THE DIFFERENCES OF SYMPHYSIS MORPHOLOGY IN CLASS II MALOCLUSIONS WITH DIFFERENT VERTICAL GROWTH PATTERN

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ABSTRACT

Background and Aim: The aim of this study was to investigate the morphologic differences of the symphysis among untreated Class II groups that were segregated according to vertical type as hypo-, normo- and hyperdivergent and Class I normal controls.

Subjects and Methods: The study consisted of 132 subjects (99 were as Class II Division 1 malocclusion while 33 were as normal Class I and used as the control group). The Class II Division 1 study group included subjects who had ANB angles greater than 4° with an overjet equal or greater than 5 mm. Based on their SN/GoGn angle, subjects were divided into three different rotation models as Hypodivergent, Normodivergent and Hyperdivergent. Variance analysis (ANOVA) was used to assess the presence of differences between groups (p<0.05).

Results: There were no significant differences for the measurement of upper (Idp-Ida) and middle (B'-B) width of the symphysis. The lower symphyseal width measurement (Pg'-Pg) was statistically shorter in hyperdivergent Class II subjects compared with all other groups (p<0.05). All Class II groups displayed greater upper symphyseal height (Ido-Bo) than control group. The inclination of symphysis (Ido-Bo-Me) was shown significantly more steep in hypodivergent Class II group.

Conclusions: An association was found between the symphysis inclination and vertical dimension. The inclination was more steep in hypo-Cl II group while more obtuse in hyper-Cl II group. The symphysis was inclined more forward according to mandibular base in all Class II subjects than control.

Key words: Class II Malocclusion, Mandibular Symphysis Morphology, Vertical Dimension.
FARKLI VERTİKAL BÜYÜME PATERNLİ SINIF II MALOKLUZYONLARDA SİMFİZİS MORFOLOJİSİNDEKİ FARKLILIKLAR

ÖZET

Amaç: Bu çalışmanın amacı, vertikal tipe göre hipo-, normo- ve hiperdiverjan olarak sınıflandırılan tedavi edilmemiş Sınıf II gruplarda ve Sınıf I normal kontrollerde simfizisin morfolojik farklılıklarını araştırmaktır.

Bireyler ve Yöntem: Çalışmaya 132 birey dahil edilmiştir (99'u Sınıf II Divizyon 1 malokluzyon, 33'ü normal Sınıf I kontrol). Sınıf II Divizyon 1 grubunda, ANB açısı 4°’den büyük olan ve 5 mm den daha fazla overjeti bulunan bireyler yer almıştır. SN/GoGn açılırlarına bağlı olarak, bireyler Hipodiverjan, Normodiverjan ve Hiperdiverjan olmak üzere üç farklı rotasyon modeli grubuna ayrılmışlardır. Gruplar arasındaki farklılıkları belirleyebilmek için Varyans Analizi (ANOVA) kullanılmıştır (p<0.05).

Bulgular: Simfizisin üst (Idp-Ida) ve orta (B'-B) genişlikleri arasında bir fark bulunmamıştır. Alt simfiz genişliği (Pg'-Pg), hipodiverjan Sınıf II bireylerde diğer tüm gruplardan anlamlı düzeyde kısa bulunmuştur (p<0.05). Tüm Sınıf II bireyler, kontrollere göre daha büyük üst simfiz uzunluğu (Ido-Bo) göstermiştir. Simfizis eğiminin (Ido-Bo-Me), hipodiverjan Sınıf II’lerde azalmış olduğu görülmüştür.


Anahtar Kelimeler: Mandibular Simfizis Morfoloji, Sınıf II Malokluzyon, Vertikal Boyut

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INTRODUCTION

The importance of mandibular symphysis starts at the embryonic stages, both symphyseal and condylar elements contain a growth plate like structure and undergo endochondral bone formation.\(^1\)\(^2\)

Mandibular symphysis serves as a center for anterior growth of the early developing mandible in the intrauterine life of mammals.\(^1\)\(^2\) The symphysis remains unfused throughout life in most mammalian species and functions as a joint, it has shown that cartilaginous tissues are transiently present and closely associated with Meckel’s cartilage and alveolar ridge.\(^2\) The symphysis is also characterized as a growth zone, active in mandibular growth in width as well as in length, during the first half of the prenatal period, and the knowledge of mandibular growth is highly beneficial in diagnosis and treatment planning.\(^2\)\(^4\) Enlow\(^1\) noted that symphysis is one of the most variable areas in the entire mandible as seen among the different basic facial types and patterns.

