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Investigation of The Relationship Between Pterygomaxillary Fissure in Adult Individuals with Different Vertical Growth Pattern of Face Development

Farklı Dik Yön Yüz Gelişimine Sahip Erişkin Bireylerde Pterygomaksiller Fissür ile İlişkisini İncelenmesi

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ÖZET

Amaç: Bu çalışmanın amacı iskeletsel Sınıf I bireylerde dik yön farklılığının pterygomaksiller fissürle morfolojisine etkisi ile vertikal kompanzasyonun ilişkisinin incelenmesidir.
Materyal ve Metot: Bu çalışma vertikal yön açısına göre 2 gruba ayrılmış, her bir alt grupta 100'er bireyin bulunduğu, İskeletsel Sınıf I özelliğe sahip toplam 200 birey üzerinde yürütülmüştür. Araştırma gruplarını oluşturan bireylerin tedavi öncesi lateral sefalometrik radyografileri üzerinde belirlenen parametreler doğrultusunda açısal ve milimetrik ölçümler (N-ANS, ANS-ME, N-ME, Ba-N/Ptm-Gn°, Ptm (Yüksekli-x), Ptm (Genişlik-y)) yapılmıştır. Yapılan retrospektif çalışmada sefalometrik görüntüler üzerinde pterygomaksiller fissürle iskeletsel dik yön gelişimi ilişkisi ayrıntılı olarak incelenmiştir. Çalışmada istatistiksel yöntem iki değişkenli verilerin analizi için 'Mann-Whitney U testi kullanılmıştır. Ayrıca Pearson korelasyon analizi ile parametreler arasındaki ilişki ortaya konmuştur.
Bulgular: Sınıf I dik yön alt gruplarının karşılaştırılmasında ölçüm değerleri bakımından istatistiksel olarak anlamlı bir farklılık yoktur (p>0,05). ANS-Me ve N-Me ölçümleri bakımından istatistiksel olarak anlamlı bir farklılık bulunmuştur (p<0,001). Bu ölçüm değerleri hiperdiverjan gruptan hipodiverjan gruba doğru azalmıştır. Yapılan Mann-Whitney U test sonucuna göre cinsiyetler ile dik yön ölçümü (Ba-N/Ptm-Gn°) ve pterygomaksiller fissür değişkeni genişlik ve yükseklik (Ptm-x ve Ptm-y) ölçümleri arasındaki ilişki istatistiksel olarak anlamlı bulunmamıştır (p>0,05).
Sonuç: Farklı dik yön boyutlarına sahip Sınıf I bireylerde dik yönün gelişiminde pterygomaksiller fissür değişikliğinden etkilenmemiştir.

Anahtar Kelimeler: Sefalometri, Vertikal gelişim, Pterygomaksiller fissür

ABSTRACT

Objective: The aim of this study was to determine the effect of vertical dimension difference on pterygomaxillary fissure in skeletal Class I individuals and its relationship to vertical compensation**.**
Material and Method: This study was carried out on 200 individuals with Skeletal Class I feature, with 100 individuals in each subgroup, according to the vertical dimension angle. Angular and millimetric measurements (N-ANS, ANS-ME, N-ME, Ba-N / Ptm-Gn °, Ptm (Height-x), Ptm (Width- y)) was made. In the retrospective study, the relation between the pterygomaxillary fissure and the development of skeletal vertical dimension on the cephalometric images was examined in detail. In the study, 'Mann-Whitney U test was used for analysis of bivariate data as statistical method. In addition, Pearson's test was used to assess the correlations between the parameters.
Results: There was no statistically significant difference in comparison of Class I vertical dimension subgroups in terms of measurement values (p> 0.05). A statistically significant difference was found in terms of ANS-Me and N-Me measurements (p <0.001). These measurement values decreased from the hyperdivergent group to the hypodivergent group. According to the Mann whitney U test results, the relationship between genders and vertical direction measurement (Ba-N / Ptm-Gn °) and pterygomaxillary fissure variable width and height (Ptm-x and Ptm-y) measurements were not statistically significant (p> 0, 05).
Conclusion: In Class I individuals with different vertical dimensions, pterygomaxillary fissure change was not affected in the development of vertical dimension.

