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Research Article

Evaluation of Facial Depth in Skeletal Class II Cases of Maxillary Origin: A Cephalometric Analysis

İsmail Korhan Gider, DDS, PhD[1], Hüseyin Ölmez, DDS, PhD[2], Ragıp Burak Örsçelik, PhD[3*]

[1] *Private Practice, İzmir, Türkiye.*
[2] *Private Practice, Ankara, Türkiye.*
[3] *Health Sciences University, Faculty of Dentistry, Department of Orthodontics, Ankara, Türkiye.*
**Corresponding author: rborscelik@hotmail.com*

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Abstract

Statement of the problem: The literature currently lacks sufficient data on the correlation between the average facial depth distance and its relationship with the anterior facial height in individuals presenting with skeletal Class II malocclusion of maxillary origin.

Objective: This study aims to examine the extent of average facial depth in individuals with maxillary-based Class II malocclusion and to assess the correlation between average facial depth and anterior facial height.

Materials and Methods: The study included 712 individuals with Class III malocclusion, with 361 being female and 351 male. Cephalometric radiographs of the participants were used to identify the pogonion (Po), nasion (N), Frankfort Horizontal plane (FH), condylion (Co), and menton (Me) points. The distance from point Co projected onto the FH plane to point N (Co'-N') was determined as the facial depth distance, while the distance between points N and Me was considered the anterior facial height distance. Subsequently, the facial depth distances of all individuals were measured and ratioed with the anterior facial height distance to establish standardized ratios for maxillary-based Class II cases.

Results: The mean facial depth measurement (Co'-N') is 86±5mm, with a corresponding ratio to the anterior facial height (N-Me) of 69±5%. When categorized by facial morphology, this ratio was determined to be 67±4% for individuals with longer faces, 68±4% for those with average facial lengths, and 70±5% for individuals with shorter facial lengths.

Conclusions: Utilizing the Co'-N'/N-Me ratio in cephalometric analysis could provide a fresh perspective on evaluating skeletal Class II malocclusions arising from maxillary development.

Keywords: Skeletal Class II Malocclusion, Anterior Facial Height, Facial Depth, Jarabak Ratio, Cephalometric Analysis.

Introduction

With growth and development, the sizes and volumes of the bones that make up the jaw facial skeleton increase, and their relationships to each other change. All structures forming the craniofacial complex mature as a result of balancing their relationships with each other vertically, sagittally, and transversely.[1,2] The normal growth and development of facial structures occur with the downward and backward movement of the glenoid fossa, the forward and downward displacement of the nasomaxillary complex, the vertical development of alveolar structures, and the growth and development occurring in the condyle. The harmony of growth and development in the condyle with other structures allows for balanced development of the face downward and forward, resulting in the emergence of normal relationships. Disruption of this delicate balance due to minor changes leads to dental or skeletal anomalies.[1-3] If the relationships between the lower and upper jaw bones carrying the teeth and the base of the skull are normal, but only the relationships between the teeth and dental arches are disrupted, dental anomalies occur. If the relationships between the lower and upper jaw bones or with the base of the skull are disrupted, skeletal anomalies occur. These anomalies are examined and classified into three groups in terms of vertical, sagittal, and transversal planes, and they occur as a result of disruptions in these relationships.[3]

Vertical anomalies can be identified by examining the angles between the mandibular plane (Go-Me) and the palatal plane (ANS-PNS) as well as the angle between the mandibular plane and the cranial base plane (S-N) in lateral cephalometric radiographic evaluations. In vertical analysis, the Jarabak ratio must also be taken into consideration.[4] Gazilerli[4] determined the mean value of the S-N/Go-Me angle to be 31.31±5 degrees in Ankara children aged 13-16 years exhibiting ideal occlusion. The researcher reported that cases with angles less than 26 degrees may indicate skeletal deep bite, while cases with angles greater than 36 degrees may indicate skeletal open bite.[4]

Transversal anomalies are examined in two groups: skeletal lateral crossbite and skeletal buccal or lingual nonocclusion, with a mismatch between the widths of the lower and upper jaw bones. The problem may originate from the lower jaw or the upper jaw. For example, in cases of hereditary Class III malocclusion with mandibular protrusion, which usually involves excessive development of the mandible in all three directions, the term skeletal lateral crossbite originating from the lower jaw is often used.[3]

