Cephalometric comparison of sagittal lip position between patients with skeletal Class II divisions 1 and 2 using different reference lines

Arūnas Vasiliauskas[1], Greta Margelytė[1], Kristina Lopatienė[1], Antanas Šidlauskas[1], Rimas Adaškevičius[2]

1Clinic of Orthodontics, Odontology Faculty, Medical Academy, Lithuanian University of Health Sciences.
2Department of Electric Power Systems, Faculty of Electrical and Electronics Engineering, Kaunas University of Technologies.

ABSTRACT

Objective: The objectives of this study were (1) to evaluate and compare sagittal lip position between skeletal Class II division 1 and 2 patients according to different cephalometric reference lines and (2) to evaluate the interrelation of the sagittal lip position and the inclination of the incisors.
Materials and Methods: A total of 100 patients with skeletal Class II (ANB>4°) and finished adolescent growth peak, evaluated with an improved version of the cervical vertebral maturation (CVM) method, were distributed into division 1 and 2, based on the inclination of the upper incisors. The inclination of upper and lower incisors was assessed by various methods. Sagittal lip position was evaluated using Burstone B, Ricketts E, Steiner S, and Holdaway H reference lines. For statistical analysis SPSS Statistics 17.0 software was used. Mann-Whitney U test and Student's t-test were applied to evaluate the significance of the average difference between samples while LS least squares method assessed the dependence between the samples. Level of significance was set at $p < 0.05$.
Results: Division 1 patients showed statistically significant higher sagittal upper and lower lip position values than division 2 patients. According to the B line, the upper lip value was 4.79±1.81 mm in division 1 and 2.29±1.37 mm - in division 2, while the lower lip values were 3.23±3.01 mm and 0.76±1.78 mm, respectively. Due to the E line, the respective values were -1.07±2.38 mm and –4.40±1.78 mm in the upper lip and S line values were 1.46±2.01 mm and -1.56±1.49 mm, respectively. A statistically significant dependence was found between sagittal lip position and incisor inclination.
Conclusions: Skeletal Class II division 1 patients had more protrusive upper and lower lips, compared to division 2 patients. Sagittal lip position highly depended on the inclination of the incisors.

Keywords: cephalometry; orthodontics, Class II malocclusion

INTRODUCTION

Lateral cephalometric radiography, as a useful tool in orthodontics, was first presented by Broadbent [1] and has successfully been used ever since. Cephalometric analysis, which includes linear and angular measurements, is an effective diagnostic method that assists in the evaluation of facial morphology, the prediction of skeletal growth, the planning of orthodontic treatment, and the evaluation of treatment outcomes. [2] In today's orthodontic treatment it is essential to estimate thoroughly not only skeletal and dental, but also soft tissues parameters. The cephalometric analysis is a simple, cheap, and sufficiently informative diagnostic technique, and the generated 2D images along with evaluation results are sufficiently reliable and may be an alternative to 3D imaging in the evaluation of soft tissue. Numerous studies have been conducted in order to evaluate the influence of orthodontic treatment on the soft tissue profile. Stamenković et al. [3] proved that when applying various treatment methods that affect skeletal and dental structures, the soft tissue profile may change as well. Kasai [4] in his study concluded that soft tissues do not necessarily equally follow the changing hard tissue profile during orthodontic treatment: some soft tissue structures are closely related to underlying hard tissues, while others are more influenced by such factors as function, thickness, and length. The authors agree that the patient's final profile highly depends on soft tissues, especially those that vary in thickness.[5-7] Hence, failure to explore the soft tissue profile may prevent the most accurate prediction of