Key Words: Cephalometry, Vertical development, Pterygomaxillary fissure

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Orjinal Araştırma Makalesi/Original Paper

Van Sag Bil Derg 2020;13(1):1-8

INDRODUCTION

Vertical directional anomalies of the face are formed as a result of many factors affecting each other during the growth period. These factors include the growth differences of the maxilla and mandible; tongue and lip function, finger sucking, long-term pacifier, habits such as baby bottle use, environmental and functional factors such as nasal airway obstruction, and dentoalveolar development with tooth persistence (Tweed, 1944). Variations in growth rate in both maxillary sutures and mandibular condyles affect the occurrence of vertical anomalies (Williams and Melsen, 1982). It is known that the height of the face, especially the lower front face, is the result of the interaction between condylar growth, sutural and alveolar development (Isaacson, 1971). For this reason, while defining the vertical features of the face, the heights of the back should be taken into account along with the heights of the face. When evaluating the face patterns, it is appropriate to use the back / front face height ratios (Arat and Rübendüz, 2005). Facial vertical development patterns are three types, namely hypodivergent (low angle), hyperdivergent (high angle) and normodivergent (normal angle). In the long face type, there is excessive vertical development and SN / Mandibular plan angle and gonial angle are increased (Fields et al., 1984; Cangialosi, 1989). In the short face type, there is decreased vertical development and SN / Mandibular plan angle and gonial angle are decreased (Opdebeeck, 1978). Hyperdivergent and hypodivergent facial types; also differ in terms of the placement of horizontal planes such as cranial base, occlusal plane, palatal plane and mandibular plane (Nanda, 1990). Some researchers have stated that horizontal facial planes are more inclined and rotated in individuals with increased lower face height, and more parallel in individuals with reduced lower face height (Muller, 1963; Sassouni and Nanda, 1964). Isaacson et al. studied the relationship between mandibular plane angle and facial proportions. The researchers stated that this angle is higher in cases with increased vertical dimensions compared to cases with decreased vertical dimension, and in addition, as the SN / MP angle increases, total upper and lower anterior facial heights increase and upper anterior facial height does not change (Isaacson, 1971). Fossa pterygopalatina is an anatomical formation located deep in the middle third of the face, containing complex vascular and neural structure sequences (Choi and Park, 2010). Fossa pterygopalatina is a space located under the orbital apex, small pyramidal, lateral to the skull (Standring, 2008). Fissura pterygopalatina; It is a structure between the tuber maxillare at the front and at the back of the anterior border of the processus pterygoideus. The connection between fossa pterygopalatina and fossa infratemporalis is provided with lateral fissura pterygomaxillaris (Vasher, 2010). Lateral cephalometric images provide diagnostic information about the skull, face and neck vertebrae, and also allow dental and skeletal evaluations by predicting facial growth. One of the most frequently used anatomical landmarks in the skull for cephalometric follow-up is pterygomaxillaris fissure (Acar and Şakul, 1991). One of the most commonly used anatomical landmarks in the skull for cephalometric follow-up is pterygomaxillaris fissure (ptm). Pterygomaxillaris fissure morphology can vary from person to person. Analyzes with pterygomaxillaris fissure show that this region is part of an anatomically balanced growth (Icen and Orhan, 2019). Knowing the anatomical variations of this important region will distinguish a pathological change in the region. In recent literature reviews, it is eliminated that the complications caused by the deficiencies in the evaluation of the region's anatomy and the failures in the treatment before orthodontic treatment interventions cause time loss. Treatment safety is guaranteed for detailed anatomical evaluations of these structures before treatment. It is possible to apply a sufficient amount of force to the correct area of the mechanics to be applied in orthodontic diagnosis and treatment or the activities of the mechanics (Williams et al., 2014).

The aim of this study is to measure width and length of fissura pterygomaxillaris, examine the distribution by age and gender in our study group, and depending on these factors, to investigate the relationship with different vertical facial development.

MATERIALS and METHODS

For the patients who applied to our orthodontic clinic for the purpose of orthodontic treatment, the permission of the Istanbul Aydin University Faculty of Dentistry “Non-Interventional Clinical Research-Pharmaceutical and Non-Medical Device Research

Orjinal Araştırma Makalesi/Original Paper

Van Sag Bil Derg 2020;13(1):1-8

Ethics Committee" (Number: B.30.2AYD.0.00.00-50.06.04 / 67) It was conducted. The chronological age of the individuals who applied to the Istanbul Aydin University Faculty of Dentistry Orthodontics Department between 2016-2019 and who were indicated for orthodontic anomaly, was between 18-40 years, according to the cervical vertebra maturation CS-5 followed by lateral cephalometric radiographs. skeletal period, no previous orthodontic treatment, minimal or moderate stenosis in the upper and lower jaw, no syndrome that may affect the development of craniofacial structures, no anatomical deformation detected in lateral cephalometric radiographs, crown covering or bridge Attention was paid for the absence of prosthetic restorations, no apparent asymmetry on the face, permanent and full front teeth in the upper and lower jaw, and no loss of more than one premolar or molar tooth in each segment in the upper and lower jaw.

