# Comparison of the posterior teeth angulations in orthodontic patients with different facial growth patterns

**Oscar Ledesma-Peraza [1], Marco Sánchez-Tito [1,2]**

[1] Facultad de Ciencias de la Salud, Universidad Privada de Tacna, Tacna, Peru
[2] Specialist in Orthodontics and Maxillary Orthopedics; MSc of Scientific Research and Innovation, PhD in Stomatology

*Correspondence:*
*Facultad de Ciencias de la Salud*
*Universidad Privada de Tacna*
*Av. Jorge Basadre Grohmann s/n*
*Tacna, Perú*
*marcosanchez2183@gmail.com*

Ledesma-Peraza O, Sánchez-Tito M. Comparison of the posterior teeth angulations in orthodontic patients with different facial growth patterns. J Clin Exp Dent. 2023;15(8):e629-34.

## Abstract

Background: Dental relationships can be affected according to the pattern of facial growth. Thus, the aim of this study was to compare the angulations of posterior teeth in patients with different patterns of facial growth.

Material and Methods: A total of 412 lateral head radiographs were included. The facial skeletal growth pattern was evaluated with the Björk-Jarabak analysis. For the angular measurements of the posterior teeth, the apex-cusp inclination of the premolars and the long axes of the molars were considered, with respect to the occlusal, palatal and mandibular plane. The intraclass correlation coefficient (ICC) was used to evaluate the intra-examiner concordance. One way ANOVA was used to compare the values between the patterns of facial growth. A significance level was set at 0.05.

Results: A high intra-examiner correlation was observed (0.75). Subjects with horizontal and normal growth presented significantly different angulations for the first and second premolars in relation to the palatal plane than the vertical growth ($p<0.05$). Subjects with horizontal growth pattern showed greater angulation of the teeth with respect to the occlusal plane than the other groups ($p<0.05$). The angulations of all mandibular teeth related to the mandibular plane were significantly higher for the group with horizontal growth ($p<0.05$).

Conclusion: The first and second premolars presented greater angulations in subjects with horizontal and normal growth than in those with vertical growth. The angulations of all mandibular teeth were significantly higher in the horizontal growth according to the mandibular plane.

*Key words: Facial growth pattern, posterior tooth, occlusal plane, palatal plane, mandibular plane.*

## Introduction

Malocclusions are the result of the imbalance between various factors such as the pattern of facial growth, oral dysfunction, environmental disturbances, inter- and intra-arch alveolar-dental discrepancies, among others (1-5). Treatment planning must consider the etiological factors of malocclusion, as well as aspects related to clinical and demographic conditions in or-

der to establish the best orthodontic treatment planning (6,7).

Skeletal growth patterns can be expressed in the facial characteristics of patients, influencing even the stages of skeletal maturation (6,8,9). A vertical facial growth pattern is related to an increase in the facial height of the lower third of the face, as well as a tendency for mandibular rotation in a clockwise direction, which may also affect the relationships of the positions of the teeth with respect to their alveolar bases, especially the mesiodistal angulations and their verticalization with respect to reference planes such as the palatal and mandibular planes (10). In addition, the vertical facial growth patterns is associated with compressed arches, posterior crossbites and a greater possibility of developing anterior open bites (10-12). On the other hand, horizontal growth patterns are usually associated with decreased facial height and a tendency to a counterclockwise rotation of the mandible; and at the dentoalveolar level, it is common to observe the presence of deep bites (11).

As mentioned earlier, dental relationships can be affected according to the pattern of facial growth. In this regard, Kim reported that in subjects with a vertical growth pattern and who developed open bites, the posterior teeth presented a mesial angulation in relation to the occlusal plane (13). This characteristic may be associated with the fact that mandibular growth trend have been shown to affect tooth eruption patterns (14). In this sense, Tsai found that in patients with vertical growth patterns, the incisors were more vertical (15).