treatment outcomes.
Many authors showed a great interest in exploring what impact altering the position of the incisors has on the soft tissue profile. A study by Meyer-Marcotty et al.[8] where skeletal Class II patients' profiles were investigated before and after treatment with the Herbst appliance, revealed important changes, such as a reduction in the red margin of the upper lip, an increase in the lower lip height, mentolabial sulcus reduction, and a flatter facial profile. Significant lip changes were observed when premolar extraction treatment was applied. The results of a study by Verma et al.,[9] showed that patients from the extraction treatment group had more retrusive both upper and lower lips. A study by Amirabadi et al.,[10] where the patients' lip parameters were evaluated before the extraction of the upper first premolars and after the extraction treatment, showed a significant reduction in the upper lip protrusion and a significant reduction in the lower lip protrusion and facial convexity when crowding was more than 4 mm. On the other hand, there are controversial data from a study conducted by Khan and Fida[11] who stated that even during the treatment, patients treated with premolar extractions showed more retruded upper and lower lips than did patients treated without extractions, while at the end of the treatment, their soft tissue profiles did not differ. Another recent study by Rathod et al.,[12] which compared long-term soft tissue changes between patients treated with extraction and patients that had no treatment, also concluded that the soft tissue profile between the groups was similar at the endpoint.
As many studies have shown, orthodontic treatment may alter lip position by changing the inclination of the incisors, and therefore soft tissues, especially lips, have to be carefully evaluated before choosing the type of the treatment. There are studies assessing lip parameters in different malocclusions[13,14] and comparing different methods of the evaluation of the sagittal lip position [14].
However, these studies do not evaluate very important parameters, such as nose length and chin thickness, which usually are the reference points for sagittal lip position measurements. Neither do they evaluate lip thickness, which has a direct influence on sagittal lip position measurements. Moreover, none of these studies divide skeletal Class II patients into divisions, but rather investigate them as a single sample regardless of the evident differences in the anterior teeth between the divisions. As mentioned above, the incisor position may affect lip position, and therefore investigating Class II patients as a single unit might provide imprecise results. The objectives of this study were (1) to evaluate and compare sagittal lip position between skeletal Class II division 1 and 2 patients according to different reference lines and (2) to evaluate the dependence of the sagittal lip position on the inclination of the incisors.

MATERIAL AND METHODS

Sample

This retrospective study comprised of 100 randomly selected pre-orthodontic patients from the "Dolphin imaging 11" (Dolphin Imaging and Management Solution) database of the of the Clinic of Orthodontics of Lithuanian University of Health Sciences. The power of the research was 0.8, when the Type I error rate was 0.05. The inclusion criteria were the following: (1) skeletal Class II, which was established according to Steiner's method, where ANB was evaluated.[15] Patients with skeletal Angle Class II (ANB angle >4°) were included in the study. (2) Finished adolescent growth peak; its evaluation was based on an improved version of the cervical vertebral maturation (CVM) method.[16] According to this method, adolescent growth peak occur between vertebral development stages 2 and 3, and therefore patients with stages 3, 4, and 5 were included in this study. All the selected patients were divided into 2 groups according upper incisor inclination which was estimated with different methods: upper incisor inclination in relation to the cranial base,[17] in relation to the NA line,[15] in relation to the Frankfort horizontal,[17] and in relation to the palatal plane.[18] Patients with protruded incisors were considered as division 1 and patients with retruded incisors were marked as division 2. Every division had 50 patients: 36 girls and 14 boys. The study was conducted with the permission of the Kaunas Regional Biomedical Research Ethics Committee (February 9, 2015, No. BE-2-12).
Collection of cephalometric analysis data
The cephalograms were taken in centric occlusion under standard conditions using digital x-ray equipment. To minimize radiation doze digital cephalometric system Kodak 8000C was used and ALARA radiation safety principle was followed. For standardized positioning, a cepha-

lostat was used to maintain the subject's head in constant relationship to the sensor (sensor-focus distance - 1.50 m, object-sensor distance - 0.15 m). This in turn standardized the distance of the subject to the sensor, x-ray exposure, and magnification exposure. All subjects were asked to stand looking straight forward, with a lead apron on their chest. Ear rods were placed into the ear canals in a comfortable position, and the orbital pointer was accurately positioned.

