INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

An Analysis of Corneal Thickness and Retinal Nerve Fibre Layer Thickness in Predicting Skeletal Class I Vs Class II Patterns - A Correlative Study

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OPEN ACCESS

Received: 05-06-2024
Accepted: 03-08-2024
Published: 17-08-2024

Citation: Rastogi S, Goyal M, Kumar M (2024) An Analysis of Corneal Thickness and Retinal Nerve Fibre Layer Thickness in Predicting Skeletal Class I Vs Class II Patterns - A Correlative Study. Indian Journal of Science and Technology 17(32): 3388-3395. https://doi.org/10.17485/IJST/v17i32.1892

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Funding: None

Competing Interests: None

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

Abstract

Objectives: To identify correlation between skeletal Class I and Class II pattern based on corneal thickness and retinal nerve fiber layer thickness. **Methods:** A total of seventy subjects were enrolled in the study with age ranging from 14-20 years. Using five orthodontic parameters (ANB, W, Yen, NA, NB) subjects were equally divided into two groups (Class I , Class II). Eye parameters (Corneal thickness and Retinal nerve fibre layer thickness) of each subject were measured and correlated with each skeletal pattern. Following the compilation of descriptive statistics, a t-test was used to make a comparison between the groups, and then Pearson's correlation was used to analyze the results. $P \leq 0.05$ was used as the level of statistical significance for this study. **Findings:** There was no statistically significant difference in the mean age and gender of the Class I and Class II samples, suggesting that the two groups' demographics were similar. There was no statistically significant difference in comparison between the Corneal thickness & Retinal nerve fibre layer thickness in Skeletal Class I vs Class II subjects. Pearson's Correlation showed no statistically significant association between the eye parameters and Skeletal Class. **Novelty:** This study concludes that there is no association between eye parameters and Skeletal Class pattern based on Corneal thickness and Retinal nerve fibre layer thickness. Further research involving larger sample-size and incorporating more eye parameters are required to understand the relationship between the two systems.

Keywords: Eye; Skeletal Class I; Skeletal Class II; Stomatognathic System; Corneal thickness; Retinal nerve layer thickness

1 Introduction

The face as a whole is work of art whereby its development is derived from multiple sources mainly the ectodermal, mesodermal and neural crest cells derivatives. To name a few parts of the cranial vault, facial bones along with mandible are derivatives from the neural crest cells. Similarly, neural crest cells also contribute to the development of parts of the eye namely- corneal endothelium and stroma, ciliary muscles, pigment of iris and its trabecular meshwork. Surface ectoderm contributes to developing the corneal epithelium, conjunctiva & lens whereas neuroectoderm is responsible for the development of retinal epithelium, epithelium lining of ciliary body & iris, optic nerve[1].

As these two body systems have similar embryonic origin it has been stipulated by Enlow's Counterpart principle that growth of any given facial or cranial part is specifically related to other structural and geometric "counterparts" in the face and cranium. Thus, a balanced growth occurs if the regional part & its counterpart enlarge to the same extent.

Zelinski et al[2,3] provided a comprehensive analysis of the neurological, muscle-fascial, and biochemical pathways between the opthalmic and the stomatognathic system. Their findings strongly support the existence of links between these two systems whereas Ozturk T et al[4] found no link between eye and hair colour, similarly formed craniofacial structures, and sagittal and vertical skeletal malocclusion. Some authors[5,6] found no clinical association between dental malocclusion and hyperopia or strabismus.

As several embryological, neurofunctional, and anatomic correlations between the stomatognathic and oculomotor systems have been proposed. Additionally, visual acuity and Skeletal Class were found to be correlated in our previous study[7], indicating that subjects with Skeletal Class II malocclusion are more likely to develop myopia. This finding prompted us to carry out this further investigation utilizing more opthalmic parameters which are routinely measured as diagnostic test in opthalmic examination in order to confirm the anatomical and clinical link by finding a correlation between the opthalmic and stomatognathic system.