Reference planes such as the palatal plane, mandibular plane, and occlusal plane have been widely described when establishing craniofacial growth characteristics (16-19), although it is known that these references can undergo modifications throughout growth and as part of mainly orthopedic mechanics.

The literature is limited in studies that relate the positions of the teeth with respect to facial growth trends, it is important to distinguish the different patterns in order to establish treatment plans that allow stable results considering the variabilities and individual characteristics of the patients. Badiee *et al*., evaluated the mesiodistal angulations of the posterior teeth in the various facial patterns, their results showed that a greater forward inclination of the posterior teeth was observed in the vertical pattern (20). Janson *et al*., compared the angulations of posterior teeth in patients with normal occlusion and open bite, finding that the maxillary and mandibular premolars were more angulated mesially with respect to the occlusal plane (21).

Therefore, the aim of this study was to compare the angulations of posterior teeth in patients requiring orthodontic treatment with different patterns of facial growth.

## Material and Methods

This retrospective cross-sectional study was approved by the ethics committee of the Faculty of Health Sciences, Universidad Privada de Tacna, Tacna, Peru, with research protocol number 85/FACSA/UI.

The sample consisted of 412 lateral head radiographs of subjects without previous orthodontic treatment and with complete dentition up to the second molars. The radiographs were obtained from the records of five orthodontic offices in the city of Tacna, Peru. All radiographs were taken by the same radiographic center, using the Orthophos SL 3D Ceph radiographic system (Dentsply Sirona, Germany), operated at 85 kVp and 8 mA, with an exposure time of 14.18 s and a Voxel size of 80 μm. Cephalometric tracing and identification of landmarks were performed by hand in a dark room by the same investigator (O.L.P.) to reduce inter-examiner differences. A negatoscope, cephalometric paper (GAC International Inc, Bohemia, NY, USA) and a 0.5 mm 3H graphite pencil (A. W. Faber-Castell, Stein, Germany) were used. A total of eight traces were made per day, to avoid visual fatigue of the operator.

The facial skeletal growth pattern was evaluated with the relationship between the angular measurements of the Björk-Jarabak analysis (22). The total sum of the sella turcica, articular and gonial angles, was considered. Values of 396°±6° represent normal growth (mesofacial), decreased values indicate horizontal growth (brachyfacial), while increased values indicate vertical growth (dolichofacial).

For the angular measurements of the posterior teeth, the apex-cusp inclination of the premolars and the long axes of the molars were considered, with respect to the occlusal plane (OP), the palatal plane (ANS-PNS) and the mandibular plane (Go-Gn), according to a previous study (20). The description of each of the angular measurements is detailed in Table 1. A representation of the measurements can be seen in Figure 1.

To assess intra-examiner error, 20% of the sample was randomly selected. Tracings and measurements were made by the same investigator with an interval of two weeks.

-Statistical analysis

For the intra-examiner evaluation, the intraclass correlation coefficient (ICC) was used, which allows measuring the level of concordance that exists between two or more assessments of a quantitative nature, considering a confidence level of 95% and a significance level of 5%. Normal distribution of the data was evaluated with the Shapiro-Francia test. All quantitative data had a normal distribution. The comparison of all the values of the measurements between the patterns of facial growth was carried out with the one-way ANOVA test followed by the Bonferroni post hoc test. All statistical analyses were