The pre-treatment records of 200 skeletal Class I hyperdivergents and hypodivergents, 101 females, 99 males in accordance with the study criteria were included in the study. The study was carried out on lateral cephalometric radiography belonging to individuals in 2 groups with 101 girls and 99 boys, 200 individuals in each subgroup. Class I as 0 ˚ <ANB ˚ <4 ˚ in anteroposterior direction using all individuals lateral cephalometric films, facial axis angle (Ba-N / Ptm-Gn˚) based on Ptm (Height-x), Ptm (Width-y) parameters and vertical face development, and 2 different groups were created according to the rotational type of the lower jaw and the norm value of 90˚, determined by Mac namara. According to this; To the group showing the high-angle growth model whose Ba-N / Ptm-Gn angle is less than 90˚, and individuals with a Ba-N / Ptm-Gn angle greater than 90˚ are included in the group with a low-angle growth model. The descriptive statistics of individuals' age and ANB˚ measurements are given in Table 1. All radiographs were taken with the same cephalometry device (Planmeca 2011-05 Proline Pan / Ceph X-Ray brand X-ray device- Helsinki, Finland) with the plane of Frankfurt parallel to the ground, the teeth were in centric occlusion and the lips were in the resting position. Cephalometric radiographs were evaluated by the same researcher using the NemoCeph NX 9.0 software program (Nemotech, Imaing and Management Solutions, Chatsworth, Madrid, Spain). Determination of the anatomical points was performed manually in digital environment (Figure 1). 1/3 of the measurements were repeated after 3 weeks, and the repetition coefficients for the measurement obtained from lateral cephalometric radiographs were found to be approximately 1 full value (r = 0.999-0.971). Statistical analysis of our study was performed using Statistical Package for Social Science (SPSS Inc, Chicago, Illinois, USA) 21.0 for Windows software. The independence test was carried out to determine whether the distribution of genders into groups was similar. Mann Whitney U test was performed between the averages of age, SNA˚, SNB˚, ANB angle, N-ANS, ANS-Me, N-Me measurements. The Mann Whitney U test was used to determine which groups were different. The significance level was considered statistically significant for p <0.001. In the study, whether there is a relationship between vertical dimension measurements and Ptm measurements was investigated by Pearson correlation coefficient.

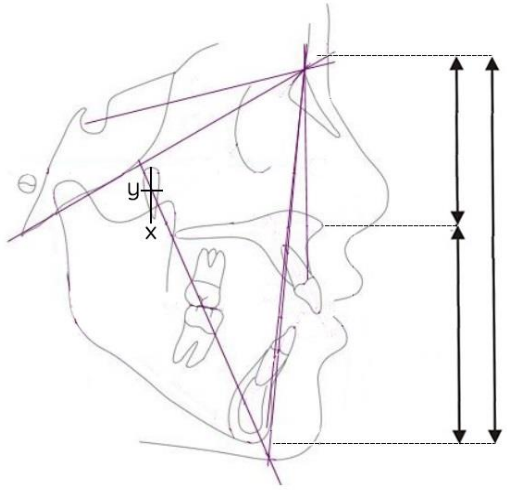

Figure 1. Cephalometric drawing -Skeletal angular and linear measurements

1. SNA (°), the angle between the SN and NA planes.
2. SNB (°), the angle between the SN and NB planes.
3. ANB (°): Angle between NA and NB planes.
4. Ba-N- / Ptm-GN (°); Face axis angle
5. PTM-x (mm); Height of pterygomaxillary fissure
6. Ptm-y (mm); Width of the pterygomaxillary fissure
7. N-ANS (mm) (Upper front face height): It is the distance between Nasion and anterior nasal spina.
8. ANS-Me (mm) (Lower front face height): It is the distance between anterior nasal spina and mentone.
9. N-Me (mm) (Total front face height): It is the distance between Nasion and menton.