Corneal endothelium and stroma which are components of cornea, are measured through corneal thickness[8] (CT) and Retinal epithelium, a component of retinal nerve fibre layer[9,10], is measured through retinal nerve fibre layer thickness (RNFL). Both CT and RNFL are routinely done opthalmic diagnostic test, and through neural crest cells, both measures share a similar embryonic origin with facial bones.

None of the study done so far has assessed corneal thickness and retinal nerve fiber thickness as variables for the eye parameter in order to determine the correlation between the two systems. Thus, the aim of this study was to find a correlation between eye parameters (Corneal thickness & Retinal nerve fibre layer thickness) and Skeletal Class I vs Class II malocclusion.

2 Methodology

The study was conducted at Teerthanker Dental College and Research Center on 70 subjects aged 17±3.17 years from the Dept. of Orthodontics & Dentofacial Orthopaedics. Before any clinical research was performed, ethical clearance was taken by the Teerthanker Mahaveer Dental College Ethical Committee (TMDCRC/IEC/19-20/PhD1) also the study was registered under Clinical Trial Registry-India before the onset of sample collection (CTRI/2020/07/026624). Informed consent was obtained from all the subjects before any clinical research was conducted.

All subject databases which included Lateral Cephalogram was recorded from the Dept. of Orthodontics.

Inclusion Criteria:

1. Subjects ongoing orthodontic treatment having Skeletal Class I/ Class II Malocclusion
2. Subjects of age group 14 to 20 years.

Exclusion criteria:

1. Subjects with any facial abnormality or condition.
2. Individuals with a prior medical history of Orthodontic, Orthognathic, or Plastic Surgery.
3. Individuals with a prior history of ocular surgery.
4. Individuals with any systemic condition that can impact vision or craniofacial growth.
5. Uncooperative patient.

For each subject, the following cephalometric parameters were used:

- ANB angle- This is an angle formed between the N-A line and the N-B line at point N Figure 1.

Skeletal Class I Malocclusion – 0° to 4°; Class II > 4°

- W angle- Angle formed between the perpendicular line from point M to S-G line and the M-G line Figure 1.

Skeletal Class I – 51° to 56°; Class II<51°

- Yen Angle- Angle formed between two lines S-M & M-G at point M Figure 1.

Skeletal Class I – 117°-123°; Class II < 117°

- Burstone N- A (HP) – Horizontal distance of A to perpendicular from HP through N (N-A) Figure 2. Normal range for Skeletal Class I Malocclusion: -2+3 mm; Class II > 0mm
- Burstone N-B (HP)-Horizontal distance of B to perpendicular from HP through N(N-B) Figure 2. Normal Range for Skeletal Class I Malocclusion: -6.9+4mm; Class II < -10mm

Fig 1. ANB, W, Yen Angle

The subjects were classified into two groups, each consisting of 35 subjects, based on the above variables. A minimum of three orthodontic variables out of five must be present in order for an individual to be classified within a specific Class among the aforementioned variables.

- Group I: Class I skeletal pattern
- Group II: Class II skeletal pattern

The subjects were then referred to the Dept. of Opthalmology at Teerthanker Medical College and Research Centre to obtain various parameters from a qualified Ophthalmologist.

Eye test variables taken were:

1. Corneal Thickness: Measurement of corneal thickness was used to estimate the metabolic status of the cornea. It was measured using a Non-Contact Tonometer/Pachymeter (NT-530P, Nidek Co Ltd; 100-240V; 50/60 Hz; 100VA; Serial no. 331449) Figure 3. Pachymeter (probe) was placed on the front of eye to measure its thickness. The probe's sound waves 'echo' from the posterior cornea. The distance traveled is directly proportional to the time it takes for an echo to reach the detector. The average corneal thickness is 525.2$\pm$38.9nm.