Class II malocclusion is a common clinical finding in dentofacial orthopedics. Prevalence rates have been found to range from 15-38% in a North American population,\(^4\) from 13-25% in European populations,\(^5\)\(^6\) from 3-5% in an Asian population.\(^5\) Class II malocclusions are characterized by a retrognathic mandible or a prognathic maxilla with variable vertical dimensions.\(^7\)\(^8\) Excessive vertical development were emphasized in Class II malocclusions by numerous research groups.\(^7\)\(^8\)\(^10\) Schudy\(^10\) focused on the term facial divergence and two extremes of it would be hypodivergence and hyperdivergence. Although various measurements have been used to classify vertical divergence of malocclusion, mandibular plane angle is one of the basic parameter.\(^9\)\(^10\)\(^11\) There is an obvious correlation between mandibular growth rotation and the symphysis morphology, which have been shown by several research groups.\(^4\)\(^12\)\(^14\) Björk and Skieller\(^12\) with their longitudinal implant studies have described remodeling pattern of forward rotating mandibles with apposition below the symphysis and an increasing in thickness by apposition at its posterior surface. In backward rotating cases, apposition has been seen at the anterior surface and resorption at the lower surface of the symphysis with apposition at its inner surface. Similarly Ricketts\(^13\) stated that symphysis morphology may be used to predict the direction of mandibular growth. Björk\(^14\) also defined the inclination of symphysis is one of the seven signs for identification of the mandibular growth. Song and Wu\(^15\) showed a decreasing at the apex and B point surface of the symphysis after the retraction of lower incisor. Protrusion of the incisors is esthetically acceptable in patients with larger symphysis and denoted that in these cases are more suitable for nonextraction treatment approach.\(^4\)

Although numerous studies have been achieved the importance of symphysis morphology to predict the direction of mandibular growth and for diagnosis and treatment planning. There are still a limited number of comparable researches on the symphysis morphologic differences in untreated Class II subject according to vertical divergency as hypo-, normo- and hyperdivergent. The purpose of this study was to investigate the morphologic differences of the symphysis among untreated Class II groups which were segregated according to vertical type as hypo-, normo- and hyperdivergent (classified according to mandibular plane inclinations) and Class I normal controls.

SUBJECTS AND METHODS

The archive files of the Department of Orthodontics at the University of Ankara were searched for records of orthodontically untreated subjects with either Class II malocclusions or Class I normal subjects. All patients and/or parents gave written informed consent prior to collection of their material. The search identified a total of 132 subjects having lateral head and hand-wrist radiographs. None of these subjects had congenitally missing teeth, obvious facial asymmetry.

These 132 samples were divided into four groups of 33 subjects. Three of the four groups were resolved as Class II study groups according to the hypodivergent, normodivergent, and hyperdivergent mandibular rotation types respectively. The forth group comprised the Class I control group (Table 1).

Class II groups

Cases with untreated Class II malocclusions were 99 (68 females, 31 males) Caucasian subjects divided into three subgroups according to their vertical morphology (MP-SN angle) as: Hypodivergent (MP-SN angle ≤27\(^\circ\)); Normodivergent (28\(^\circ\) to 37\(^\circ\)), and Hyperdivergent (≥38\(^\circ\)).\(^9\)\(^10\)\(^16\)\(^18\)

The parameter MP was defined as a line drawn from gnathion (Gn) to the inferior border of the angular area of the mandible.\(^16\)\(^17\) These 99 Class II subjects were diagnosed according to whether they exhibited Class II molar relationship, excessive overjet (≥5 mm) and an ANB (point
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A-nasion-point B) angle greater than 4° (Table 1).
It is planned to have an overjet value above the 5 mm in addition to other inclusion criteria for hypodivergent Class II group. The purpose of these criteria was to avoid hypodivergent Class II Division 1 subjects from Class II Division 2 morphology.

Class I Control Group

Data obtained from the 33 (15 females, 18 males) normal Class I subjects were used as control group. The individuals were segregated by age and skeletal maturation period. All subjects had Class I molar and canine relationship, with less than 3 mm of crowding and no gross asymmetries in the dental arches and ANB angles of 0-4°

Each subject was assigned a skeletal maturation stage and this was compared with standard plates of Greulich and Pyle methodologies and samples were further divided into groups based on the skeletal development stages as: Prepubertal (PP2=, MP3= and S); Pubertal (MP3cap and DP3u), and Postpubertal (PP3u, MP3u and Ru). All subjects were balanced according to skeletal development stages utilizing a hand-wrist radiographic criteria with the aim that even Class II groups and the control group had similar numbers of individuals in all 3 stages of skeletal maturations (prepubertal, pubertal, postpubertal) to obtain homogeneity among all groups (Table 1).

