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Association of symphyseal morphology with lower incisor inclination in sagittal and vertical growth patterns

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Abstract

Introduction: The dimensions of mandibular symphysis sets limitations to the amount of possible lower incisor movements and restricting orthodontic tooth movements within these boundaries being crucial for optimal results. Hence the purpose of this study was to determine significance of symphyseal morphology and lower incisor position in Class I, Class II, Class III malocclusions and facial patterns.

Material and Methods: Pretreatment Lateral Cephalograms of three hundred patients (aged 18 years and above) were taken and they were classified into skeletal malocclusions (n= 50 each of Class I, II and III) and vertical facial patterns (n=50 each of low, normal and high angle). Computer aided descriptive statistical analysis was performed using the SPSS 17.0 software.

Results: The correlation between symphyseal height and width with lower incisor inclination proved significant in sagittal and vertical growth patterns.

Conclusions: It can be suggested from this study that symphyseal morphology and lower incisor position is correlated to sagittal and vertical growth patterns. The biological limits of tooth movement in a narrow symphysis, usually associated with high angle cases and Class III cases, have unfavorable outcome.

Keywords: Anterior alveolar dimension; incisor inclination; facial patterns; malocclusions

Introduction

The dimension of mandibular symphysis sets limitation to the amount of possible lower incisor movement and restricting orthodontic tooth movements within these boundaries being crucial for optimal results.[1,2] It is important to assess the limits of tooth movement at the beginning of the treatment.[1,3] However, neglecting these cortical boundaries particularly where maximum retraction or protraction is required, dental movements may lead to complications such as root dehiscence, fenestration, root resorption or gingival recession.[1,4,5] Previous studies have also shown that different mandibular symphyseal morphology is associated with different growth patterns.[3,6] The goal of this study was to assess the statistical variations in dimension of the symphysis in skeletal malocclusions i.e. Class I, II and III and in vertical facial patterns i.e. low, normal and high angle cases. Therefore, the hypothesis of the present study was that anterior mandibular alveolar height is high and alveolar width is narrow in high angle patients whereas symphyseal width increases with increase in incisor inclination.

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Material and Methods

This is a retrospective study conducted at the Department of Orthodontics, Islamic

International Dental Hospital, Islamabad. The pre-treatment cephalometric records were collected (n= 300) and divided into six groups according to vertical patterns: low, normal and high angle (n=50 each) and sagittal patterns i.e. Class I, II and III (n=50 each). The data was taken from archived records of the Department of Orthodontics taken between November 2017 to February 2018.

Patients aged 18 years and above with no previous orthodontic treatment and craniofacial anomaly were included in the sample. Patients with missing lower incisors or impacted lower canines, having facial asymmetry and those with molar relationship not established were excluded from the study. The Lateral Cephalograms were traced manually. The cephalometric analysis including four angular and three linear measurements were compiled. The angular measurements comprised of ANB, Mandibular to Maxillary plane angle (MMA), SN to Mandibular plane angle (SNMP) and Lower Incisor to Mandibular plane angle (IMPA). The linear measurements taken were Hold-away ratio, Jaraback's ratio and Mandibular anterior alveolar width and height. MMA, SNMP and Jaraback's ratio were used to categorize normal, low and high angle cases. ANB measurement was used to categorize Class I, Class II and Class III cases. Alveolar height was measured from the root apex of the lower incisor to Menton (Me) on mandibular plane (Figure 1). For alveolar width, a parallel line was constructed to the occlusal plane which passed through the root apex of the mandibular incisor. The distance from outer to inner border of alveolar boundary was measured to attain the width of the symphysis (Figure 2). Incisor inclination was evaluated by measuring the Lower incisor to Mandibular plane angle (Figure 1) and Hold-away ratio. All measurements were cross checked for reproducibility and errors.

Statistical analysis was made with the help of SPSS 17.0 and presented in the form of tables. One-way ANOVA and Tukey's HSD Test for multiple comparisons was applied to establish the significance between the variables.