In the sagittal plane, the elements determining the relationships between the lower and upper jaws and the cranial base are the SNA, SNB, and ANB angles. Anteroposterior classifications are made taking into account the ANB angle. According to international norms, the SNA angle is stated as 82 degrees, the SNB angle as 80 degrees, and thus the ANB angle as 2 degrees.[3] Gazilerli[4] determined the average values for Turkish children aged 13-16 with ideal occlusion in Ankara as SNA=81, SNB=78, and ANB=3 degrees. When classified based on the ANB angle, cases with an ANB angle between 2±2 (0-4) degrees are classified as skeletal Class I; cases with an ANB angle greater than 4 degrees are classified as skeletal Class II; and cases with an ANB angle below zero are classified as skeletal Class III anomalies.[3]

The subject of the current study, Class II malocclusions, are characterized by an increased ANB angle, with Class II Division 1 malocclusions characterized by an increase in overjet, and Class II Division 2 malocclusions characterized by an increase in overbite. However, Class II malocclusions can also be examined in four groups: dentoalveolar, functional or neuromuscular, skeletal, and dentoalveolar and skeletal combinations.[5,6] Class II malocclusions are described in four different components in the anteroposterior direction: maxillary skeletal position, maxillary dentoalveolar position, mandibular dentoalveolar position, and mandibular skeletal position.[7-15]

Until today, various analysis methods have been proposed for individuals with skeletal Class II malocclusion using different reference points and planes to determine their relationships accurately.[15-20] However, to date, there is almost no data on Turkish individuals with skeletal Class II malocclusion regarding the average facial depth and the relationship between this distance and anterior facial height.

The aim of the current study is to determine the average facial depth distance in Turkish individuals with skeletal Class II malocclusion of maxillary origin and to investigate the relationship between this distance and anterior facial height.

Materials & Methods

This study was conducted in accordance with the Helsinki Declaration of 1975. The necessary sample size for the study was calculated using GPower Ver. 3.00.10 (GPower Franz Faul, Germany) software, taking into account possible data losses.

The study group was formed by including cephalometric radiographs of a total of 712 individuals, 361 female and 351 male, with skeletal Class II malocclusion. Cephalometric radiographs were divided into two main groups, female and male. For statistical analysis to detect differences between girls and boys, the overall group was considered. The overall group was further divided into three subgroups according to chronological age to show a balanced distribution considering growth and development differences between girls and boys. Girls and boys aged 9 (inclusive) to 13 (inclusive) were classified as Group I, those aged 14 (inclusive) to 20 (inclusive) as Group II, and those aged 21 and above as Group III. In the overall group, individuals aged 9 (inclusive) to 13 (inclusive) were classified as Group I, those aged 14 (inclusive) to 20 (inclusive) as Group II, and those aged 21 and above as Group III.

Lateral cephalometric radiographs were obtained with the jaws in centric occlusion and the Frankfort horizontal plane parallel to the ground. On the obtained radiographs, the following points were marked with a 0.3 mm pencil: Sella (S), Nasion (N), Anterior Nasal Spine (ANS), Posterior Nasal Spine (PNS), A Point (A), B Point (B), Menton (Me), Constriction Gonion (Co-Go), Orbit (Or), Pterygoid Point (Ptm), Condylion (Co), Porion (Po), Pogonion (Pog), N' (projection of nasion point on the FH plane), ANS' (projection of ANS on the FH plane), PNS' (projection of PNS on the FH plane), A' (projection of A point on the FH plane), B' (projection of B point on the FH plane), Pog' (projection of Pogonion on the FH plane), Ptm' (projection of Ptm point on the FH plane), S' (projection of sella point on the FH plane), Co' (projection of condylion point on the FH plane), and Go' (projection of constriction gonion point on the FH plane) (Figure 1).

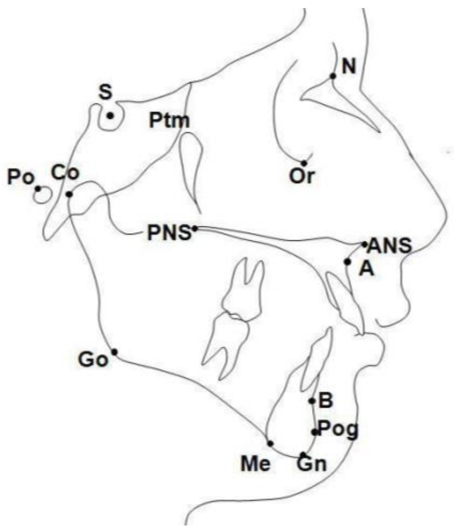

Figure 1. Anthropometric points used in cephalometric analysis.

