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A clinical and cephalometric study of nasal morphology in post pubertal growth phase as a valid predictor of craniofacial growth direction and its relationship to facial skeletal morphology

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KEYWORDS

cervical vertebrae, growth, nasal morphology

ABSTRACT:

Objectives: The present study is designed to predict the craniofacial growth by correlating nasal morphology, skeletal pattern and cervical vertebral maturation stages. This study emphasizes the importance of nasal dimensions in determining the growth so that newer and simpler diagnostic aids can be brought into use by further research for growing children.

Materials and Methods: Clinical examination of 120 subjects seeking orthodontic treatment (60 females and 60 males) who were in the post pubertal age group of 12-15 years and 13-17years, respectively, was performed. Pretreatment lateral cephalograms of these patients were obtained. Cephalometric evaluation was done for nasal and skeletal dimensions. The data was collected and correlated and analysed using SPSS software version 22.

Result: , CVM staging has shown significant correlation with nasal length (F value 4.89 and p value 0.001), nasal depth (F value 6.22 and p value 0.001), palatal length (F value 11.19 and p value 0.001), maxillary height (value 14.24 and p value 0.001), nasolabial angle (F value 2.84 and p value 0.027) and nasofrontal angle (F value 4.12 and p value 0.004). Age showed highly significant correlation (F value 14.49 and p value 0.001) with CVM staging.

Conclusion: Clinical and lateral cephalometric assessment of nasal morphology is a reliable method of growth prediction which is of greatest importance in orthodontics.

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INTRODUCTION-

A soft tissue profile analysis based on conventional profile photos and lateral cephalograms is typically performed to assess face attractiveness.[1] Due to its precise placement in the centre of the face, the nose has a significant influence on facial aesthetics.[2]

The nose, which occupies the majority of the centre part of the face and works in perfect harmony with the lips and chin to establish a person's distinctive facial feature.[3]

To achieve the intended treatment goals, an orthodontist must have a thorough understanding of the link between these facial components and the changes that can be predicted during and after growth with orthodontic and surgical treatment.[4]

Facial bone growth and growth and development of the human body are closely related processes.[5]

Nasal growth is thought to almost stop by the time a girl reaches the age of sixteen and a boy reaches the age of eighteen but is known to continue relatively steadily into adolescence.[6]

One could interpret a person's nose shape as a sign of their age, sex, race, and ethnicity. While the other soft tissue morphology changes with orthodontic treatment, the basic structure of nose remains unaffected by orthodontic treatment, indicating that orthodontists should give nasal growth and development a more careful thought.[7]

A growing body of research has focused on lateral cephalometric radiographs to assess changes in the size and shape of the cervical vertebrae in growing subjects as a biological measure of skeletal maturity. The morphology of the cervical vertebral bodies is known to change with growth, and the lateral cephalogram can be used to assess skeletal maturity and growth prediction.[8]

The peak of the adolescent spurt is generally believed to happen at around ages 12 for girls and 14 for boys in terms of stature, and about two years prior to the peak, the spurt starts.[9]

By comparing the nasal morphology, skeletal pattern and cervical vertebrae maturation identification of proper growth spurt can be done. Various studies have been done previously by many researchers but still there is need for further research. This study includes the clinical examination and cephalometric evaluation of nasal and skeletal dimensions in boys and girls and comparing them with CVM staging. Hence, present study aims to establish the role of nasal morphology in predicting the craniofacial growth.

MATERIALS AND METHOD

150 patients were examined for profile, nasal morphology and Angle's classification out of which 120 were selected as study sample. The sample comprises of 120 subjects (60 males and 60 females) with malocclusion. Males were in the age group of 13 to 17 years and females were the age group of 12 to 15 years who reported for orthodontic consultation. Extraoral and intraoral clinical examination of these patients was done to assess the nasal morphology, profile and Angle's classification of malocclusion. The data was collected from the above mentioned sample size. All participants have read and signed informed consent form.