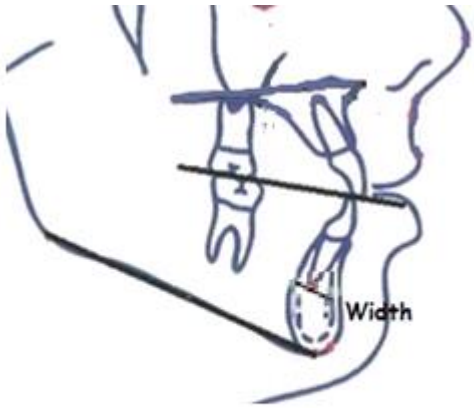

Figure 2: Measurement of symphyseal width

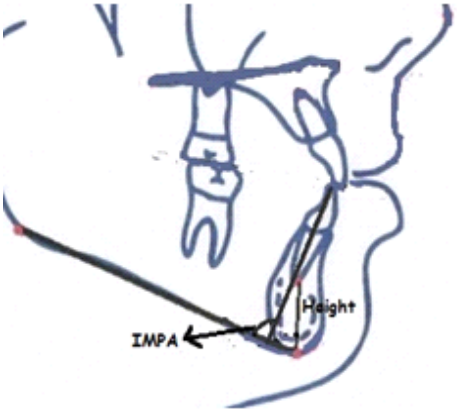

Figure 1: Measurement of IMPA and Symphyseal height

Results

Various comparisons were made to correlate the incisor inclination with sagittal and vertical growth planes in the first step. In the second step, symphyseal height and width were compared in antero-posterior and vertical growth patterns. The comparisons were made by using one-way ANOVA to correlate the incisal inclination, symphyseal width and height in sagittal and vertical growth planes. Post-Hoc Tukey's HSD test was applied to compare the results between the subsets. The mean value of IMPA, symphyseal height and width are graphically represented in figure 3.

An increased value of IMPA was statistically associated with Class I and Class II growth patterns whereas, Class III sagittal growth patterns revealed decreased IMPA (87.0 ± 9.58 mm, Table I). The statistical tests revealed correlation between incisor inclination with sagittal Class I and III (p-value 0.00) and also between Class II and III (p-value 0.00, Table II). The width of the mandibular symphysis of the patients with Class III revealed a statistically significant decrease (7.20 ± 2.50 mm) as compared to Class I (9.02 ±2.56 mm) and Class II (8.36 ± 2.33 mm) patients. The mean differences between Class I and Class III (p-value 0.001) and Class II and Class III (p-value 0.04) were found to be statistically significant.

	Class	Mean± SD
Incisal Inclination	Class I	100.10 ± 10.65
	Class II	102.8 ± 10.25
	Class III	87.00 ± 9.58
Symphyseal Height	Class I	19.84 ± 14.82
	Class II	19.36 ± 3.69
	Class III	14.90 ± 3.21
Symphyseal Width	Class I	9.02 ± 2.56
	Class II	8.36 ± 2.33
	Class III	7.20 ± 2.50

Table 1: Mean value of incisal inclination, symphyseal height and width in sagittal growth pattern

The analysis of the symphyseal height in sagittal growth patterns showed a significant increase in the symphyseal height in Class I (19.84 ± 14.82 mm) and a decrease in Class III (14.90 ± 3.21mm) cases. Comparison of Class I with Class III (p-value 0.019) and that of Class II and Class III showed significant mean difference (p-value 0.038).

These results can help us conclude that the Class III cases were found to be associated with decreased height and width of the mandibular symphysis and retroclined lower incisors. Class I and II cases were found to have increased height and width and proclined lower incisors.

The mean value of incisal inclination in low, normal and high angle cases were found to be 100.14 ± 13.49, 97.66 ± 9.15 and 95.62± 8.57 respectively (Table III). The Post Hoc Tukey's test revealed that the mean difference between the vertical growth patterns and IMPA were statistically insignificant.

Variable	Vertical Class	Comparison Class	Mean Difference (SD)	P Value
Incisal Inclination	Class I	Class II	-2.720	0.377
		Class III	13.100	0.000*
	Class II	Class III	15.820	0.000*
Symphyseal Width	Class I	Class II	0.660	0.357
		Class III	1.820	0.001*
	Class II	Class III	1.160	0.044*
Symphyseal Height	Class I	Class II	0.480	0.962
		Class III	4.940	0.019*
	Class II	Class III	4.460	0.038*

Table 2: Relation of incisal inclination, symphyseal width and symphyseal height in sagittal growth patterns

Variable	Class	Mean ± SD
Incisal Inclination	Low angle	100.14 ± 13.49
	Normal angle	97.66 ± 9.15
	High angle	95.62± 8.57
Symphyseal Height	Low angle	16.42 ± 3.94
	Normal angle	18.02 ± 3.62
	High angle	21.44 ± 14.66
Symphyseal Width	Low angle	9.82 ± 2.38
	Normal angle	8.42 ± 1.76
	High angle	7.04 ± 1.87

Table 3: Mean values of incisal inclination, symphyseal height and width in vertical growth patterns

High angle cases presented with increased symphyseal height (21.44 ± 14.66 mm) as compared to low (16.42 ± 3.94 mm) and normal (18.02 ± 3.62 mm) angle cases. However, the mean difference between high and low angle cases was found statistically significant (p-value 0.017).

Symphyseal width was found more in low angle cases (9.82 ± 2.38 mm) as compared to those of normal (8.42 ± 1.76 mm) and high (7.04 ± 1.87 mm) angle cases. The mean difference between the symphyseal widths of all growth patterns was statistically significant (Table IV).