RESULTS

In comparison of Class I vertical direction subgroups, Ba-N / Ptm-Gn measurement value is statistically significant at the level of p <0.001. The values of these angles decrease as the vertical direction decreases (p <0.001) (Table1).

Table 1: Socio-Demographic Properties

	High Angle	Low Angle	P
	Mean±Sd	Mean±Sd	
Age(years)	22,63 ± 1,36	22,9 ± 1,17	0,788 NS
ANB°	3,05 ± 0,21	3,23 ± 0,25	0,435 NS
Ba-N/Ptm-Gn°	93,67± 2,53	88,53± 1,6	**0,000***

. SNA˚ and SNB˚ measurement values are statistically significant at p <0.001 level among Class I hyperdivergents and hypodivergents subgroups. In comparison of Class I subgroups, it was observed that the SNA and SNB measurement values decreased from the hyperdivergent group to the hyperdivergent group. (P <0.001) (Table 2).

Table 2: Standard deviations, means and statistical evaluation of skeletal parameters in the hyperdivergent and hypodivergent subgroups of Class I group

	High Angle	Low Angle	P
	Mean±Sd	Mean±Sd	
SNA°	78,1 ± 0,65	83,15±0,81	**0,000***
SNB°	74,22 ± 0,58	81,62±0,49	**0,000***
N-ANS (mm)	48,56±1,05	48,18±1,36	0,940 NS
ANS-Me (mm)	65,28 ± 0,65	59,35±1,45	**0,000***
N-Me (mm)	115,65±1,12	105,75±2,2	**0,000***

These measurement values decreased from the hyperdivergent group to the hypodivergents group. While there was no statistically significant difference in terms of N-ANS measurement values (p> 0.05) , a statistically significant difference was found in terms of ANS-Me and N-Me measurements (p <0.001) (Table 2). There was no statistically significant difference between the gender of pterygomaxillaris fissure in comparison of subgroups of Class I vertical dimensions (p> 0.05) (Table 3).

Table 3: Standard deviations, means and statistical evaluation of pterygomaxillaris fissure parameters according to the gender of Class I group.

	Female n=101	Male N=99	P
	Mean±Sd	Mean±Sd	
Ptm-(Height-x)	25,68 ± 3,16	25,79±3,09	0,576 NS
Ptm-(Width-y)	5,19± 1,03	5,21 ± 1,02	0,258 NS

When comparing the subgroups of Class I vertical dimensions, there was no statistically significant difference in the vertical and width distance (Ptm-x, Ptm-y) between the upper and lower point of the pterygomaxillaris fissure (p> 0.05). Although the Ptm-x measurement value could not be statistically significant, it decreased from the hyperdivergent group to the hypodivergents group (Table 4).

Table 4: Standard deviations, means and statistical evaluation of pterygomaxillaris fissure parameters in Class I group hyperdivergent and hypodivergent subgroups.

	High Angle	Low Angle	P
	Mean±Sd	Mean±Sd	
Ptm-(Height-x)	25,64 ±3,24	25,55±3,2	0,765 NS
Ptm-(Width-y)	5,18±1,14	5,1±1,1	0,330 NS

Hypodivergent, Ba-N/Ptm-Gn<90;
hyperdivergent, Ba-N/Ptm-Gn >90;
Mean , average;
Sd, standard deviation;
n, number of individuals;
* , p <0.001;
NS , not significant;
p, significance level according to test

DISCUSSION

In the analysis of face types with open and deep bite anomalies, dimensional and proportional measurements are frequently used because the vertical dimension shows facial development. The change in facial rates is the result of different growth in facial segments (DeCoster, 1939; Chang, Kinoshita, Kawamoto, 1993). Therefore, some researchers have linked the formation of vertical malocclusions to this discordant proportional growth in the dentofacial region. For this purpose, in our study, it was aimed to examine the facial proportions of individuals with different vertical dimensional facial development, and to examine which anatomical regions are the most prominent changes, especially in individuals with extreme and inadequate perpendicular direction development, in other words, which factor is more determinant in these development models. Dentoalveolar compensation plays an important role in compensating for skeletal incompatibilities leading to the formation of anomaly in the sagittal and vertical dimensions. It is seen that the ANB° values of each Class I vertical dimension group in this study are within normal limits and reflect the characteristics of the skeletal anomalies desired to be examined in the study. The fact that the individuals in the groups compensated the vertical anomaly at the dentoalveolar level and reached the "normal ANB" value (Bibby, 1980), and the fact that the averages are within the normal range indicates that the groups in this study are true dentoalveolar compensated individuals with skeletal anomalies.