Definitions of cephalometric landmarks used in this study are presented in Table 1. Planes and lines are presented in Table 2. Angular and linear measurements and their definitions are shown in Table 3.

The inclination of the lower incisors was estimated using 3 methods: lower incisor inclination in relation to line NB,[15] in relation to the mandibular plane,[17] and in relation to the occlusal plane [17]. For the evaluation of the sagittal lip position, 4 different reference lines were used: Burstone B line,[19] Steiner S line,[15] Holdaway H line,[5] and Ricketts E line.[20] (Figure 1)

The sagittal lip position was assessed in millimeters by measuring the distance between the most prominent lip point to the reference line.

Lip thickness was assessed by applying Arnett's method.[21] Upper lip thickness was measured from the upper lip vermillion point ULA to the upper lip inside, while lower lip thickness – from the lower lip vermillion point LLA to the lower lip inside. Nose depth was measured from point Sn to point Pr,[22] while chin thickness was evaluated by measuring the distance from point Pog to point Pog' [21].

METHOD ERROR

The reliability of the method was tested by measuring 20 randomly selected lateral cephalograms. The intraclass correlation coefficient was used to estimate the difference of measurements between 2 observers [23]. There were no statistical differences found between cephalometric data in different time intervals.

STATISTICAL ANALYSIS

In order to conduct statistical analysis, SPSS Statistics 17.0 software was used. The significance of the average difference between independent samples was evaluated using the Mann-Whitney U test and Student's t-test. Correlation between the samples was determined by using Pearson's Correlation and Spearman's Correlation coefficient. To evaluate the dependence between the samples, the LS least squares method was applied. The difference in soft tissue thickness between female and male patients was measured according to the t-test for the equality of means. The level of significance for the analysis was set at $p < 0.05$.

RESULTS

The angle ANB value was 5.59±0.98° in division 1 patients and 5.54±0.88° - in division 2 patients. This difference between the divisions was not statistically significant ($p = 0.76$), meaning that those two samples had equal skeletal Class II.

In order to avoid possible sex-influenced soft tissue differences between boys and girls, which might affect the reference lines when evaluating sagittal lip position, such parameters as lip thickness, nose length, and chin thickness were compared between male and female patients in each division. No statistically significant differences were found between males and females in both divisions. The mean values of lip thickness, nose length, and chin thickness are demonstrated in Table 4.

Hence, no differences between the sexes were found, and further on, male and female patients were considered as a single sample.

A strong correlation was observed between all methods of the evaluation of upper and lower incisor inclination. The upper incisor inclination values were statistically significantly higher in division 1 patients according to all methods. All the applied methods also showed that division 1 patients had more protrusive lower incisors. This difference was statistically significant when assessed by the L1-NB and L1-Occ methods. The descriptive analysis of incisor inclination values is shown in Table 5.

A strong correlation was found between all methods of the evaluation of sagittal upper and lower lip position. The descriptive analysis of sagittal lip position is demonstrated in Table 6.

All methods indicate that division 1 patients had statistically significantly higher upper and lower lip sagittal position values.

A statistically significant dependence was found between the sagittal upper lip position assessed by Steiner's and Burstone's methods and upper incisor inclination evaluated by all methods ($p < 0.001$). When the sagittal upper lip position was evaluated by using the Ricketts method, it demonstrated a statistically significant depend-

ence on all the methods of the evaluation of upper incisor inclination (p < 0.001), except for the U1-Pal method, in which case the dependence was not statistically significant (p = 0.219).
Sagittal lower lip position, evaluated by all reference lines, demonstrated a statistically significant dependence on lower incisor inclination assessed by all methods. All values were p <0.05. Both upper and lower lips were thicker in division 1 patients, but this difference was not statistically significant (upper lip p = 0.055, and lower lip p = 0.762). Mean upper lip thickness values were 12.05±2.31 mm in division 1 and 11.12±2.47 mm - in division 2, while lower lip thickness values were 8.90±2.95 mm and 8.53±1.77 mm, respectively. Nose length values were slightly higher in division 2 patients, but this difference was not statistically significant (p = 0.077). Mean values were 19.22±2.38 mm in division 1 and 20.02±2.51 mm - in division 2. There was no statistically significant difference in chin thickness between the divisions (p = 0.992). Mean values were 11.66±2.18 mm in division 1 and 11.74±1.68 mm - in division 2.