Symphysis methodology

For the determination of symphysis morphology, five traditional and five relative landmarks were identified and digitized. These landmarks were described in Figure 1. The landmarks chosen divided the symphysis into seven linear parts and a geometric shape of it formed by the seven parts (Figure 1). To measure the height and inclination of the symphysis, two relative points (Ido and Bo) was defined. Ido represent the top of the symphysis and positioned at midpoint of Idp-Ida line. Due to the determination of Bo point, B’ point was created primarily. B’-B line was generated as parallel to Idp-Ida line and Bo point positioned at midpoint of this line (Figure 1).

The height of symphysis was defined as the superior (Ido-Bo) inferior (Bo-Me) and total (Ido-Bo+Bo-Me) dimensions. The inclination of symphysis was defined as the angle Ido-Bo-Me. The width of the symphysis was defined as superior (Idp-Ida), middle (B’-B), and lower (Pg’-Pg) dimensions (Figure 1).

Statistical Method

All statistical analyses were performed using the SPSS software package (Version 12.0.1, SPSS Inc, Chicago, Ill).

Figure 1. a. The definition of the landmarks (Ida Infradentale anterior; the highest anterior point of alveolar bone, Idp Infradentale posterior; the highest posterior point of alveolar bone, Ido Infradentale midpoint; the midpoint of Ida-Idp line B point B’; the intersection point of B-B’ line as parallel to Ida-Idp line on the posterior surface of the symphysis, Bo; the midpoint of B-B’ line, Pg; Pogonion, Pg’; the most prominent point of posterior symphysis, Gn; gnathion, Me; menthon). b. Linear measurements. c. Angular measurements.
SymphyS i S  morphology in ClaSS  ii  m alo CC lu S ion S

Variance analysis (ANOVA) was used to determine the differences within groups. In addition, the Duncan test was applied to investigate the differences between groups.

Method Error

An error analysis exercise was carried out using 66 randomly selected radiographs, which were retraced after an interval of several days. Systematic bias was examined using SPSS software reliability analysis and intraclass correlation coefficients (ICCs) were assessed.

RESULTS

The ICCs of variation between the parameters were found to be greater than 0.902, indicating a good correlation. All descriptive statistics are summarized in Table 2.

In total 17 of the 22 cephalometric measurements showed significant differences (p<0.05 and p<0.01). The angular measurements of B'-Pg'-Me, B-Ida-Idp and Idp-Pg'-Me did not show any statistically significant differences in all groups. Similarly, in all sample, there was no significant differences for the measurement of upper (Idp-Ida) and middle (B'-B) width of the symphysis (Figure 2). However, the lower symphyseal width measurement (Pg'-Pg) was statistically shorter in hyperdivergent Class II subjects compared with all other groups (p<0.05), (Table 2).

All Class II groups displayed greater upper symphyseal height (Ido-Bo) than control group. However this difference was statistically insignificant between hypodivergent Class II and control group. Hyperdivergent Class II group exhibited significantly greater total symphyseal height (Ido-Bo+Bo-Me) among all Class II subjects while it was similar and insignificant compared with control group. Upper symphyseal height (Ido-Bo) was highly greater in hyperdivergent Class II subjects (p<0.01), whilst the lower height of symphysis was significantly shorter in the same group (Table 2).

Hypodivergent Class II group had significantly steep symphysial inclination (Ido-Bo-Me). In addition, in hyperdivergent Class II subjects inclination angle was found to be more flat which was statistically significant only compared with hypodivergent Class II group.

The mean linear and angular values for each symphyseal measurement were plotted in an X and Y reference plane and a superimposition of these geometric shapes are presented in Figure 3.

DISCUSSION

The Class II subjects’ data was divided into hypo-, normo-, and hyperdivergent according to mandibular plane angle for each of the symphyseal measurements. Individuals in the control group were all in Class I normal subjects and were not allocated vertical classification such as hypo-, normo-, and hyperdivergent. The MP-SN (SN/GoGn) angles in the control group ranged from 24º to 40º (Table 1) the mean angle was 31.81º which confirms that the control group was statistically within the normal range (Table 2).