**Table 1**: Description of the cephalometric magnitudes.

| Maxillary mesiodistal angulation (°) | |
|---|---|
| Mx4.PP | Angle between the long axis of the maxillary first premolar and the ANS-PNS |
| Mx5.PP | Angle between the long axis of the maxillary second premolar and the ANS-PNS |
| Mx6.PP | Angle between the long axis of the maxillary first molar and the ANS-PNS |
| Mx7.PP | Angle between the long axis of the maxillary second molar and the ANS-PNS |
| Mx4.OP | Angle between the long axis of the maxillary first premolar and the OP |
| Mx5.OP | Angle between the long axis of the maxillary second premolar and the OP |
| Mx6.OP | Angle between the long axis of the maxillary first molar and the O*P* |
| Mx7.OP | Angle between the long axis of the maxillary second molar and the OP |
| **Mandibular mesiodistal angulation (°)** | |
| Md4.MP | Angle between the long axis of the mandibular first premolar and the Go-Gn |
| Md5.MP | Angle between the long axis of the mandibular second premolar and the Go-Gn |
| Md6.MP | Angle between the long axis of the mandibular first molar and the Go-Gn |
| Md7.MP | Angle between the long axis of the mandibular second molar and the Go-Gn |
| Md4.OP | Angle between the long axis of the mandibular first premolar and the OP |
| Md5.OP | Angle between the long axis of the mandibular second premolar and the OP |
| Md6.OP | Angle between the long axis of the mandibular first molar and the OP |
| Md7.OP | Angle between the long axis of the mandibular second molar and the OP |
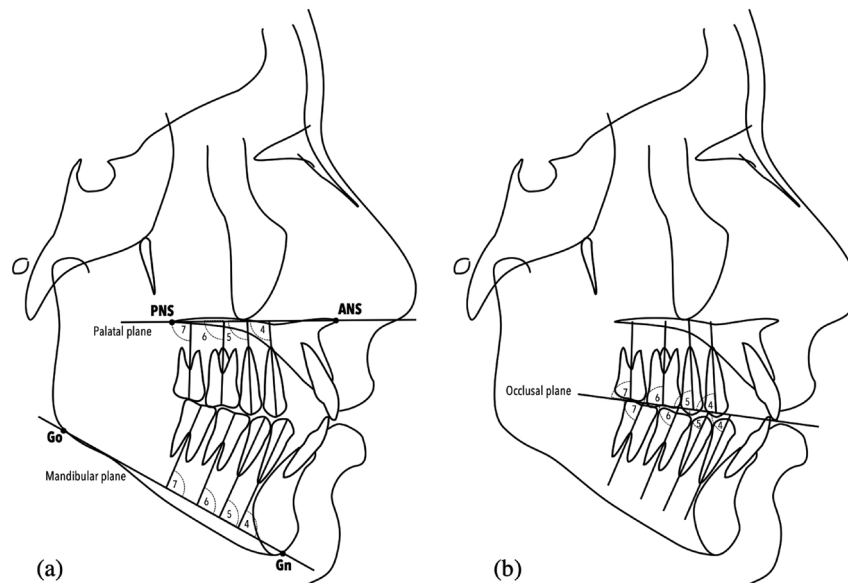


**Fig. 1**: Reference planes. (a) Posterior maxillary and mandibular teeth in relation to palatal and mandibular planes. (b) Posterior maxillary and mandibular teeth in relation to the occlusal plane.

performed with the Stata® 17 Software (StataCorp LP, College Station, TX, USA) for MacOS. The significance level considered in this study was 5%.

## Results

The interclass correlation coefficient test showed coefficients with values greater than 0.75, with a 95% confidence interval for all variables. This indicates a high correlation between intra-examiner measurements.

Table 2 shows the characteristics of the subjects included in the sample of radiographs. A predominance of the normal growth pattern is observed, over vertical and horizontal growth.

The results showed that the first and second premolars,

**Table 2**: Characteristics of the sample (n=412).

| Variable | n | % |
|---|---|---|
| Sex | | |
|    Male | 167 | 40.53 |
|    Female | 245 | 59.47 |
| Facial Pattern Growth | | |
|    Horizontal Growth | 85 | 20.63 |
|    Normal Growth | 227 | 55.10 |
|    Vertical Growth | 100 | 24.27 |
| Age* | 22.71 | 9.72 |

Expressed in mean and standard deviation.

and maxillary first molar of the groups with horizontal and normal growth presented greater and significantly different angulations in relation to the palatal plane than the group with vertical growth (*p*<0.05). In the case of the maxillary second molar, the angulation was greater for the group with horizontal growth and statistically different from the other groups (*p*<0.05) (Table 3). Regarding the angulation of the maxillary teeth with respect to the occlusal plane, it was observed that the horizontal group presented a greater angulation for the premolars and first molar with respect to the other two groups