Inclusion Criteria :

- Boys and girls in post pubertal phase of growth.
- Patient's age for boys ranging from 13- 17 years and for girls 12-15 years.
- Girls in the pre-menarche and post-menarche phase will be included.
- Patient's with Class I, Class II, Class III skeletal pattern
- Patient's with all types of profiles were included.
- No history of systemic condition or endocrinal disorders.
- Any type of malocclusion i.e. Angle's Class I, Class II, Class III.
- Patient willing to participate in the study.
- There should be no history of previous orthodontic treatment.

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- No other critical health issues or mental retardation and should not be going under any psychiatric treatment.

Exclusion Criteria :

- Patient age group other than 13-17 years for boys and 12-15 for girls.
- Patient treated with orthodontic treatment.
- Patient with history of previous orthognathic surgery or in need orthognathic surgery.
- Cleft lip and cleft palate patient.
- Patient with history of any major facial trauma.
- Patients with craniofacial syndromes, neurological or psychiatric disorders.
- Any physical or mental health problem that can affect outcome of orthodontic treatment.

Method of Data Collection:

120 subjects including the male and female growing patients fulfilling the criteria mentioned above are selected and examined clinically. Profile and nasal morphology were evaluated geometrically(G-Sn-Pg) and with vernier caliper. Standardized pretreatment lateral cephalograms of 120 patients falling in the inclusion criteria were obtained and studied manually. As the Angle's classification does not always match with skeletal pattern, random sampling of Angle's classification was done with approx Angle's Class 1-66 subjects, Angle's Class 2 - 47 subjects and Angle's Class 3 -7 subjects.

The following cephalometric landmarks were chosen for assessment

Glabella (G'): the most prominent point of the frontal bone.

Soft-tissue nasion (N'): the point of greatest concavity in the midline between the forehead and the nose

Nasion (N): the intersection of the frontal and nasal bones.

ANS- Anterior nasal spine

PNS- Posterior nasal spine

Pronasale (Pr): the tip of nose (nasal tip).

Columella (Cm): the most convex point on the columellar-lobular junction.

Subnasale (Sn): the point at which the columella merges with the upper lip in the midsagittal plane.

Labrale superior (Ls): the point indicating the mucocutanous border of the upper lip.

Soft-tissue pogonion (Pg'): the most anterior point on the chin in the midsagittal plane.

Cephalometric values of the following were recorded for every subject

Nasal length (N'-Pr): the distance between N' and Pr.

Nasal depth : the perpendicular distance between Pr and the line drawn through N' to Sn.

Maxillary height: the distance between N and ANS

Palatal length: the distance between ANS and PNS

Nasolabial angle (NLA): the angle formed by the intersection of the Cm tangent and the upper lip (Ls).

Nasofrontal angle (NFA): the angle formed by the intersection of the Glabella tangent and tangent to dorsum of nose.