2. Retinal Nerve Fibre Layer Thickness: Optical coherence tomography (OCT) is a noncontact imaging technique that was used to assess tissue thickness with micrometer scale sensitivity Figure 4. Cross-sectional images of the retina Figure 5 obtained with a scanning interferometer allow for precise measurement of ocular tissue thickness, such as that of the retinal nerve fibre layer (RNFL) and neural retina, based on the reflectivities of the retinal layers. The thickness of the retinal nerve fibre layer was measured using low coherence light. The normal RNFL range is 99.4$\pm$9.6 microns.

These ophthalmic variables were then analysed and correlated with orthodontic parameters of the respective subjects.

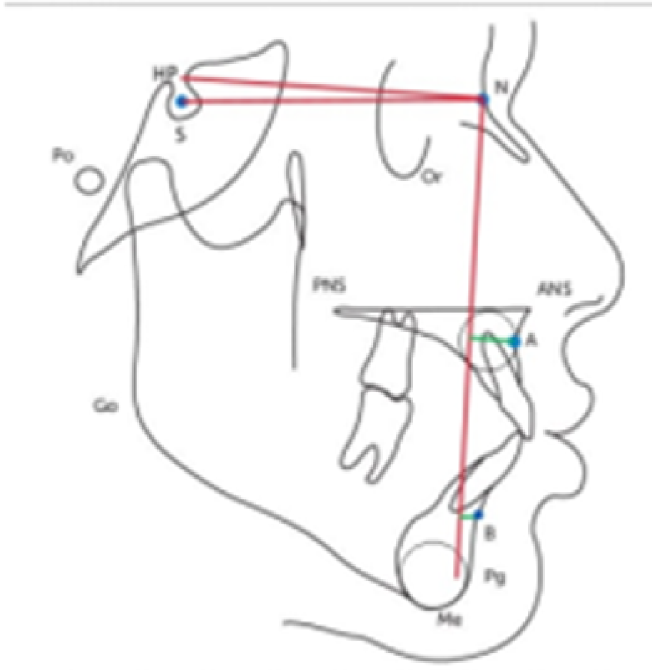

Fig 2. Burstone NA, NB

Fig 3. Non-Contact Tonometer

Fig 4. Optical coherence tomography

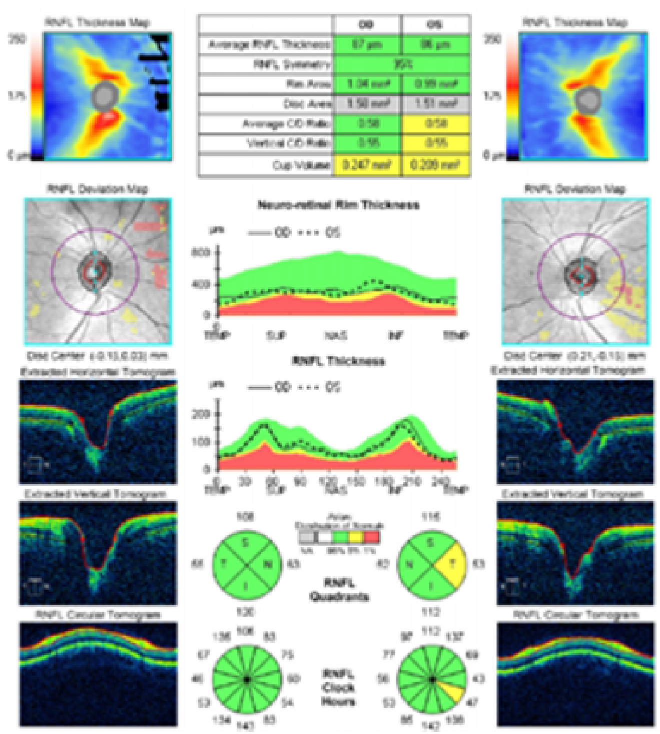

Fig 5. RNFL measured through Optical Coherence Tomography

Statistical analysis

The data was uploaded into Microsoft Excel and analyzed utilizing SPSS package 22.0 for pertinent statistical comparisons. Descriptive statistics were collected and a comparison between the groups was conducted using a t-test. The correlation was evaluated using Pearson's correlation coefficient, which ranges from 0 to 1. The statistical significance level was defined as a p-value of 0.05 or less.