(*p*<0.05), while for the groups with normal and vertical growth, these differences were not significant. In addition, the second molar presented similar angulations in the three groups (*p*>0.05) (Table 3). The angulations of all mandibular teeth with respect to the mandibular plane were significantly higher for the group with horizontal growth, followed by the group with normal and vertical growth (*p*<0.05) (Table 3). On the other hand, it was observed that when the angulation of the mandibular posterior teeth with respect to the occlusal plane was analyzed, the first and second premolars had similar angulations for the group with horizontal and normal growth, while the angulations for both molars were statistically different between the three groups (*p*>0.05) (Table 3).

## Discussion
Facial growth patterns have been extensively studied and considerations regarding diagnosis and orthodontic treatment mechanics have been established (23-25). These considerations are mainly related to the rotation tendencies of the jaws and the magnitudes of forces applied with orthodontic appliances or intermaxillary elastics (26,27).

**Table 3**: Comparison of all cephalometric magnitudes according to the skeletal growth patterns.

| Variable | Horizontal Growth Mean±SD | Normal Growth Mean ±SD | Vertical Growth Mean±SD | *p* value |
|---|---|---|---|---|
| Maxillary mesiodistal angulation relative to Palatal plane (°) | | | | |
| Mx4.PP | 93.67±5.62[A] | 94.68±6.55[A] | 92.43±6.33[B] | 0.012* |
| Mx5.PP | 88.18±4.56[A] | 88.09±6.08[A] | 85.85±5.72[B] | 0.028* |
| Mx6.PP | 83.40±6.16[A] | 82.22±6.16[A] | 80.39±6.58[B] | 0.004* |
| Mx7.PP | 79.08±9.27[A] | 76.06±8.41[B] | 73.55±8.03[C] | <0.001* |
| Maxillary mesiodistal angulation relative to Occlusal plane (°) | | | | |
| Mx4.OP | 77.08±5.16[A] | 74.62±5.75[B] | 73.30±5.89[B] | <0.001* |
| Mx5.OP | 83.25±3.84[A] | 80.98±4.98[B] | 80.03±4.16[B] | <0.001* |
| Mx6.OP | 87.64±4.64[A] | 86.81±5.19[AB] | 85.49±5.27[B] | 0.014* |
| Mx7.OP | 92.21±8.50[A] | 91.52±8.13[A] | 92.89±6.33[A] | 0.336 |
| Mandibular mesiodistal angulation relative to Mandibular plane (°) | | | | |
| Md4.MP | 81.71±6.59[A] | 79.50±5.94[B] | 77.75±5.91[C] | <0.001* |
| Md5.MP | 81.95±5.90[A] | 78.84±5.17[B] | 76.48±5.91[C] | <0.001* |
| Md6.MP | 82.24±6.30[A] | 79.17±5.90[B] | 76.00±6.87[C] | <0.001* |
| Md7.MP | 88.13±7.48[A] | 84.72±7.21[B] | 82.54±7.65[C] | <0.001* |
| Mandibular mesiodistal angulation relative to Occlusal plane (°) | | | | |
| Md4.OP | 84.03±6.72[A] | 82.97±5.95[A] | 80.78±5.60[B] | <0.001* |
| Md5.OP | 83.87±5.20[A] | 83.66±4.95[A] | 82.06±5.28[B] | 0.017* |
| Md6.OP | 83.37±5.26[A] | 83.08±5.91[A] | 82.87±5.70[A] | 0.838 |
| Md7.OP | 77.39±6.34[A] | 77.58±7.10[A] | 76.01±6.42[A] | 0.147 |

SD = Standard deviation.
Superscript capital letters in rows indicate statistically significant difference between groups.
* Statistically significant at *p*<0.05.

The subjects involved in this study were adult orthodontic patients, considering the stability and maturity of facial characteristics. Upper and lower facial heigh are reached on average at the age of 12 years for women and 15 for men (28).