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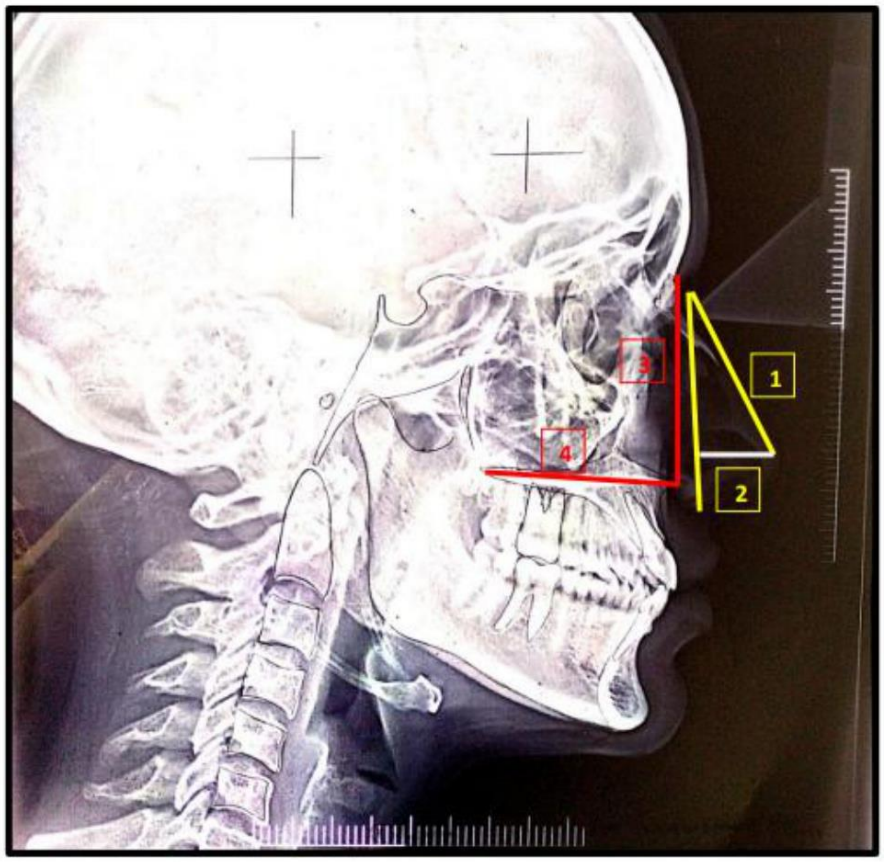

Figure 1- Cephalometric radiograph showing **1**-Nasal length**, 2**-Nasal depth**, 3**-Maxillary height**, 4**-Palatal length

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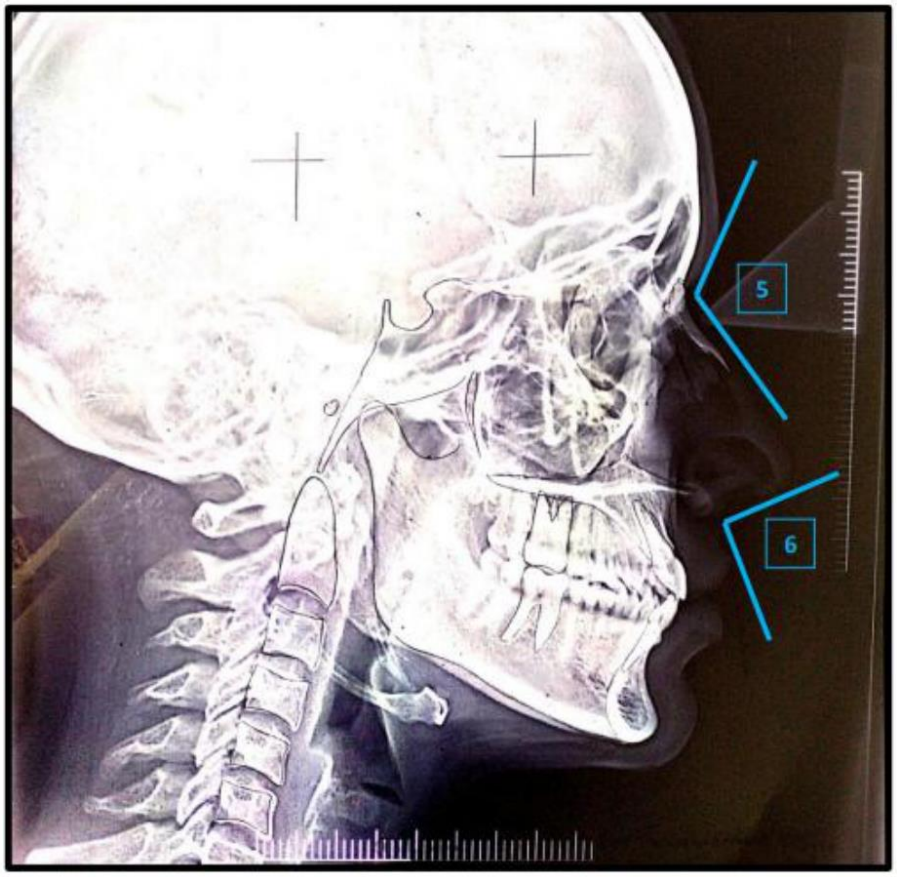

Figure 2- Cephalometric radiograph showing **5**- Nasofrontal angle **6**- Nasolabial angle

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Stastistical analysis

Cephalometric measurements of chosen values were obtained and correlated; and the gender and age specific data was stastistically analysed using SPSS software version 22. Spearman correlation and One Way ANOVA tests were used to analyse the data.