Table 1 Definitions of landmarks used in this study

Landmarks	Definitions
S - Sella	The midpoint of sella turcica.
N - Nasion	The extreme anterior point of the frontonasal suture.
A – Point A	The deepest point in the curvature of the maxillary alveolar process.
B – Point B	The deepest point in the curvature of the mandibular alveolar process.
O - Orbitale	The most inferior point on the infraorbital rim.
Po - Porion	The most superior point of the external acoustic meatus.
ANS – Point ANS	The tip of the anterior nasal spine.
PNS – Point PNS	The tip of the posterior nasal spine.
Go - Gonion	The most convex point along the inferior border of the ramus.
Gn - Gnathion	The midpoint between Pogonion and Menton.
Me - Menton	The most inferior point of the chin.
Pog - Pogonion	The most anterior point of the chin.
Pr - Pronasale	The tip of the nose.
Cm – Point Columella	The most anterior point on the columella of the nose.
Sn - Subnasale	The point at which the nasal septum merges with the upper cutaneous lip in the midsagittal plane.
ULA – Point ULA	The most anterior point of the upper lip.
LLA - Point LLA	The most anterior point of the lower lip.
Pog' – soft tissue Pogonion	The most anterior point of the soft tissue chin.

Table 2 Planes and lines used in this study

Variables	Definitions
FH – Frankfort Horizontal	The line connecting Orbitale and Porion.
Pal - Palatal	The line connecting ANS and PNS.
Occ - Occlusal	The line connecting overlapping cusps of first molars and incisal overbite.
SN – Cranial base	The line connecting Sella and Nasion.
NA **NB**	The line connecting Nasion and point A. The line connecting Nasion and point B.
Burstone B line	The line connecting Subnasale and soft tissue Pogonion.
Ricketts E line	The line connecting Pronasale and soft tissue Pogonion.
Steiner S line	The line connecting point Columella and soft tissue Pogonion.
Holdaway H line	The line connecting point ULA and soft tissue Pogonion.

Table 3 Angular and linear measurements used in this study

Measurements	Variables	Definitions
Angular	ANB	Angle determined by points A, N, and B.
	U1-SN	Angle determined by the longitudinal axis of the upper incisors and the cranial base plane.
	U1-NA	Angle determined by the longitudinal axis of the upper incisors and the line connecting points N and A.
	U1-FH	Angle determined by the longitudinal axis of the upper incisors and the Frankfort horizontal plane.
	U1-Pal	Angle determined by the longitudinal axis of the upper incisors and the Palatal plane.
	L1-NB	Angle determined by the longitudinal axis of the lower incisors and the line connecting points Nasion and point B.
	L1-GoGn	Angle determined by the longitudinal axis of the lower incisors and the line connecting points Gonion and Gnathion.
	L1-Occ	Angle determined by the longitudinal axis of the lower incisors and the Occlusal plane.
Linear	ULA – B line	Distance between point ULA and B line in mm.
	LLA – B line	Distance between point LLA and B line in mm.
	ULA – E line	Distance between point ULA and E line in mm.
	LLA – E line	Distance between point LLA and E line in mm.
	ULA – S line	Distance between point ULA and S line in mm.
	LLA – S line	Distance between point LLA and S line in mm.
	LLA – H line	Distance between point LLA and H line in mm.
	ULA – upper lip inside	Distance between point ULA and the upper lip inside in mm.
	LLA – lower lip inside	Distance between point LLA and the lower lip inside in mm.
	Sn-Pr	Distance between Subnasale and Pronasale.
	Pog-Pog	Distance between Pogonion and soft tissue Pogonion.