According to the results of this study, it was determined that the position of the maxilla (SNA°) and the position of the mandible relative to the skull base (SNB°) in the anterior-posterior direction (retusive maxilla and mandible) in the Class I individuals with the shift of the growth pattern towards the vertical and the increase in the vertical dimension. This result is compatible with the literature (Schudy, 1963; Isaacson et al., 1971). Bishara and Jakobsen emphasized that in individuals with increased vertical dimensions of the face, the maxilla and mandible are more retrusive than normal, but both jaws are synchronized (Bishara and Jakobsen, 1985). In parallel with these results, in our study, SNA° and SNB° angles increased or decreased in accordance with each other. Upper anterior height (N-ANS) was statistically similar among all Class I subgroups in our study. This result is compatible with the literature (Klocke et al., 2002). Contrary to this result, there are also studies reporting that the height of the upper anterior surface of the hypodivergent individuals increased (Nahoum, 1971; Lopez-Gavito et al., 1985; Siriwat and Jarabak, 1985). The reason for these opposite results may be the difference in the selection of individuals included in the study group. In our lower anterior height (ANS-Me) study, Class I decreased as all the subgroups moved from the hyperdivergent group to the hypodivergent group. This result is compatible with the literature (Schudy, 1963; Nahoum, 1971; Bishara and Jakobsen, 1985). Kuitert et al. (2006) stating that the height of the lower face is closely related to the overbite, especially in individuals with long faces, he reported that in women with lower face height more than 72 mm and in men more than 76 mm, the maxillary and mandibular frontal alveolar and basal adaptive changes could not prevent openbite. The highest ANS-Me dimension measured in this study is 67 mm (Kuitert et al., 2006). In individuals with different vertical dimension growth models, the original face type tends to be strongly preserved with increasing age. Facial growth pattern may become more prominent in adulthood with advancing age and / or epigenetic factors can aggravate or inhibit these growth trends (Bishara and Jakobsen, 1985; Nanda and Rowe,1989; Chung and Mongiovi, 2003). In the light of this information, in order to make the results more realistic, the selection of the individuals included in the study has been paid attention to the end of the pubertal growth spurt, and our study was conducted on individuals between the ages of 18-40 years. Thus, our research was completed to a large extent in the growth of the lower and upper jaw and facial development, and the vertical facial development pattern was performed on individuals who were largely shaped (Neyzi et al, 1975a; Neyzi et al., 1975b; Love et al., 1990). Gender is an important factor in the development of craniofacial structures and the shaping of the growth pattern. Since the adolescent period, morphological differences begin to become evident due to gender hormones and metabolic activity differences between male and female individuals (Siriwat and Jarabak, 1985). Thus, our study was completed to a large extent after the end of growth of the lower and upper jaw and facial development, and it was ensured to be performed on individuals whose vertical dimension facial development pattern was largely shaped (Neyzi et al., 1975a; Neyzi et al., 1975b; Love et al., 1990). For this reason, considering the changes related to the gender factor, the evaluations were made separately for both genders, and the differences arising from the growth model were more realistic. A number of criteria have been developed to determine vertical facial growth and / or mandibular rotations. Some researchers have classified sample groups according to whether there is an open or deepbite at the dental level (Nahoum, 1971, Cangialosi, 1984; Fields et al., 1984). Some researchers also used face height ratios and / or mandibular plane angle in this classification (Steiner and Hills ,1953; Schudy, 1966; Nanda, 1988; Janson et al., 1994; Schendel et al., 1994). Among the measurements used for this purpose, the anterior head basal plane and the angle formed between the pterygomaxillary and mandibular plane (Ba-N / Ptm-Gn) were used (Schudy, 1963; Isaacson et al., 1971; Bishara and Jakobsen, 1985; Love et al.,1990; Chang et al., 1993; Karlsen, 1995; Schudy, 1996;). Researchers, 2 different groups were formed according to the rotation type of the perpendicular direction face development according to the rotation type of the lower jaw and the norm value of 90˚ determined for this angle. According to this; Ba-N / Ptm-Gn angle is less than 90˚ and high-angle growth model is included in the group, while individuals with Ba-N / Ptm-Gn angle greater than 90˚ are included in the group with low-angle growth model (Steiner and Hills, 1953; Schudy, 1966). Pterygomaxillaris fissure height (Ptm-x) and pterygomaxillaris fissure width (Ptm-y) decreased in the Class I group from hyperdivergent individuals to hypodivergent individuals. It was concluded that the increase