard placement of the eye chart is on a wall that is 20 feet away from your eyes. Vision is considered “normal” when there is a 20/20 vision (or 20/20 visual acuity), that is, a letter can be read at 20 feet.

Corneal Diameter

The corneal diameter (CD) is the limbus-to-limbus distance, and clinically both the horizontal and vertical dimensions are regarded as important.

Corneal Thickness

Corneal thickness measurements are indicative of the metabolic status of the cornea, as they provide an index of corneal hydration. Such measurements give valuable information on the physiological status of the cornea and its changes associated with disease, trauma, and hypoxia.

Axial Length

The axial length is the distance from the corneal surface to an interference peak corresponding to the retinal pigment epithelium. A majority of axial length elongation takes place in the first 3–6 months of life and a gradual reduction of growth over the next 2 years, and by 3 years the adult size is attained.

Retinal Nerve Fiber Layer (RNFL)

Optical coherence tomography is a relatively new noncontact imaging technique that has been developed to assess tissue thickness with micrometer scale sensitivity.

Intraocular Pressure (IOP)

In human eyes in particular, the axial length undergoes daily fluctuations of some 15–40 μm, with a mean period of approximately 21 hours. Although diurnal fluctuations in axial length have been observed in many species, the underlying physiologic control mechanisms are unknown.

Various scans obtained during investigation were shown in Figure 1 and interpreted in Figure 2.

Statistical Analysis

The data obtained were subjected to statistical analysis.

The statistical analysis was done using Statistical Package of Social Science. Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons. Quantitative variables were compared using mean values and qualitative variables using proportions. Significance level was fixed at $p < 0.05$.

Results

Table 1 illustrates descriptive statistics for optical parameters for group I. The mean corneal diameter of the left eye was slightly higher than the right. The mean corneal thickness of the right eye was slightly higher than the left. The mean axial length of the right eye was slightly higher than the left. The mean RNLF of the right eye was slightly higher than the left.

Table 2 illustrates descriptive statistics for optical parameters for group II. The mean corneal diameter of the left eye was slightly higher than the right. The mean corneal thickness of the right eye was slightly higher than the right. The mean corneal diameter of the left eye was slightly higher than the right. The mean RNLF of the right eye was slightly higher than the left.

Table 3: Descriptive statistics for optical parameters for group III

| Parameter         | Minimum | Maximum | Mean   | Std. deviation |
|-------------------|---------|---------|--------|----------------|
| Visual acuity RT  | 0.0000  | 0.5440  | 0.036295 | 0.1019236     |
| Visual acuity LT  | 0.0000  | 0.6990  | 0.043047 | 0.1112065     |
| Corneal diameter RT | 10.99  | 13.58   | 11.8400  | 0.53919       |
| Corneal diameter LT | 11.00  | 12.30   | 11.8708  | 0.37218       |
| Corneal thickness RT | 454    | 590     | 535.98  | 30.178        |
| Corneal thickness LT | 456    | 590     | 536.12  | 31.277        |
| Axial length RT   | 21.73   | 25.10   | 23.5351  | 0.77267       |
| Axial length LT   | 21.50   | 25.15   | 23.5139  | 0.85975       |
| RNLF RT           | 85      | 111     | 95.53   | 8.352         |
| RNLF LT           | 83      | 115     | 93.08   | 7.958         |
| IOP RT            | 10      | 18      | 13.41   | 1.779         |
| IOP LT            | 10      | 16      | 12.88   | 1.752         |
eye was slightly higher than the left. The mean IOP of the right eye was slightly higher than the left.

Table 3 illustrates descriptive statistics for optical parameters for group III. The mean corneal diameter of the left eye was slightly higher than the right. The mean corneal thickness of the left eye was slightly higher than the right. The mean axial length of the right eye was slightly higher than the left. The mean RNLF of the right eye was slightly higher than the left. The mean IOP of the right eye was slightly higher than the left.

Table 4 illustrates the Pearson correlation matrix between dental and optical parameters among group I, which shows negative correlation between visual acuity of the left eye and mandibular plane angle, beta angle, and ANB angle.