On the cephalometric radiographs, planes were drawn including the SN plane (passing through the Sella and Nasion points), the FH plane (passing through the Porion and Orbit points), and the Nv plane (perpendicular to the FH plane and descending from N'). Subsequently, the distances Co-A, Co-Pog, Nv-A, Nv-Pog, ANS'-Or, N'-Or, PNS'-Or, A'-Or, B'-Or, Pog'-Or, Ptm'-Or, S'-Or, Go'-Or, and Co'-Or were measured (Figure 2).

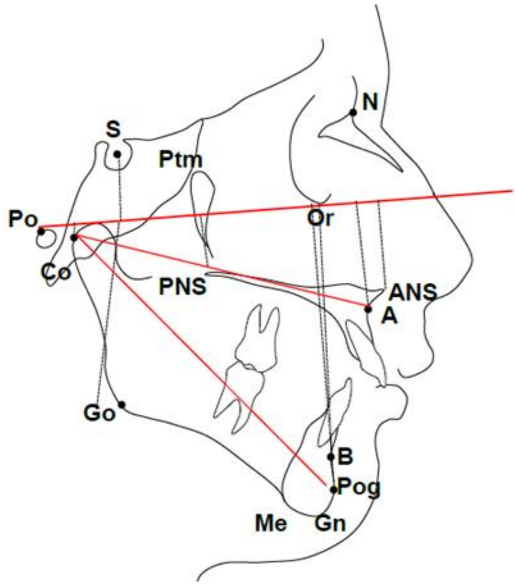

Figure 2. Distance measurements.

Finally, on the cephalometric radiographs, the SNA, SNB, and ANB angles were measured (Figure 3).

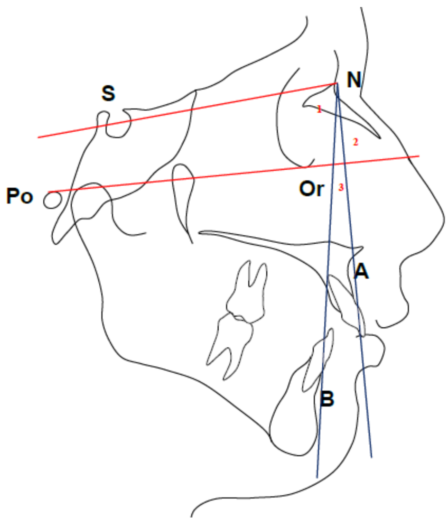

Figure 3. SNA, SNB and ANB angles.

The Jarabak ratio (S-Go/N-Me) and Co-A/Co-Pog ratios were calculated from the values obtained from the measurements.

Results

The obtained data were analyzed using SPSS for Windows, Version 15.00 (SPSS Inc., USA). First, a descriptive statistical analysis of the obtained data was conducted. Next, an independent samples t-test was used to determine the significance of differences between two independent means to assess differences in the measurements obtained based on gender. To assess differences based on age groups, one-way analysis of variance (ANOVA) was used. In cases where differences were found in the ANOVA results, Tukey and Bonferroni post-hoc tests were applied to determine which age group(s) contributed to the difference. A significance level of P<0.05 was considered indicative of a significant difference in statistical decisions.

The descriptive statistics results obtained from cephalometric analyses are provided in Table 1, Table 2, Table 3, and Table 4.

Table 1. Descriptive values obtained from the analysis of angular measurements.

	Minimum	Maximum	Mean	Standard Deviation
SNA⁰	75.90	86.30	82.01	2.16
SNB⁰	65.60	81.80	75.42	2.74
ANB⁰	0.40	13.10	6.59	1.89

Table 2. Descriptive values obtained from the analysis of distance measurements.