In this study, the Björk-Jarabak analysis was used to determine the facial skeletal growth pattern of the subjects. This method has proven to be valid for this purpose in various populations, since it is established from the total relationship of the polygon formed by the saddle, articular and goniac angles (29-32). Other strategies such as the use of the angle of the mandibular plane seem not to be adequate for the determination of the facial pattern, due to the high variability (33).

This study evaluated the mesiodistal angulation of posterior teeth in orthodontic patients with different facial growth patterns. The results showed that the pattern with normal growth was the most frequent (55.1%), followed by the vertical growth pattern (24.27%). These results are similar to those reported by Mohammadi Shayan *et al.*, who found a distribution of the normal facial pattern of 47.2%, followed by the long facial pattern of 41.4% and the short facial pattern of 11.5% in an Iranian population (34). Magnani *et al.*, reported that the most frequent facial pattern in a black Brazilian population was the mesofacial pattern in women (74%), while in men the mesofacial (47%) and dolichofacial (53%) patterns were more balanced (35). On the other hand, Amatya *et al.*, found that the hypodivergent facial growth pattern was the most frequent (71.1%), while normodivergent growth was 18.3% in a Nepali population with class I malocclusion (36).

Differences in the angulations of the teeth in the mesiodistal direction in different skeletal patterns have been previously reported (10,20,21). In general, the results of this investigation showed that the average angulation of the teeth decreases from the first premolar to the second molar, likewise it decreases as the growth becomes more vertical. In fact, the group with vertical growth presented minor angulations in the four maxillary and mandibular teeth with respect to the palatal plane, occlusal plane, and mandibular plane.

Nielsen described that subjects with an increase in the lower facial height present a more posterior growth pattern of the mandibular condyle, consequently the expression of growth at the level of the chin is more vertical associated with a vertical pattern of eruption of the posterior teeth and retroclined anterior teeth. On the other hand, in subjects with more horizontal growth, the eruptive pattern presents a considerably mesial migration (10).

Thus, the direction of the skeletal growth pattern appears to be directly associated with the eruptive pattern of the teeth. As previously described, the horizontal facial planes such as the palatal plane and the mandibular pla-

ne tend to be more divergent in subjects with vertical growth and increased lower facial height, while in those with more horizontal growth the planes are more parallel to each other (33,37). This characteristic could explain why the means of the angulations of the teeth with respect to these reference planes vary from smaller angulations in the case of subjects with vertical growth when compared to the values of greater angulations in subjects with horizontal growth.

In patients with vertical growth, the verticalization of the teeth can be the consequence of a dental compensation. Thus verticalization can be present with the aim of closing the open bite (38,39). Badiee *et al.*, reported that in patients with a vertical growth pattern, the posterior teeth presented forward inclinations; while in those patients with horizontal growth, the inclinations were backwards. Additionally, they reported an increase in the angulation of the maxillary and mandibular teeth in relation to the palatal and mandibular plane in patients with vertical growth, while the angulations decreased in relation to the occlusal plane (20). These differences in the results with those reported in this study may be due to the fact that in the previous studies the inclinations of the teeth were evaluated in subjects with open bite, normal bite and deep bite, while in the present investigation, this variable was not included in the model, because no marked differences were observed in the studied sample that would allow the appropriate classification for its study.

Janson *et al.*, compared the angulations of the posterior teeth in patients with open bite and normal occlusion, their results showed that the first and second maxillary and mandibular premolars of the subjects with open bite presented a greater mesial angulation with respect to the occlusal plane than a difference from the subjects with normal occlusion, while the maxillary and mandibular first and second molars presented greater distal inclinations with respect to the palatal and mandibular plane (21). When comparing the mean values of the angulations of the teeth in the group with normal occlusion with respect to the palatal and mandibular plane, Janson *et al.* results were similar to those reported in this investigation.