The current study is a second part of a previous published report. Similarly as described in the previous study, there were some limitations due to the number of subjects and on account of sexual dimorphism. Significant craniofacial size differences that especially includes mandibular lengths between males and females have been reported by several researches. Buschang et al. stated that sexual dimorphism in mandibular size favouring males could be temporarily confounded in early years by the earlier growth spurt of females, given that male proportions are larger than their female counterparts. It is underlined that sexual dimorphism should be taken into account for a cephalometric study. However, in the current study, because of the lack of appropriate archive data, it was not possible to segregate the groups according to sex and maturation stage. Therefore, it was decided to include as many patients

<table>
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<tr>
<th></th>
<th>Total (n)</th>
<th>ANB</th>
<th>MP-SN</th>
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<td>≤27°</td>
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<td>28° to 37°</td>
<td>21</td>
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<td>12</td>
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<td>&gt;4°</td>
<td>≥38°</td>
<td>22</td>
<td>11</td>
<td>12</td>
</tr>
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<td>33</td>
<td>0° to 4°</td>
<td>24° to 40°</td>
<td>15</td>
<td>18</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 1. Group descriptions.

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as could be found to fit the study selection criteria. Thus, there was a mixture of sexes in different stages of puberty which may present a bias in the study. An attempt was made to overcome this bias with the evaluation of skeletal maturation stages of the subjects using hand-wrist radiographs which were matched in all groups.\textsuperscript{20}

Consideration of the symphysis morphology is an important factor in evaluation of diagnosis and treatment planning. It is shown that the height and width of the symphysis are factors that affect treatment plan.\textsuperscript{2, 28} Czarnecki et al.\textsuperscript{28} demonstrated that a larger chin morphology with a combination of other facial elements such as lip and nose are admissible for harmonizing the face. A wider symphysis may be more compatible with more protrusion of the incisor. On the contrary, in cases that have a narrower symphysisal width and a small chin, the extraction treatment plan should be taken into account because of limited incisor protrusion and to compensate for arch length discrepancies.\textsuperscript{4, 28}

The current results revealed that ANB, Pg'-Me-Pg, and Me-Pg-B angles, and B'-Pg', Me-Pg and Pg-B lengths were similar and statistically not significant within all Class II groups (Figure 2). However, these measurements were significantly different between the Class II and control groups when compared. In addition, the angular measurements of B'-Pg'-Me, B-Ida-Idp, and IdpPg'Me and the linear measurements of B'-B, and Idp-Ida (upper symphysisal widths) were not significant among all groups (Figure 2). As is shown in Figure 2, the morphologic similarities within Class II groups were appeared especially in the lower half of the symphysis (below the line B'-B), while the similarities between Class II and the control subjects were shown in the upper half of the symphysis (above the line B'-B).

The upper widths of the symphysis (Idp-Ida and B'-B) were similar in all groups, while lower symphysisal width (Pg'-Pg) was shorter only in hyper-Cl II group. This result was in line with Aki et al.'s.\textsuperscript{4}

Buschang and co-workers\textsuperscript{29} reported in their longitudinal study that between 6 and 15 years old of age, the vertical growth changes were most pronounced in the upper half of the symphysis. Endo et al.\textsuperscript{30} pointed out importance of the absence of the mandibular incisor on the symphysisal morphology, whose findings indicated that congenitally missing mandibular incisor subjects exhibited a significantly smaller mandibular symphysis area than the normal subjects. Both Buschang et al.\textsuperscript{29} and Endo et al.\textsuperscript{30} concluded that the critical role of the alveolar segment on the continuous growth of the mandibular symphysis, resulting in an increase in the height of the mandibular body. The findings of the vertical differences of the present study were greater for hyper-Cl II subject in the upper half of the symphysis (Ido-B0), besides hypo-Cl II group exhibited smaller upper symphysisal height (Figure 3). Current hyper-Cl II subjects had no open-bite, this can be explained that although many factors were associated with exhibition of open-bite,
Table 2. Cephalometric records describing skeletal angular and linear measurements of morphology in Class II subgroups and Class I controls with descriptive statistics and results of analysis of variance and the Duncan test. (1: Hypodivergent Class II, Division 1, 2: Normodivergent Class II, Division 1, 3: Hyperdivergent Class II, Division 1, 4: Control group) * P<.05; ** P<.01