Table 4 Descriptive analysis of lip thickness, nose length, and chin thickness in female and male subjects.

	Division 1					Division 2				
	Female (n=36)		Male (n=14)		P	Female (n=36)		Male (n=14)		P
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Cephalometric variables										
Upper lip thickness (mm)	11.86	2.39	12.54	2.11	NS	10.96	2.52	11.52	2.38	NS
Lower lip thickness (mm)	8.77	3.10	9.22	2.59	NS	8.80	1.76	7.84	1.65	NS
Nose length (mm)	18.98	1.83	19.82	3.43	NS	20.22	2.55	19.49	2.43	NS
Chin thickness (mm)	11.48	2.15	12.12	2.27	NS	11.63	1.77	12.02	1.42	NS

N.S. – not significant

Table 5 Descriptive analysis of the inclination of upper and lower incisors.

	Division 1			Division 2			
	Mean	SD	SE	Mean	SD	SE	P
Cephalometric variables							
U1-SN (°)	113.40	4.90	0.69	94.07	6.42	0.91	< .05*
U1-NA (°)	31.57	4.42	0.62	11.76	5.72	0.81	< .05*
U1-FH (°)	121.32	6.44	0.91	102.11	8.24	1.17	< .05*
U1-Pal (°)	120.10	4.85	0.69	102.60	6.01	0.85	< .05*
L1-NB (°)	26.11	6.43	0.91	22.69	6.82	0.96	< .05*
L1-GoGn (°)	97.99	7.0	0.99	96.12	7.38	0.04	NS
L1-Occ (°)	62.45	6.34	0.90	69.63	6.61	0.93	< .05*

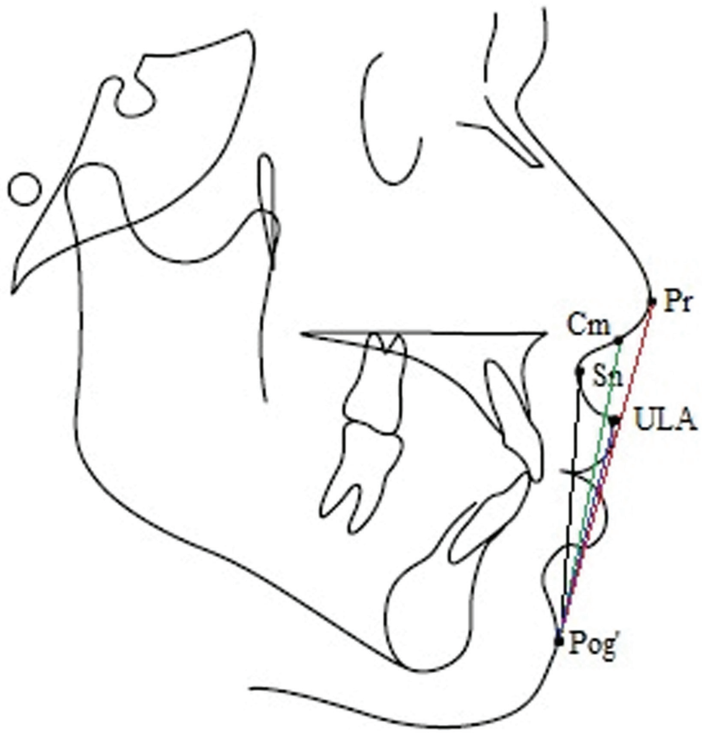
* P < .05; N.S. – not significant

Table 6 Sagittal upper and lower lip position descriptive analysis.

	Upper lip					Lower lip				
	Division 1		Division 2			Division 1		Division 2		
	Mean	SD	Mean	SD	P	Mean	SD	Mean	SD	P
B line (mm)	4.79	1.81	2.29	1.37	< .05*	3.23	3.01	0.76	1.78	< .05*
E line (mm)	-1.07	2.38	-4.40	1.78	< .05*	-0.07	3.12	-3.24	2.03	< .05*
S line (mm)	1.46	2.01	-1.56	1.49	< .05*	1.33	3.04	-1.54	1.90	< .05*
H line (mm)	-	-	-	-		0.53	2.61	-0.58	1.56	< .05*

* P < .05

Figure 1. Reference lines of the sagittal lip position: Burstone B line, Steiner S line, Holdaway H line and Ricketts E line.