Table 5 illustrates the Pearson correlation matrix between dental and optical parameters among group II, which shows positive correlation between visual acuity of the left eye and mandibular plane angle.

Table 6 illustrates the Pearson correlation matrix between dental and optical parameters among group III, which shows no statistically significant correlations between dental and optical parameter correlation to be found. Although there was statistically significant correlation was found within the optical as well as dental parameters.
Eye development is initiated by the master control gene Pax-6, a homeobox gene, and so is the stomatognathic system. The Pax-6 gene locus is a transcription factor for the various genes and growth factors involved in eye formation.

In an immunohistochemical study by Lei, the expression of Pax-6 was seen in various developmental stages of the tooth. At the bud stage and cap stage, Pax-6 was expressed in the central parts of the tooth buds/enamel organs and in the oral epithelia adjacent to the tooth germs.

As the various systems in the body are interconnected to form a single structural unit, a pathological condition in one area can also affect other areas. There are many known correlations between the visual and motor system. The importance of visual function, particularly the paracentral peripheral field of view, in motor coordination, ambulation, and the maintenance of balance has been amply demonstrated. In line with current medical principles, which are moving toward a more holistic view of the human body, this study aims to investigate, in an interdisciplinary manner, the incidence of dental malocclusions together with posture and eye convergence disorders. This study was conducted to determine the clinical association between teeth malocclusions, wrong posture, and ocular convergence disorders. A total of 605 children attending at the 3rd, 4th, and 5th years of seven Genoa primary schools were examined. Each child underwent the following examinations: (i) dental/occlusal,
### Table 4: Pearson correlation matrix between dental and optical parameters among group 1

|        | Age     | Mandibular plane | ANB | Beta | Visual acuity | Corneal diameter | Corneal thickness | Axial length | RNLF | IOP LT | IOP RT |
|--------|---------|------------------|-----|------|---------------|------------------|-------------------|--------------|------|--------|--------|
| Age    | 1       | 0.100            | 0.235| 0.064| 0.205         | 0.132            | 0.118             | 0.211        | 0.172| 0.115  | 0.253  | -0.141 | -0.059 | 0.000 | 0.057 |
| Mandibular plane | 1 | 0.063            | 0.233| 0.271| -0.350*       | -0.271           | -0.126             | 0.104        | 0.092| 0.186  | 0.020  | 0.002  | -0.022 | -0.139 | -0.169 |
| ANB    | 1       | 0.338*           |      |      |               | -0.304*          | -0.094             | 0.023        | 0.049| 0.033  | -0.013 | 0.045  | 0.036  | 0.021 | 0.034 |
| Beta   | 1       | 0.353*           |      |      |               | -0.169           | -0.051             | 0.123        | 0.127| 0.163  | -0.021 | -0.269 | -0.238 | -0.065 | -0.062 |
| Visual acuity | 1 | 0.144            |      |      |               |                 |                   |              |      |        |        |        |        |      |      |
| Visual acuity LT | 1 | -0.065           | 0.010|      | -0.064        | -0.053           | -0.060             | 0.016        | 0.222| 0.302* | 0.006  | -0.038 |        |      |      |
| Corneal diameter RT  | 1 | 0.688**          | 0.274|      | 0.235         | -0.047           | 0.125             | -0.036       | 0.072| 0.570* | 0.592* |        |        |      |      |
| Corneal diameter LT  | 1 | 0.521**          | 0.494**|      | 0.186         | 0.235            | 0.039             | 0.073        | 0.407**| 0.398* |        |        |        |      |      |
| Corneal thickness RT  | 1 | 0.974**          | 0.373**|      | 0.015         | 0.025            | 0.437**           | 0.340*       |        |        |        |        |        |      |      |
| Corneal thickness LT  | 1 | -0.054           | 0.306*|      | -0.057        | -0.049           | 0.389**           | 0.308*       |        |        |        |        |        |      |      |
| Axial length RT       | 1 | 0.530**          | 0.096|      | 0.081         | -0.237           | -0.428**          |             |        |        |        |        |        |      |      |
| Axial length LT       | 1 | 0.099            | 0.222|      | 0.272         | 0.079            |                   |              |        |        |        |        |        |      |      |
| RNLF RT              | 1 | 0.857**          |      |      | 0.126         | -0.043           |                   |              |        |        |        |        |        |      |      |
| RNLF LT              | 1 | 0.246            |      |      | 0.088         |                   |                   |              |        |        |        |        |        |      |      |
| IOP RT               | 1 | 0.901**          |      |      | 0.006         |                   |                   |              |        |        |        |        |        |      |      |
| IOP LT               | 1 | 0.077            |      |      | 0.176         |                   |                   |              |        |        |        |        |        |      |      |