	Minimum	Maximum	Mean	Standard Deviation
NV-A (mm)	-9.10	13.90	-0.37	2.69
NV-Pog (mm)	-30.70	3.50	-12.80	5.74
Co-A (mm)	73.80	119.80	92.18	7.16
Co-Gn (mm)	82.80	151.10	116.59	9.70
N-Me (mm)	99.60	169.10	125.29	10.37
N-ANS (mm)	40.50	80.60	56.90	5.24
ANS-Me (mm)	55.40	102.00	72.04	7.21
S-Go (mm)	56.10	111.80	80.53	8.27
ANS'-O' (mm)	9.90	34.20	20.57	3.67
A'-O' (mm)	2.20	25.00	14.14	3.37
B'-O' (mm)	0.00	14.20	4.03	3.02
Co'-O' (mm)	55.70	97.40	72.14	6.20
Go'-O' (mm)	54.50	91.50	68.88	6.70
N'-O' (mm)	6.60	25.70	14.54	3.18
PNS'-O' (mm)	23.70	57.50	35.63	4.45
Pog'-O' (mm)	0.00	17.00	4.76	3.49
PTM'-O' (mm)	27.30	88.30	38.30	5.27
S'-O' (mm)	44.90	76.40	57.74	4.66

Co'-N' (mm)	69.50	113.90	86.59	7.31

Table 3. Descriptive statistics results for proportional values.

	Minimum	Maximum	Mean	Standard Deviation
S-Go/N-Me %	63,42	6,93	42,17	79,80
Co'-N'/N-Me %	68,97	5,28	55,93	91,43
S-Go/Co'-N' %	92,23	10,11	44,26	122,94
N'-O/Co'-N' %	19,11	2,95	10,32	27,90
Co'-O/Co'-N' %	80,89	2,95	72,10	89,68

The analysis of measurements obtained from girls and boys using the t-test revealed significant differences in the following values: Co-A (P=0.012), Co-Gn, N-Me (P=0.005), ANS-Me (P=0.027), S-Go (P=0.010), A'-O' (P=0.001), N'-O' (P=0.001), Co'-N' (t=2.750; P=0.006), N'-O'/Co'-N' (P=0.006), and Co'-O'/Co'-N' (P=0.001). When comparing age groups, significant differences were observed in the SNA (P=0.026), ANS'-O' (P=0.045), and Go'-O' (P=0.021) values. To determine which age groups contributed to these differences, a Tukey post-hoc test was conducted, revealing that the significant differences in the ANS'-O' and Go'-O' distances and the SNA angle stemmed from differences between individuals aged 14-20 and those aged 21 and above (respectively; P=0.034, P=0.021, and P=0.026).

In the statistical analysis conducted using the Student's t-test, significant differences were found between girls and boys aged 9-13 in the following parameters: Co-A (P=0.022), N-ANS (P=0.012), ANS'-O' (P=0.002), Co'-O' (P=0.001), Go'-O' (P=0.002), PNS'-O' (P < 0.001), PTM'-O' (P=0.014), S'-O' (P=0.026), Co'-N' (P=0.004), Co'-N'/N-Me (P=0.009), and S-Go/Co'-N' (P < 0.001).

Among individuals aged 14-20, significant differences were observed between girls and boys in the following parameters: Co-A (P=0.005), Co-Gn (P=0.008), N-Me (P=0.008), ANS-Me (P=0.014), S-Go (P=0.016), ANS'-O' (P=0.004), A'-O' (P < 0.001), N'-O' (P < 0.001), PNS'-O' (P=0.042), Co'-N' (P=0.001), N'-O'/Co'-N' (P=0.004), and Co'-O'/Co'-N' (P=0.001). In individuals aged 21 and above, significant differences were found in the following parameters: ANB (P=0.029), Co-A (P < 0.001), Co-Gn (P < 0.001), N-Me (P=0.005), N-ANS (P=0.007), A'-O' (P=0.020), Co'-O' (P < 0.001), Go'-O' (P=0.022), N'-O' (P=0.006), PNS'-O' (P < 0.001), S'-O' (P < 0.001), Co'-N' (P < 0.001), and S-Go/Co'-N' (P=0.015).

In the two-way analysis of variance comparison of parameters, significant differences were found in individuals aged 21 and above, between girls and boys, in the following measurements: Co-A (P=0.001), Co-Gn (P=0.001), N-Me (P=0.005), N-ANS (P=0.007), A'-O' (P=0.020), Co'-O' (P=0.001), Go'-O' (P=0.022), N'-O' (P=0.006), PNS'-O' (P=0.001), S'-O' (P=0.001), Co'-N' (P=0.001), and N'O'/Co'-N' (P=0.001). In the 14-20 age group, significant differences were observed in the following measurements: Co-A (P=0.005), Co-Gn (P=0.008), N-Me (P=0.008), ANS-Me (P=0.014), S-Go (P=0.016), ANS'-O' (P=0.004), A'-O' (P=0.001), N'-O' (P=0.001), PNS'-O' (P=0.042), Co'-N' (P=0.001), N'O'/Co'-N' (P=0.004). In the 9-13 age group, significant differences were found in the following measurements: Co-A (P=0.022), N-ANS (P=0.012), ANS'-O' (P=0.002), Co'-O' (P=0.001), Go'-O' (P=0.002), PNS'-O' (P=0.001), PTM'-O' (P=0.014), S'-O' (P=0.026), Co'-N' (P=0.004), Co'-N'/N-Me (P=0.009), S-Go/Co'-N' (P < 0.001), and Co'-O'/Co'-N' (P=0.015).