RESULT

The study participants were divided into two groups on the basis of Gender. The study included 60 males and 60 female participants.

Table 1: Distribution of participants according to clinical parameters

Parameters	Categories	Frequency	Percent
Profile	Concave	7	5.8
	Convex	97	80.8
	Straight	16	13.3
Angle's Classification	C-1type1	35	29.2
	C-1type2	31	25.8
	C-2div1	43	35.8
	C-2div2	4	3.3
	C-3	7	5.8
Clinical parameters	Nasal Length	Mean = 50.52±4.89 mm	
	Nasal Depth	Mean = 17.53±2.16 mm	

The mean age of the participants was 13.97±1.47 years. The profile of 5.8% (N=7) patients was concave, 80.8% (N=97) patients was convex and 13.3% (N=16) patients was straight. **(Table 1)**

The patients were classified according to Angle classification. 29.2% (N=35) patients were classified as Class I type I, 25.8% (N=31) patients as Class I type 2, 35.8% (N=43) patients as Class II Div I, 3.3% (N=4) patients as Class II div II and 5.8% (N=7) patients as Class III. The mean Nasal length of patients was 50.52±4.89 mm and Nasal Depth was 17.53±2.16 mm**. (Table 1)**

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Table 2: Cephalometric Evaluation of study participants

Parameters	Mean ± S.D.
Nasal Length	49.65±4.82
Nasal Depth	16.65±2.01
Palatal Length	55.48±4.88
Maxillary Height	55.45±6.76
Nasofrontal angle	126.12±14.23
Nasolabial angle	98.76±11.10

The cephalometric evaluation of participants showed mean Nasal Length of 49.65±4.82 mm, mean Nasal Depth of 16.65±2.01 mm, mean Palatal Length of 55.48±4.88 mm, mean Maxillary Height of 55.45±6.76 mm, mean Nasofrontal angle of 126.12º±14.23º and mean Nasolabial angle was 98.76º±11.10º**. (Table 2)**

Correlation of CVM staging with Age and cephalometric parameters

Table 3: Correlation of CVM staging with Age and cephalometric Parameters

Parameters	CVM	
AGE	Correlation Coefficient	.531**
	Sig. (2-tailed)	.000
Nasal Length	Correlation Coefficient	.314**
	Sig. (2-tailed)	.000
Nasal depth	Correlation Coefficient	.326**
	Sig. (2-tailed)	.000
Palatal Length	Correlation Coefficient	.553**
	Sig. (2-tailed)	.000
Maxillary Height	Correlation Coefficient	.489**
	Sig. (2-tailed)	.000
NasoFrontal Angle	Correlation Coefficient	.021
	Sig. (2-tailed)	.820
NasoLabial Angle	Correlation Coefficient	.211*
	Sig. (2-tailed)	.021

Spearman Correlation,*Significant

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The CVM staging showed moderately positive correlation with Age (r=0.531), Nasal Length (r=0.314), Nasal Depth (r=0.326), palatal length (r=0.553), maxillary height (r=0.489) and weekly positive correlation with Nasolabial Angle (0.211). **(Table 3)**

Association of Various Parameters with CVM staging

Table 4: Association between Age and CVM staging

CVM stage	N	Mean	Std. Deviation	F value	P value
CS-2	15	12.60	0.51	14.49	0.001**
CS-3	20	13.15	1.04		
CS-4	41	14.07	1.33		
CS-5	36	14.39	1.42		
CS-6	8	16.29	0.76		