Further studies are necessary to establish patterns of relationship between the characteristics of the position of the teeth and facial growth patterns, considerations on buccolingual angulations, overjet, overbite and curve of Spee must be taken into account. As well as the study of dental compensation in patients with ortho-surgical requirement.

## Conclusions
The results of the present investigation showed that in relation to the palatal plane, the first and second premolars presented greater angulations in subjects with ho-

rizontal and normal growth than in those with vertical growth. The angulations of all mandibular teeth with respect to the mandibular plane were significantly higher for the group with horizontal growth, followed by the group with normal and vertical growth.

## References

1. Fernandez CCA, Pereira CVCA, Luiz RR, Vieira AR, De Castro Costa M. Dental anomalies in different growth and skeletal malocclusion patterns. Angle Orthod. 2018;88:195-201.
2. Kluemper GT, Spalding PM. Realities of craniofacial growth modification. Atlas Oral Maxillofac Surg Clin North Am. 2001;9:23-51.
3. Kahn S, Ehrlich P, Feldman M, Sapolsky R, Wong S. The Jaw Epidemic: Recognition, Origins, Cures, and Prevention. Bioscience. 2020;70:759-771.
4. D'Onofrio L. Oral dysfunction as a cause of malocclusion. Orthod Craniofac Res. 2019;22:43-48.
5. El-Mangoury NH, Mostafa YA. Epidemiologic panorama of dental occlusion. Angle Orthod. 1990;60:207-14.
6. Castaldo G, Cerritelli F. Craniofacial growth: evolving paradigms. Cranio. 2015;33:23-31.
7. Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J Orthod Dentofacial Orthop. 2015;148:22-36.
8. Nanda RS, Ghosh J. Facial soft tissue harmony and growth in orthodontic treatment. Semin Orthod. 1995;1:67-81.
9. Prlić A, Stunja M, Šimunović Aničić M, Anić Milošević S, Meštrović S. Skeletal Maturation in Different Vertical Facial Growth Pattern. Acta Stomatol Croat. 2021;55:302-307.
10. Nielsen IL. Vertical malocclusions: etiology, development, diagnosis and some aspects of treatment. Angle Orthod 1991;61:247-60.
11. Siriwat PP, Jarabak JR. Malocclusion and facial morphology is there a relationship? An epidemiologic study. Angle Orthod. 1985;55:127-38.
12. Moon SC, Kim HK, Kwon TK, Han SH, An CH, Park YS. Patterns of vertical facial growth in Korean adolescents analyzed with mixed-effects regression analysis. Am J Orthod Dentofacial Orthop. 2013;143:810-8.
13. Kim YH. Anterior openbite and its treatment with multiloop edgewise archwire. Angle Orthod. 1987;57:290-321.
14. Heij DG, Opdebeeck H, van Steenberghe D, Kokich VG, Belser U, Quirynen M. Facial development, continuous tooth eruption, and mesial drift as compromising factors for implant placement. Int J Oral Maxillofac Implants. 2006;21:867-78.
15. Tsai HH.Cephalometric studies of children with long and short faces. J Clin Pediatr Dent. 2000;25:23-8.
16. Pyakurel U, Thapaliya KB, Singh K, Gupta A, Gupta S, Bajracharya M, Shrestha RM, Mishra P. Assessment of Palatal Plane and Occlusal Plane for Determining Anteroposterior Jaw Relation. JNMA J Nepal Med Assoc. 2019;57:3-7.
17. Lulla P, Gianelly AA. The mandibular plane and mandibular rotation. Am J Orthod. 1976;70:567-71.
18. Wang RY, Han M, Liu H, Wang CL, Xian HH, Zhang L, et al. Establishment of reference mandibular plane for anterior alveolar morphology evaluation using cone beam computed tomography. J Zhejiang Univ Sci B. 2012;13:942-7.