*Highly significant i.e., p value is less than 0.01
**Moderately significant i.e., p value is less than 0.05

### Table 5: Pearson correlation matrix between dental and optical parameters among group 2

|        | Age     | Mandibular plane | ANB | Beta | Visual acuity | Corneal diameter | Corneal thickness | Axial length | RNLF | IOP LT | IOP RT |
|--------|---------|------------------|-----|------|---------------|------------------|-------------------|--------------|------|--------|--------|
| Age    | 1       | -0.036           | -0.109| -0.119| 0.006         | 0.117            | 0.243             | 0.133        | -0.219| -0.034 | -0.190 | -0.276 | 0.167  | 0.290* |
| Mandibular plane | 1 | 0.065            | 0.172| 0.349*| -0.114        | 0.114             | -0.114             | 0.060        | -0.160| 0.176  | 0.172  | 0.175  | 0.169  | 0.164  | 0.117  | 0.156 |
| ANB    | 1       | 0.632**          | -0.085| 0.014| 0.004         | -0.132            | -0.110             | -0.085       | -0.126| 0.043  | 0.087  | 0.032  | 0.025  |        |        |      |
| Beta   | 1       | -0.058           | -0.072| 0.114| -0.004        | -0.132            | -0.110             | -0.085       | -0.126| 0.043  | 0.087  | 0.032  | 0.025  |        |        |      |
| Visual acuity RT | 1 | 0.781**          | 0.368**|      | 0.058         | 0.025             | 0.063             | 0.162        | 0.121| 0.077  | 0.012  | -0.004 | 0.116  |        |        |      |
| Visual acuity LT | 1 | 0.368**          |      |      | 0.029         | -0.012            | 0.006             | 0.211        | 0.224| 0.082  | 0.019  | -0.028 | 0.072  |        |        |      |
| Corneal diameter RT  | 1 | 0.616**          | 0.089|      | 0.119         | 0.118             | 0.266             | -0.134       | -0.126| 0.130  | 0.152  |        |        |        |        |      |
| Corneal diameter LT  | 1 | 0.616**          | 0.089|      | 0.119         | 0.118             | 0.266             | -0.134       | -0.126| 0.130  | 0.152  |        |        |        |        |      |
| Corneal thickness RT  | 1 | 0.971**          |      |      | 0.107         | 0.293*            | -0.141            | -0.258       | 0.460**| 0.450* |        |        |        |        |        |      |
| Corneal thickness LT  | 1 | 0.971**          |      |      | 0.107         | 0.293*            | -0.141            | -0.258       | 0.460**| 0.450* |        |        |        |        |        |      |
| Axial length RT       | 1 | 0.648**          |      |      | 0.011         | -0.129            | 0.012             | 0.061        |        |        |        |        |        |        |        |      |
| Axial length LT       | 1 | -0.010           | 0.052|      | 0.223         | 0.263             |                   |              |        |        |        |        |        |        |        |      |
| RNLF RT              | 1 | 0.862**          |      |      | 0.010         | -0.169            |                   |              |        |        |        |        |        |        |        |      |
| RNLF LT              | 1 | 0.047            |      |      | 0.012         | -0.101            |                   |              |        |        |        |        |        |        |        |      |
| IOP RT               | 1 | 0.883**          |      |      | 0.006         |                   |                   |              |        |        |        |        |        |        |        |      |
| IOP LT               | 1 | 0.883**          |      |      | 0.006         |                   |                   |              |        |        |        |        |        |        |        |      |