One Way ANOVA test, **Highly significant

The mean age of participants in CS 2 stage was 12.60±0.51 years, CS 3 stage was 13.15±1.04 years, CS 4 stage was 14.07±1.33 years, CS 5 stage was 14.39±1.42 years and in CS 6 stage was 16.29±0.76 years. There was significant difference between different CVM staging with F value 14.49 and p value 0.001. **(Table 4)**

Table 5: Association between Nasal Length and Nasal depth with CVM staging

	Nasal length						Nasal depth				
CVM stage	N	Mean	Std. Deviation	F value	P value	CVM stage	N	Mean	Std. Deviation	F value	P value
CS-2	15	45.93	4.59	4.89	0.001**	CS-2	15	15.73	1.33	6.22	0.001**
CS-3	20	49.25	5.73			CS-3	20	16.85	2.74		
CS-4	41	49.15	4.17			CS-4	41	15.83	1.48		
CS-5	36	51.92	4.64			CS-5	36	17.69	1.95		
CS-6	8	50.00	0.00			CS-6	8	17.57	0.98		

One Way ANOVA test,*Significant for nasal length and nasal depth

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The mean nasal length in CS 2 stage was 45.93±4.59 mm, CS 3 stage was 49.25±5.73 mm, CS 4 stage was 49.15±4.17 mm, CS 5 stage was 51.92±4.64 mm and in CS 6 stage was 50.00±0.00. There was significant difference between different CVM staging with F value 4.89 and p value 0.001. (**Table 5)**

The mean Nasal Depth in CS 2 stage was 15.73±1.33 mm, CS 3 stage was 16.85±2.74 mm, CS 4 stage was 15.83±1.48 mm, CS 5 stage was 17.69±1.95 mm and in CS 6 stage was 17.57±0.98. There was significant difference between different CVM staging with F value 6.22 and p value 0.001. **(Table 5)**

Table 6: Association between Palatal Length and Maxillary height with CVM staging

	Palatal length						Maxillary height				
CVM stage	**N**	**Mean**	**Std. Deviation**	**F value**	**P value**	**CVM stage**	**N**	**Mean**	**Std. Deviation**	**F value**	**P value**
CS-2	15	51.60	2.82			CS-2	15	50.60	2.80		
CS-3	20	53.00	5.02			CS-3	20	51.95	6.30		
CS-4	41	54.78	4.50	11.19	0.001**	CS-4	41	52.46	4.91	14.24	0.001**
CS-5	36	58.28	4.21			CS-5	36	57.00	6.55		
CS-6	8	60.00	0.00			CS-6	8	66.43	5.26		

One Way ANOVA test,*Significant for both palatal length and maxillary height

The mean palatal length in CS 2 stage was 51.60±2.82 mm, CS 3 stage was 53.00±5.02 mm, CS 4 stage was 54.78±4.50 mm, CS 5 stage was 58.28±4.21 mm and in CS 6 stage was 60.00±0.00. There was significant difference between different CVM staging with F value 11.19 and p value 0.001. **(Table 6)**

The mean maxillary height in CS 2 stage was 50.60±2.80 mm, CS 3 stage was 51.95±6.30 mm, CS 4 stage was 52.46±4.91 mm, CS 5 stage was 57.00±6.55 mm and in CS 6 stage was 66.43±5.26 mm. There was significant difference between different CVM staging with F value 14.24 and p value 0.001. **(Table 6)**

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Table 7: Association between Naso Frontal Angle and Naso Labial Angle with CVM staging

	Nasofrontal angle						Nasolabial angle				
CVM stage	**N**	**Mean**	**Std. Deviation**	**F value**	**P value**	**CVM stage**	**N**	**Mean**	**Std. Deviation**	**F value**	**P value**
CS-2	15	135.27º	5.70º	4.12	0.004 *	CS-2	15	92.40	9.35	2.84	0.027 *
CS-3	20	121.25º	19.18º			CS-3	20	94.80	11.56		
CS-4	41	123.73º	11.16º			CS-4	41	101.56	11.69		
CS-5	36	125.00º	15.40º			CS-5	36	100.33	10.83		
CS-6	8	138.14º	4.88º			CS-6	8	99.29	0.49		