19. Khan M, Raza Kazmi SM, Khan FR, Quraeshi S. Relationship of natural occlusal plane with different anatomical landmarks. J Pak Med Assoc. 2021;71:863-867.
20. Badiee M, Ebadifar A, Sajedi S. Mesiodistal angulation of posterior teeth in orthodontic patients with different facial growth patterns. J Dent Res Dent Clin Dent Prospects. 2019;13:267-273.
21. Janson G, Laranjeira V, Rizzo M, Garib D. Posterior tooth angulations in patients with anterior open bite and normal occlusion. Am J Orthod Dentofacial Orthop. 2016;150:71-7.
22. Jarabak JR, Fizzel JA. Technique and Treatment With Light Wire Appliances. 2nd ed. St Louis, Mo: CV Mosby; 1972.
23. Carrillo JJP, Rubial MC, Albornoz C, Villalba S, Damiani P, de Cravero MR. Applicability of the Moyers' Probability Tables in Adolescents with Different Facial Biotypes. Open Dent J. 2017;11:213-220.
24. Grover N, Kapoor DN, Verma S, Bharadwaj P. Smile analysis in different facial patterns and its correlation with underlying hard tissues. Prog Orthod. 2015;16:28.
25. Costea MC, Bondor CI, Muntean A, Badea ME, Mesaroş AŞ, Kuijpers-Jagtman AM. Proximity of the roots of posterior teeth to the maxillary sinus in different facial biotypes. Am J Orthod Dentofacial Orthop. 2018;154:346-355.
26. Li JL, Kau C, Wang M. Changes of occlusal plane inclination after orthodontic treatment in different dentoskeletal frames. Prog Orthod. 2014;15:41.
27. Davidovitch M, Konstantarakis E, Athanasios V, Sella-Tunis T. Effects of Class II elastics during growth on the functional occlusal plane according to skeletal pattern and extraction vs nonextraction. Angle Orthod. 2023;93:19-25.
28. Farkas LG, Posnick JC, Hreczko TM. Growth patterns of the face: a morphometric study. Cleft Palate Craniofac J. 1992;29:308-15.
29. Al Maaitah EF, Alomari S, Al-Khateeb SN, Abu Alhaija ES. Cranial base measurements in different anteroposterior skeletal relationships using Bjork-Jarabak analysis. Angle Orthod. 2022;92:613-8.
30. Alshahrani I, Kamran MA, Alhaizaey A, Abumelha N. Evaluation of skeletal variations and establishment of Cephalometric Norms in Saudi Sub Population using Bjork Jarabak's analysis. Pak J Med Sci. 2018;34:1104-1109.
31. Kuramae M, Magnani MB, Boeck EM, Lucato AS. Jarabak 's cephalometric analysis of Brazilian black patients. Braz Dent J. 2007;18:258-62.
32. Nabeel FT, Barakati SF. cephalometric measurements of a Saudi adult sample according to Jarabak's analysis. Pak Oral Dent J. 2009;29:281-286.
33. Nanda SK. Growth patterns in subjects with long and short faces. Am J Orthod Dentofacial Orthop. 1990;98:247-58.
34. Mohammadi Shayan A, Behroozian A, Sadrhaghighi A, Moghaddam SF, Shahmorad Moghanlou A, Amanabi M. Prevalence of dental anomalies in different facial patterns and malocclusions in an Iranian population. J Oral Biol Craniofac Res. 2022;12:525-528.
35. Magnani MBB de A, Nouer DF, Kuramae M, Lucato AS, Boeck EM, Vedovello SAS. Evaluation of facial pattern in Black Brazilian subjects. Braz. J. Oral Sci. 2016;6:1428-31.
36. Amatya S, Shrestha RM, Napit S. Growth pattern in skeletal class I malocclusion: a cephalometric study. Orthod J Nepal. 2021;11:49-54.
37. Björk A. Prediction of mandibular growth rotation. Am J Orthod. 1969;55:585-99.
38. Chang YI, Moon SC. Cephalometric evaluation of the anterior open bite treatment. Am J Orthod Dentofacial Orthop. 1999;115:29-38.
39. Kim YH. Overbite depth indicator with particular reference to anterior open-bite. Am J Orthod. 1974;65:586-611.