*Highly significant i.e., p value is less than 0.01
**Moderately significant i.e., p value is less than 0.05
### Table 6: Pearson correlation matrix between dental and optical parameters among group III

| Age | Mandibular plane ANB | Beta angle | Visual acuity RT | Visual acuity LT | Corneal diameter RT | Corneal diameter LT | Corneal thickness RT | Corneal thickness LT | Axial length RT | Axial length LT | RNLF RT | RNLF LT | IOP RT | IOP LT |
|-----|----------------------|------------|------------------|------------------|--------------------|--------------------|--------------------|--------------------|------------------|----------------|----------|--------|--------|--------|
| Age | 1                    | -0.065     | -0.095           | -0.226           | 0.138              | 0.126              | 0.032              | 0.001              | 0.251            | -0.069       | -0.096   | 0.114   | 0.086   |
| Mandibular plane | 1 | 0.014 | -0.100 | 0.067 | -0.039 | 0.086 | 0.043 | -0.198 | 0.037 | -0.043 | 0.093 | 0.099 | 0.236 | 0.251 |
| ANB | 1 | 0.631** | -0.129 | -0.171 | 0.060 | -0.034 | 0.236 | 0.244 | -0.164 | -0.139 | 0.230 | 0.139 | 0.182 | 0.165 |
| Beta angle | 1 | -0.021 | -0.136 | -0.022 | -0.104 | 0.030 | -0.170 | -0.128 | 0.165 | 0.125 | 0.012 | 0.036 |
| Visual acuity RT | 1 | 0.767** | 0.115 | 0.270 | -0.220 | -0.185 | 0.176 | 0.161 | 0.135 | 0.064 | -0.055 | -0.100 |
| visual acuity LT | 1 | -0.080 | 0.020 | -0.169 | -0.131 | 0.153 | 0.127 | -0.043 | -0.015 | -0.359* | -0.340* |
| Corneal diameter RT | 1 | 0.710** | 0.111 | 0.110 | -0.054 | -0.120 | 0.308* | 0.145 | 0.186 | 0.242 |
| Corneal diameter LT | 1 | -0.024 | -0.060 | 0.118 | 0.160 | 0.100 | -0.127 | 0.208 | 0.108 |
| Corneal thickness RT | 1 | 0.985** | -0.362* | -0.273 | 0.372** | 0.098 | -0.069 | 0.084 |
| Corneal thickness LT | 1 | -0.398** | -0.317* | 0.422** | 0.164 | -0.047 | 0.131 |
| Axial length RT | 1 | 0.946** | -0.262 | -0.194 | -0.157 | -0.161 |
| Axial length LT | 1 | -0.199 | -0.200 | -0.218 | -0.207 |
| RNLF RT | 1 | 0.896** | -0.012 | 0.087 |
| RNLF LT | 1 | -0.105 | 0.004 |
| IOP RT | 1 | 0.866** |
| IOP LT | 1 | | |

*Highly significant i.e., p value is less than 0.01
**Moderately significant i.e., p value is less than 0.05
into consideration in our study. Thus, the visual acuity can serve as a basis for the determination of malocclusion in a horizontal grower.

**Group II: Average Grower**
A positive correlation is seen between the visual acuity of the left eye and the mandibular plane in group II, i.e., average grower. It was observed that by determining the visual acuity in an average grower, it can be assumed that some type of malocclusion may be present.

**Group III: Vertical Grower**
There was no statistically significant correlations between dental and optical parameters in group III. However, there was a statistically significant correlation that was found within the optical as well as dental parameters.

**Conclusion**
Positive correlation was found between visual acuity and mandibular plane angle among the average growth pattern, and negative correlation was found between visual acuity and mandibular plane angle among the horizontal growth pattern. So, correlation is present between dental and eye variables.

Hence, if the patient is referred from an ophthalmologist, then by analyzing the various eye variables and correlating them with the growth pattern of the patient, malocclusion can be forestalled.

In the future, it will serve as an excellent interdisciplinary approach to diagnosis and treatment planning.

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