In cephalometric radiographs, facial height was classified as short (<62%), normal (62-65%), and long (>65%) based on the Jarabak ratio (S-Go/N-Me). Subsequently, the Co'-N'/N-Me ratios obtained from 712 cephalometric radiographs were compared using the Tukey Post-Hoc Test. In all comparisons between short/normal, normal/long, and short/long facial groups, the Co'-N'/N-Me ratio was found to be statistically significant (P < 0.001 for all).

Discussion

In cases of mandibular skeletal Class II malocclusion, current cephalometric analyses may be inadequate for determining the sagittal and vertical relationships between the upper and lower jaws. The authors of this study, recognizing the limitations of current analyses in mandibular skeletal Class II cases, believed that values obtained from the ratio of facial depth to anterior facial height could provide important clues for diagnosis and treatment monitoring. Therefore, the study focused on linear measurements and ratios rather than angular measurements.

In the present study, numerous cephalometric points were reviewed to determine the boundaries of facial depth distance. Although the CC point (the projection of Ptm on the FH plane) was considered as a more stable point than Condylion for determining the posterior boundary of facial depth, it was ultimately decided to abandon the idea of using the CC point as Ricketts[18] suggested that the CC point may not precisely represent the posterior boundary of facial depth. In Harvold's analysis[21], Co-A distance was accepted as the effective midfacial length, suggesting that selecting the Condylion point for the facial depth distance would be appropriate in the present study. Furthermore, in Harvold's analysis[21], the Harvold Triangle was defined by the edges formed by the effective midfacial length (Co-A), the effective mandibular length (Co-Gn), and the ANS-Me distance. Therefore, for the facial depth distance, the Co'-N' distance, which connects the projections of the Co and N points on the FH plane, was chosen. Additionally, in the present study, it was decided that the portion of the Co'-N' distance anterior to the orbita point would represent the anterior part of facial depth (N'-O'), while the portion posterior to the orbita point would represent the posterior part of facial depth (Co'-O').

The Condylion point is an anthropometric point that can be challenging to mark on cephalometric radiographs. However, in the present study, this difficulty was overcome by removing the metallic recording markers from the ear rods during radiograph acquisition and maximizing the quality of the obtained radiographs.[21] Although the Frankfort Horizontal (FH) plane, which is determined as the reference plane, may not be considered reliable in some sources[22], the use of the anatomical porion instead of the ear rods and the high quality of cephalometric radiographs obtained with advancing technology have made the FH plane quite reliable in our opinion.[23] Therefore, in the present study, FH, which has been used in numerous previous studies, was accepted as the reference plane.

In the present study, the statistically significant difference in the selected facial depth distance between males and females is thought to be due to the larger cranial structures in males compared to females.[23] This excess observed in males is consistent with the results of studies by Wylie[19] and Burstone.[24] However, it has been reported by McNamara[17] that the facial depth distance does not only increase with gender but also with age. The results of the present study are in line with the results of previous studies in this respect as well.

In the present study, the ratio of the anterior facial depth to the total facial depth (N’-O/Co’-N’) and the ratio of the posterior facial depth to the total facial depth (Co’-O/Co’-N’) were evaluated. The results of the study indicate that the values of the anterior facial depth are influenced by gender in favor of males. However, when the anterior facial depth (N’-O/Co’-N’) was examined in terms of age groups, no significant changes were found in either gender. This result may be due to the similarity in the amount of change in N’-O distance compared to the change in facial depth distance (Co’-N’). The values of the posterior facial depth, on the other hand, were found to be influenced by gender in favor of females. When the posterior facial depth (Co’-O/Co’-N’) was examined in terms of age groups, a non-significant decrease was observed in both genders, and it was thought that this decrease might be related to the level of similarity between the changes in Co'-O distances and the changes in facial depth distance (Co'-N').