in the vertical dimension and the decrease in Ptm height and width did not show statistically significant correlation with linear measurements determining the Ptm morphology. When the hyperdivergent and hypodivergents subgroups of the Class I group were evaluated in terms of Ptm millimeter length measurements, the height and width of Ptm (Ptm-x and Ptm-y) increased in hyperdivergent individuals and decreased in individuals. There are studies in the literature that support our findings (Acaret al., 1991; Moiseiwitsch and Irvine, 2001). Tsunori et al. (1998) claimed that there was a link between the development of the vertical and transversal maxillofacial complex and increased muscle activity. In the literature, soft tissue thicknesses have been investigated in different perpendicular patterns. Macari and Hanna (2014) found that jaw-tip soft tissue measurements were less in hyperdivergence individuals than in normal and hypodivergent adults. Çelikoğlu et al. (2015) also reported that soft tissue thicknesses were lower in high angle individuals in both men and women. In our study, no statistical difference was found in the evaluation of the relation of PMF with other anatomical structures according to gender, localization and height ($p > 0.05$). Moiseiwitsch and Irvine (2001) determined in their study on cadavers that the difference between the genders was statistically significant in the length of Ptm ($p < 0.01$). They stated that they did not find any difference in terms of Ptm lengths in their studies that separated their patients according to their ethnic origin (Moiseiwitsch and Irvine, 2001). In our study, the average PTM length did not differ between men and women. Different results have been obtained due to the measurement difference made in other studies. Since Moiseiwitsch and Irvine (2001) measured the results they made in their study, the point they determined as the starting reference point and the point we determined in our study were not the same, so different results were compared from the result found. However, the length of Ptm detected in our study was found the same in men and women, the difference was not statistically significant ($p > 0.05$). Moiseiwitsch and Irvine (2001) attributed the reason for the difference in measurements to the male cadavers being larger than the female cadavers. In the literature searches, most researchers used the lower end point of Ptm as a reference point in cephalometric analysis (Tsunori et al., 1998; Macari and Hanna, 2014). In some studies, in cases where external orthopedic forces such as headgear are used, the use of the designated point as a reference point has been criticized because its location is unstable (Cevidanes et al., 2005; Hwang et al., 2011; Celikoglu et al., 2015). While Cevidanes et al. (2005) showed the 3D displacement of Ptm during treatment with Fränkel appliance; Iseri and Solow (1995) pterygomaxils showed that the displacement in the region is slightly inferior and posterior; In their study, Piva et al. (2005) showed the posterior movement of Ptm during headgear use. This situation shows us that the shape or location of PTM can change in any pathological situation or as a result of external forces application. According to the results of our study, it is considered that PTM's lower end point as a reference orthodontically will not be suitable especially in the adult patient group, because the location of PTM cannot be fixed and may be affected by various factors such as resorption, sexual dimorphism and pathologies. Albert et al. (2007) evaluated the changes in the skull and facial aging in their study, and summarized the changes in hard and soft tissue as follows: in hard tissues; They reported a small growth in the craniofacial skeleton between the ages of 20-30, an increase in the anterior (usually lower) facial height, and an increase in the mandibular length. Although the age progression causes changes in the fissure area, it suggests that it does not cause macro changes in the general morphology of the fissure (Nielsen, 1991). In a study conducted on Macaca mulatta monkeys, it has been shown that orthodontic forces applied more than required cause resorption both in the maxillary tuberosity region and in pterygoid plates (Isaacson et al., 1971). During the distalization of the maxillary molar teeth, Ptm was observed to be displaced towards the posterior and it was stated that clinical observations should be made in terms of changes that may occur in the vital structures in the FPP (Schendel et al., 1976; Andria et al., 2004; Burstone et al., 2007).

In the groups formed according to the vertical dimensional facial development, it was found that significant differences did not affect the anatomical structures in the vertical orientation aspect ratios. Regarding Ptm in both genders, significant differences were not observed between low-angle and high-angle groups in vertical dimension face development. At the same time, it is thought that it should be supported by further studies that may trigger the formation of skeletal anomalies depending on Ptm morphology.

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