Variable	Vertical Class	Comparison Class	Mean Difference (SD)	P Value
Incisal Inclination	Low angle	Normal angle	2.480	0.475
		High angle	4.520	0.088
	Normal angle	High angle	2.040	0.604
Symphyseal Width	Low angle	Normal angle	1.400	0.002*
		High angle	2.780	0.000*
	Normal angle	High angle	1.380	0.002*
Symphyseal Height	Low angle	Normal angle	-1.600	0.649
		High angle	-5.020	0.017*
	Normal angle	High angle	-3.420	0.143

Table 4: Comparison of incisal inclination, Symphyseal height and width in vertical growth patterns

There was no difference in incisal inclination among low, normal and high angle cases. The width of the symphysis, however, increased in low angle cases and reduced in high angle cases. The height of mandibular symphysis increased and the width of the symphysis and incisal inclination decreased in patients with high vertical growth pattern.

Discussion

Size and shape of mandibular symphysis provides valuable information about the amount of orthodontic tooth movements that can be carried out within the biological limits safely.[1-4,7-13] However, a good diagnosis should also take into consideration the soft tissue surrounding the dentition, since the orthodontists ultimately assess both occlusal and esthetic criteria during treatment planning.[7] In this study, we made use of the pre-treatment lateral Cephalograms to assess the cortical dimensions of the symphysis and correlated them with the lower incisor inclination. This correlation was assessed on the basis of different vertical growth patterns i.e. high, normal and low angle patients and sagittal growth patterns i.e. Class I, II and III patients separately. The mandibular dimensions taken were height from the root apex to the bony Menton (Me) and width taken parallel to the functional occlusal plane at the level of the root apex. The pre-treatment Cephalograms of patients aged 18 years and above were used to ensure the completion of mandibular growth.[14]

Yolanda et al. correlated the mandibular symphysis using different measurements in relation to skeletal class, vertical growth pattern and lower incisor inclination.[11] The study was carried out on 3-dimensional radiographs and the measurements employed in Yolanda's study were very different to those of ours due to which these studies are not comparable. Nevertheless, one comparable conclusion made in Yolanda's study was that as incisor inclination increases, symphyseal height increases as well. This conclusion correlates to the Class I and II cases.

According to the present study, greater differences were observed between Class III patients as compared to the Class I and II. Retrusive lower incisors with short and narrow mandibular symphysis were observed in patients with Class III as compared to Class I and II cases. Lesser differences were observed between the mandibular dimensions and incisor inclination of Class I and II patients.

The incisor inclinations in Class II and III cases i.e. proclined and retroclined respectively, depict the dentoalveolar compensatory mechanism to stabilize the occlusion.[4,9,12,15]

The analysis of the vertical growth pattern showed that patients with high angle presented with a long and narrow symphysis when compared with normal and low angle cases. And lesser differences were observed between normal and low angle patients.

The results were consistent with studies of Handelman[1] which stated that a thin alveolus is frequently encountered in patients with long lower facial height and severe bi-maxillary proclination. Manea et al. found a positive correlation between the incisor inclination and the width of the symphysis, showing a relationship in the facial growth patterns.[16]

According to Ponraj,[8] low angle subjects mostly have thicker symphysis and reduced alveolar height whereas it's opposite in high

angle subjects. Bjork[17] has reported that high angle patients generally have a narrow and elongated morphology of mandibular symphysis.

Aki et al.[13] Ricketts[14] and Gracco et al.[18] concluded in their studies that in low angle cases, the mandibular cortical dimensions are smaller in height and larger in width.

Artun and Krogstad[5] indicated that excessive proclination of mandibular incisors in a thin alveolar housing may lead to periodontal damage. Moreover, Wehrbein[13] concluded that there are increased chances that minor bone dehiscence might already be present in a narrow symphysis which leads us to believe that caution must be exercised before performing any labial orthodontic tooth movements in such cases.

Baysal et al. reported that the range of movement of lower incisors should be limited in high angle patients as compared to normal or low angled patients.[4]

Therefore, the amount of tooth movement in high angle cases beyond their limit should be avoided as it would lead to bone resorption, dehiscence, periodontal defects and other iatrogenic effects.[1,5-7,14,15,17-19]

Hence, the biological safe limits for orthodontic movement of teeth are of paramount importance for preventing undesirable effects on the mandibular anterior alveolar bone.

The use of 2-dimensional radiological assessment is the main limitation of the present study as a lateral Cephalogram does not provide very accurate measurement of the symphysis due to divergence of X-rays. According to some reports, Lateral Cephalograms underestimate the actual dimensions of bone.[20,21]

Conclusions

Lower incisor inclination correlated with sagittal and vertical growth patterns. Symphyseal height and width also correlated with skeletal class and vertical growth patterns. This study reveals that anterior alveolar mandibular bone and lower incisor position is different between patients with high and low angles and Class II and III skeletal patterns. High angle cases have narrow and elongated symphysis whereas low angle cases have wider and shorter symphysis. Class I and II cases present with proclined lower incisors, high symphyseal heights and wider widths. However, Class III cases presented with retroclined lower incisors and decreased symphyseal height and width.

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