When the obtained data was evaluated, it was determined that the mean facial depth distance (Co'-N') was 86±5 mm, and the ratio of this distance to the anterior facial height (N-Me) was 69±5%. The ratio of the facial depth distance to the anterior facial height was determined to be 67±4% in individuals with long faces, 68±4% in normal individuals, and 70±5% in individuals

Conclusion

In the Turkish population consisting of 712 individuals with maxillary-based skeletal Class II, the mean facial depth distance is 86±5 mm, and the ratio of this distance to the anterior facial height (N-Me) is approximately 69±5%.

References

1.Enlow DH. Handbook of facial growth. 2nd edition. Philadelphia: WB Saunders Company; 1982. p. 1-12.

2.Erenoğlu N. Kraniyofasiyal yapının üç boyutlu incelenmesi. A.Ü.Diş Hek. Fak. Ortodonti anabilim dalı doktora tezi, Ankara, 1990.

3.Rotberg S. Fried N, Kane J, Shapiro E. Predicting the wits appraisal from the ANB angle. Am J Orthod Dentofacial Orthop 1980;77:636-42.

4.Gazilerli Ü. Normal kapanışlı 13-16 yaşlar arasındaki Ankara çocuklarında Steiner normları Doçentlik Tezi, Ankara, 1976.

5.Angle EH. Treatment of malocclusion of the teeth and fractures of the maxilla. 6 ed. S.S. White, Philadelphia and Europen norms. Angle Orthod 1900;71:170-176.

6.Droel R, Isaacson RJ. Some relationships between the glenoid fossa position and various skeletal discrepancies. Am J Orthod Dentofacial Orthop 1972;6:164-78.

7.Altemus LA. Horizontal and vertical relationship in normal and ClassII division 1 malocclusion in girls 11-15 years. Angle Orthod 1955;5:120-37.

8.Bacon W, Girardin P, Turlot JC. A Comparison of cephalometric norms for the African Bantu and a Caucasoid population. Eur J Orthod 1983;5:233-240.

9.Baldridge JP. A study of the relation of the maxillary first permanent molar to the face in Class I and Class II malocclusions. Angle Orthod 1941;11:100-109.

10.Başçiftci FA, Uysal T, Büyükerkmen A. Craniofacial structure of Anatolian Turkish adults with normal occlusions and well-balanced faces. Am J Orthod Dentofacial Orthop 2004;125:366-72.

11.Baume RM, Buschang PH, Weinstein S. Stature, head height, and growth of the vertical face. Am J Orthod Dentofacial Orthop 1983;83:477-484.

12.Baughan B, Demirjian A, Levesque GY, LaPalme-Chaput L. The pattern of facial growth before and during puberty as shown by French-Canadian girls. Ann Hum Biol 1979;6:59-76.

13.Beatty EJ. A modified technique for evulating apical base relationship. Am J Orthod 1975;68: 303-315.

14.Feldmann I, Lundstrom F, Peck S. Occlusal changes from adolescence to adulthood in untreated patients with Class II Division 1 deepbite malocclusion. Angle Orthod 1999;69:33-38.

15.Burstone, CJ., James, RB, Legan HL, Murphy GA, et al. Cephalometrics for orthognathic surgery. J Oral Surg 1978;36:269-77.

16.Downs W.B. Variation in facial relationship: their significance in treatment and prognosis. Am J Orthod 1948;34:812-40.

17.McNamara JA. A method of cephalometric evaluation, Am J Orthod Dentofacial Orthop 1984;86:449-69.

18.Ricketts RM. A foundation for cephalometric communication. Am J Orthod Dentofacial Orthop 1960;46:330-57.

19.Wylie WL. The assessment of anteroposterior dyspiasia. Angle Orthod 1947;17:97-109.

20.Steiner CC. Cephalometrics in clinical practice. Angle Orthod 1959;29:8-29.

21.Harvold EP. The Activator in interceptive orthodontics. 1st edition. St. Louis: Mosby Co; 1974. p. 33-121.

22.Steiner CC. Cephalometrics for you and me. Am J Orthod Dentofacial Orthop 1953;39:729-755.

23.Schulholf J. Manual R.M.D.S computerized cephalometrics. Revised 1st edition. California: Sherman Oaks: 1973. p. 22-25.

24.Freeman RS. Adjusting ANB angles to reflect the effect of maxillary position. Angle Orthod 1981;51:162-71.