DISCUSSION

Many investigators had interest in exploring the interrelation between skeletal class, soft tissue profile and surrounding soft tissues. The main disadvantage of this and similar studies is, that soft tissue parameters are evaluated in 2D view. The greatest accuracy may be achieved when analyzing 3D images, yet the disadvantage of this technique is high costs, and therefore cephalography is used as an alternative technique for the planning of orthodontic treatment.

Zhang et al.13 classified patients into 3 groups: Angle Class I, Angle Class II division 1, and Angle Class III. The aim of the study was to characterize the soft tissue profile (including sagittal lip position) specific to every group. The results showed that Angle Class II division 1 patients had more protrusive upper and lower lips, compared to Angle Class I patients. The upper lip was also found to be more protrusive than the lower lip. A study by Joshi et al.14 focused more on the sagittal lip position, and its aim was to evaluate differences in the sagittal lip position between different skeletal classes. The researchers reached the conclusion that the Sushner line was most suitable for the evaluation of the sagittal lip position in Chinese population with skeletal Class I and Class II patients, and the Burstone line was most suitable for Class III patients. The main shortcoming of these studies is that skeletal Class II patients were not divided into division 1 and division 2. As the present study revealed, the sagittal position of both upper and lower lips statistically significantly depended on incisor inclination. According to all reference lines, both upper and lower lips were statistically significantly more protruded in division 1 patients. In addition, previous studies did not take into account the parameters that may influence the sagittal lip position, such as lip thickness, nose length, and chin thickness. In the present study, these factors had no influence because neither lip or chin thickness nor nose length differed between the divisions. On the other hand, there are studies claiming that soft tissues adjust to the skeletal anomaly and camouflage it.[24-27] Usually, in this type of studies, skeletal classes are compared, but there also are studies where skeletal Class II divisions were investigated separately.[25,26] The results of the study where soft tissue profiles of patients with different skeletal classes (skeletal Class II division 1 and division 2, and skeletal Class III) were compared to the soft tissue profile of Class I patients showed that skeletal Class II division 1 patients had thinner upper lips and shallower upper lip sulci, while division 2 patients had thicker upper lips.[25] A study where only skeletal Class II division 1 and division 2 were evaluated showed that division 1 patients had thinner upper lips, shallower upper lip sulci, and thicker lower lips, compared to division 2 patients.[26] As mentioned above, in our study, lip thickness did not differ between the divisions, hence the hypothesis that soft tissues camouflage skeletal discrepancies was not confirmed.

The present study revealed, that sagittal lip position is highly affected by incisors inclination, therefore in future studies, these two groups should be investigated separately instead of one sample in order to get more precise results, evaluating different skeletal class soft tissue profile.

According to all reference lines (Burstone B line, Ricketts E line, Steiner S line, and Holdaway H line), division 1 patients had more protruded upper and lower lips, compared to division 2 patients.

All the applied methods showed that the sagittal position of the upper lip statistically significantly depended on the inclination of the upper incisors, and the sagittal position of the lower lip – on the inclination of the lower incisors.

REFERENCES

1. Broadbent BH. A new x-ray technique and its application to orthodontia. Angle Orthod 1931; 1:45–66.

2. Baumrind S, Frantz RC. The reliability of head film measurements. 1. Landmark identification. Am J Orthod 1971; 60(2):111-127.

3. Stamenkovic Z, Raickovic V, Ristic V. Changes in soft tissue profile using functional appliances in the treatment of skeletal class II malocclusion. Srp Arh Celok Lek 2015; 143(1-2):12-5.