<table>
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<th>Measure Name</th>
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<th>Normodivergent(2)</th>
<th>Hyperdivergent(3)</th>
<th>Class I Control (4)</th>
<th>Test</th>
<th>Duncan Test</th>
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<td>Mean±SD</td>
<td>Mean±SD</td>
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<td>1-3</td>
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<td>SNB</td>
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<td>SN/GoGn</td>
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<td>31.81±0.61</td>
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<td>Ida-Idp-B’</td>
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<td>80.97±1.52</td>
<td>83.13±1.14</td>
<td>83.86±1.18</td>
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<td>130.31±1.7</td>
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<td>78.75±0.97</td>
<td>80.69±1.66</td>
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<td>73.6±1.84</td>
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<td>Me-Pg-B</td>
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<td>Pg-B-Ida</td>
<td>147.76±1.46</td>
<td>149.17±1.38</td>
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</tr>
<tr>
<td>U1⊥NA</td>
<td>4.91±0.5</td>
<td>5.36±0.37</td>
<td>7.01±0.43</td>
<td>3.75±0.31</td>
<td>**</td>
<td>NS</td>
</tr>
<tr>
<td>L1⊥NB</td>
<td>4.86±0.43</td>
<td>5.87±0.43</td>
<td>6.99±0.37</td>
<td>4.56±0.26</td>
<td>**</td>
<td>NS</td>
</tr>
<tr>
<td>Overjet</td>
<td>9.45±0.46</td>
<td>9.37±0.48</td>
<td>9.98±0.54</td>
<td>3.32±0.12</td>
<td>**</td>
<td>NS</td>
</tr>
<tr>
<td>Overbite</td>
<td>8.89±0.41</td>
<td>4.12±0.4</td>
<td>2.43±0.4</td>
<td>2.46±0.17</td>
<td>**</td>
<td>NS</td>
</tr>
</tbody>
</table>

SD; Standard Deviation, * P<.05; ** P<.01
greater upper symphyseal heights was a compensatory mechanism in hyper-Cl II subjects without open-bite. On the other hand, smaller upper symphyseal heights in hypo-Cl II group can be thought of as a mechanism of adaptation in a similar way.

Our study was based on both sagittal and vertical jaw relationship measurements taken directly from two-dimensional (2D) lateral cephalometric radiographs. The use of 2D cephalograms may represent a study limitation. However, Swasty et al.\(^\text{27}\) also have shown a similar finding for heights and dissimilar findings for the width in their cone beam computerized tomography (CBCT) scans study. They demonstrated that subjects with long faces had a great amount of change in the height of the mandibular cross-section CBCT scans from the molars to incisor and also indicated that cross-sectional areas that generated from mandible was longer at the symphysis compared with subjects with average and short faces. Although the width of the mandibular cross-section finding of short face group differs from ours, they also stated that short face group had wider symphysis compared with those of long- and average face groups.\(^\text{27}\) However, present findings have revealed that the widths of the symphysis are similar and statistically insignificant for all groups.

In the comparison of the symphyseal inclination between the Class II and Class I control samples, the measurement of BoMeGo, which represents the angle between mandibular plane and the symphysis, were greater in all Class II groups compared with control group. It can be concluded that the symphysis was positioned more forward in Class II subjects. However, this difference showed statistically significance only for normo-Cl II and control subjects. It has been reported that a greater inclination of the symphysis is associated with an anterior growth direction and a smaller inclination is often consistent with hyperdivergent patterns.\(^4\),\(^13\),\(^31\) The current results showed that the internal inclination of the symphysis (IdoBoMe) was more obtuse in hyper-Cl II group, while hypo-Cl II subjects had the smallest value (p<0.05). An association between prediction of mandibular growth and the morphology of the symphysis have been shown,\(^4\),\(^8\),\(^12\),\(^13\) whereas there are also studies that have reported difficulties and found the method unreliable.\(^32\),\(^33\)

According to Björk,\(^14\) in high-angle cases, the pronounced apposition below the symphysis and the anterior part of the mandible produces an anterior rounding. This finding matched with ours in terms of symphyseal height. However, Björk\(^14\) also has stated that in the vertical type of growth, the symphysis swings forward in the face and the chin is prominent, while in the sagittal type, it swings back, with a receding chin. This could not be confirmed in the present study. The hyper- Cl II group due to symphyseal inclination is more obtuse; the chin is more receding than the other Cl II and control subjects.

**CONCLUSION**

The morphologic findings of the symphysis in this study indicated that:
SYMPHYSIS MORPHOLOGY IN CLASS II MALOCCLUSIONS

1. The inclination of the symphysis was found to be related to vertical dimension. The increased vertical dimension results more obtuse symphyseal inclination.
2. The symphysis was positioned more forward in all Class II subjects than control. It was more prominent in normo-Cl II group.
3. The widths of the symphysis were similar for all groups.
4. The upper symphyseal heights increased in hyper-Cl II subjects whereas decreased in hypo-Cl II subjects.
5. The symphyseal morphologic similarities within Class II subgroups were observed in the lower half of the symphysis while the similarities between Class II and the control subjects were shown in the upper half of the symphysis.

REFERENCES