3 Result And Discussion

When age was compared between Class I and Class II samples, the mean difference was -0.74 and this difference was not statistically significant (p>0.05), indicating that the samples for both groups were comparable in terms of age Table 1.

Table 1. Illustrates age wise comparison between Class I and Class II skeletal pattern

	CLASS	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t	df	p
Age	CLASS I	35	17.0000	3.17156	.53609	-.74286	-.892	68	.375
	CLASS II	35	17.7429	3.76784	.63688				

When distribution of participants was done according to Gender it was found that out of 35 participants having Class I 23 (65.7%) were male and 12 (34.3%) were female and this difference in proportion was statistically significant (p<0.05) whereas in Class II 12 (34.3%) were male and 23 (65.7%) were female and this difference in proportion was not statistically significant (p>0.05) Table 2.

Table 2. Gender wise Distribution of Participants

		Frequency	Percent	p
CLASS I	Male	23	65.7	0.91
	Female	12	34.3	
	Total	35	100.0	
CLASS II	Male	12	34.3	0.91
	Female	23	65.7	
	Total	35	100.0	

Mean distribution of angular (ANB, W, Yen Angle) and linear parameters (Burstone NA, NB) of orthodontic variables were calculated is shown in Table 3.

Table 3. Illustrates the mean distribution of angular and linear parameters of ANB, W, Yen, NA, NB

		N	Minimum	Maximum	Mean	Std. Deviation
ANB	CLASS I	35	1.00	4.00	3.0000	1.81497
	CLASS II	35	5.00	11.00	8.0000	1.81497
W	CLASS I	35	47.00	63.00	54.2571	3.35492
	CLASS II	35	39.00	56.00	48.8286	3.72974
Yen	CLASS I	35	114.00	133.00	121.5143	3.74458
	CLASS II	35	100.00	125.00	112.9714	4.89589
NA	CLASS I	35	-7.00	5.00	-1.1429	3.25525
	CLASS II	35	-4.00	12.00	.7714	3.19085
NB	CLASS I	35	-19.00	3.00	-6.1429	5.87689
	CLASS II	35	-21.00	5.00	-11.0286	6.14284

On comparing CT-Rt between Class I vs Class II pattern, mean difference (3.08) was found to be non-significant (p<0.05). Similar findings were seen on comparing CT-Lt between Class I vs Class II pattern with a mean difference (-10.22) which was also non-significant (p<0.05) Table 4.

Table 4. Illustrates comparison of Corneal thickness and retinal nerve fibre length values and Class I vs Class II malocclusion

	CLASS	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t	df	p
CT-Rt	CLASS I	35	545.9429	35.46078	5.99397	3.08571	.364	68	.717
	CLASS II	35	542.8571	35.52476	6.00478				
CT-Lt	CLASS I	35	527.8000	89.70402	15.16275	-10.22857	-.627	68	.533
	CLASS II	35	538.0286	35.61600	6.02020				
RNFL-Rt	CLASS I	35	94.8000	9.47380	1.60136	2.31429	.882	68	.381
	CLASS II	35	92.4857	12.30106	2.07926				
RNLF-Lt	CLASS I	35	94.2286	8.99374	1.52022	-.57143	-.202	68	.840
	CLASS II	35	94.8000	14.10632	2.38440				

The mean difference (2.31) based on RNFL-Rt in Class I vs Class II pattern was determined to be non-significant ($p<0.05$). Comparing RNFL-Lt and Class I vs Class II pattern revealed similar results, with a mean difference (-0.57) that was likewise not statistically significant ($p<0.05$) Table 4.

Pearson's correlation analysis revealed that there was no statistically significant difference ($p>0.05$) between Skeletal Class and CT-Rt (r=-0.119; p=0.328), CT-Lt (r=0.05; p=0.965), RNFL-Rt (r=-0.045; p=0.710), and RNLF-Lt (r=0.056; p=0.64) Table 5.