4. Kasai K. Soft tissue adaptability to hard tissues in facial profiles. Am J Orthod Dentofacial Orthop 1998; 113(6):674-684.

5. Burstone CJ. Lip posture and its significance in treatment planning. Am J Orthod 1967; 53(4):262-284.

6. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. Am J Orthod 1983; 84(1):1-28.

7. Merrifield LL. The profile line as an aid in critically evaluating facial esthetics. Am J Orthod 1966; 52(11):804-822.

8. Meyer-Marcotty P, Kochel J, Richter U, Richter F, Stellzig-Eisenhauer A. Reaction of facial soft tissues to treatment with a Herbst appliance. J Orofac Orthop 2012; 73(2):116-125.

9. Verma SL, Sharma VP, Singh GP, Sachan K. Comparative assessment of soft-tissue changes in Class II Division 1 patients following extraction and non-extraction treatment. Dent Res J 2013; 10(6):764-771.

10. Amirabadi GE, Mirzaie M, Kushki SM, Olyaee P. Cephalometric evaluation of soft tissue changes after extraction of upper first premolars in class IotaIota div 1 patients. J Clin Exp Dent 2014; 6(5):e539-45.

11. Khan M, Fida M. Soft tissue profile response in extraction versus non-extraction orthodontic treatment. J Coll Physicians Surg Pak 2010; 20(7):454-9.

12. Rathod AB, Araujo E, Vaden JL, Behrents RG, Oliver DR. Extraction vs no treatment: Long-term facial profile changes. Am J Orthod Dentofacial Orthop 2015; 147(5):596-603.

13. Zhang DQ, Shi X, Zheng MQ. The study on characteristics of soft tissue profile for different malocclusion. Hua Xi Kou Qiang Yi Xue Za Zhi 2004; 22(6):496-8.

14. Joshi M, Wu LP, Maharjan S, Regmi MR. Sagittal lip positions in different skeletal malocclusions: a cephalometric analysis. Prog Orthod 2015; 16:8.

15. Steiner CC. The use of cephalometrics as an aid to planning and assessing orthodontic treatment: Report of a case. Am J Orthod 1960; 46(10):721-735.

16. Baccetti T, Franchi L, McNamara JA,Jr. An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. Angle Orthod 2002; 72(4):316-323.

17. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. Angle Orthod 1952; 22(3):142-5.

18. McNamara JA Jr, Ellis E 3rd. Cephalometric analysis of untreated adults with ideal facial and occlusal relationships. Int J Adult Orthodon Orthognath Surg 1988; 3(4):221-231.

19. Burstone CJ. Lip posture and its significance in treatment planning. Am J Orthod 1967; 53(4):262-284.

20. Ricketts RM. Esthetics, environment, and the law of lip relation. Am J Orthod 1968; 54(4):272-289.

21. Arnett GW, Jelic JS, Kim J, Cummings DR, Beress A, Worley CM,Jr, et al. Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. Am J Orthod Dentofacial Orthop 1999; 116(3):239-253.

22. Bhushan R, Kumar S, Chauhan AK, Mohan S, Shekhar M, Narnoly A. Assessment of the relationship between maxillary rotation and nasal morphology in males. Contemp Clin Dent 2015; 6(Suppl 1):S12-7.

23. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986 8; 1(8476):307-310.

24. Kamak H, Celikoglu M. Facial soft tissue thickness among skeletal malocclusions: is there a difference? Korean J Orthod 2012; 42(1):23-31.

25. Tanic T, Blazej Z, Mitic V. Soft tissue thickness of face profile conditioning by dento-skeletal anomalies. Srp Arh Celok Lek 2011; 139(7-8):439-445.

26. Tanic T, Blazej Z, Mitic V. Analysis of soft tissue thickness in persons with malocclusions of Class II division 1 and Class II division 2. Srp Arh Celok Lek 2012; 140(7-8):412-8.

27. McIntyre GT, Millett DT. Lip shape and position in Class II division 2 malocclusion. Angle Orthod 2006; 76(5):739-744.