Table 5. Correlation of ANB with Eye Parameters

		CT-Rt	CT-Lt	RNFL-Rt	RNLF-Lt
Class	Pearson's Correlation Coefficient r	-.119	.005	-.045	.056
	p value	.328	.965	.710	.646

Different scientific methodologies were used to evaluate any potential relationships between the stomatognathic and opthalmic system. Recent study by Zelinski G et al.[2,3] emphasised that stomatognathic system and the organ of vision are connected neurologically, biochemically, and fascially. Several studies[11,12] have shown that the growth factors and genes responsible for eye development also have a notable impact on the development of the stomatognathic system. Pax-6 functions as a "master control" gene for the development of the eyes. In addition to being expressed in the central areas of the tooth buds and enamel organs, it is also expressed in the oral epithelium next to the tooth germs during the bud and cap stages.

Ochi S et al[12] discussed the significance of Pax-6 in the development of human neuroectoderm tissue, which plays a critical role in the production of the lens, corneal epithelium, and retinal neuroepithelium. This gene is also found to be vital for the development of parts of teeth and facial bones[13]. This also emphasized us to conduct this study to find the association between two systems on the basis of various opthalmic parameters.

Few studies compared visual defect to malocclusion[14,15].Our previous study[7] shows that based on comparison between ANB angle and Visual acuity, subjects having Skeletal Class II malocclusion were more prone to develop myopia whereas in this study no such correlation was seen based on corneal thickness and retinal nerve fibre layer thickness. Caruso et al.[16] found that individuals with a second molar class have a higher occurrence of exodeviations. Additionally, there was a statistically significant increase in the percentage of individuals with fusional amplitudes showing convergence below the cut-off value.

A study conducted by Ozturk T et al.[4] did not find any correlation between skeletal malocclusion and hair or eye color, which is similar to our findings. A correlation between molar class modifications and convergence or ocular motility deficits was not found by some authors[14,17]. However, it should be noted that the study did not focus on a specific type of defect but rather used the presence or absence of all types of convergence or ocular motility defects as its criterion. Our results are consistent with those of Gupta G et al.[18], who likewise discovered no association between the thickness of the corneal/retinal nerve fiber layer and the divergence of the skeletal Class I pattern.

The prevalence of malocclusion in the Indian population varied from 28.4% to 66.7%, as recorded by several indexes or classifications[19]. Contrarily, according to WHO estimates, there were 19 million visually impaired children under the age of 15 and 1.4 million with irreversible blindness when the Vision 2020 program began. Half of these incidents could have been avoided[20]. We must immediately address these two extremely common disorders. If we can establish connections between the two systems, it will be a crucial tool for early diagnosis and treatment planning for Opthalmologists and Orthodontists.

Limitation of this study are the limited sample size, which was restricted to a certain geographical area, and the difficulty to establish a cause-and-effect link based on the data that was provided. In order to overcome these limitations, additional research that incorporates a greater number of variables on a larger scale is required. In the future, ophthalmologists and orthodontists need to look for such association in order to improve the diagnostic accuracy and therapeutic solutions. Therefore, employing a multidisciplinary proactive strategy seeks to facilitate the identification and resolution of various challenges in a streamlined manner.

4 Conclusion

This study is one of the first of its kind in which the two commonly used diagnostic tests—corneal thickness and retinal nerve fiber thickness—were utilized to evaluate the association between the skeletal pattern and the eye. This study concludes that there was no statistically significant correlation seen in relation to Corneal thickness [CT-Rt (r= -0.119; p= 0.328), CT-Lt (r= 0.05; p= 0.965] and Retinal nerve fibre layer thickness [RNFL-Rt (r= -0.045; p= 0.710), and RNLF-Lt (r= 0.056; p= 0.64)] in Skeletal Class I vs Class II subjects. However, correlation is not a definitive conclusion to a malocclusion, further research on larger sample size including more variables is needed to determine the relationship. Future diagnostic precision and treatment options will benefit greatly from increased understanding of this relationship between orthodontists and ophthalmologists.

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