One Way ANOVA test,*Significant for both Naso Frontal Angle and Naso Labial Angle

The mean Nasofrontal Angle in CS 2 stage was 135.27º±5.70º, CS 3 stage was 121.25º±19.18º, CS 4 stage was 123.73º±11.16º, CS 5 stage was 125.00º±15.40º and in CS 6 stage was 138.14º±4.88º. There was significant difference between different CVM staging with F value 4.12 and p value 0.004. **(Table 7)**

The mean Nasolabial Angle in CS 2 stage was 92.40º±9.35º, CS 3 stage was 94.80º±11.56º, CS 4 stage was 101.56º±11.69º, CS 5 stage was 100.33º±10.83º and in CS 6 stage was 99.29º±0.49º. There was significant difference between different CVM staging with F value 2.84 and p value 0.027. **(Table 7)**

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Correlation of Skeletal profile with Age and cephalometric parameters

Table 8: Correlation of Skeletal profile with Age, CVM and cephalometric Parameters

Parameters	Skeletal profile	
AGE	Correlation Coefficient	-.237**
	Sig. (2-tailed)	.009
Nasal Length	Correlation Coefficient	.041
	Sig. (2-tailed)	.658
Nasal depth	Correlation Coefficient	.167
	Sig. (2-tailed)	.068
Palatal Length	Correlation Coefficient	-.049
	Sig. (2-tailed)	.598
Maxillary Height	Correlation Coefficient	-.224*
	Sig. (2-tailed)	.014
NasoFrontal Angle	Correlation Coefficient	-.196*
	Sig. (2-tailed)	.032
NasoLabial Angle	Correlation Coefficient	.224*
	Sig. (2-tailed)	.014
CVM	Correlation Coefficient	-.096
	Sig. (2-tailed)	.298

Spearman Correlation,*Significant

The skeletal pattern showed weak positive correlation with Maxillary height (rho=0.224), Nasofrontal angle (rho=0.196) and Nasolabial Angle (0.224). The skeletal pattern showed weak Negative correlation with Age (rho=-0.237). **(Table 8)**

DISCUSSION

Understanding the structure and development of the human face is essential for both the diagnosis and treatment of malocclusion. It has always been understood that one of the most {important requirements for successful orthodontic therapy is the improvement of facial form. The entire skeletal and soft tissue components of the craniofacial complex's grow differently, which affects how a face looks. [1]

A person's race, sex, and other facial features are associated with their nasal characteristics.[1]. The results showed that nasal length and nasal depths increased with increases in jaw length and facial height, even though some of the correlation coefficients were low.[1]

The present study showed similar result, that the nasal depth showed strong correlation with maxillary height and palatal length.

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The jaw position, the maxillary and mandibular jaw lengths had an impact on the nasal parameters. [9]

Class II patterns were primarily linked to convex noses, class I noses to straight noses, and class III patterns to concave noses.[10]

The present study demonstrates similar results depecting maxillary jaw length having its effects on the nasal parameters. Cephalometric palatal length and maxillary height has shown highly significant correlation between males and females.

Skeletal pattern showed highly significant correlation and facial profile showed significant correlation between males and females.

For a variety of orthodontic procedures, the best treatment duration can be ascertained using the CVM method. Because the stages of mandibular growth can be identified on the lateral cephalometric radiograph that is routinely taken for orthodontic treatment, the CVM method has an advantage in this regard. These results serve as the foundation for assessing when to begin growth modification therapy.[11]

In this study, after comparing CVM staging with nasal and skeletal parameters, CVM staging has shown significant correlation with nasal length, nasal depth, palatal length, maxillary height and nasolabial angle. Age showed highly significant correlation with CVM staging.

Therefore only one radiograph i.e. lateral cephalogram can be sufficient for growth prediction as CVM staging and nasal dimensions both compliment each other in diagnosis.

Also it was derived that there is highly significant correlation between nasal morphology that was measured clinically and cephalometrically.

CONCLUSION

It was found that the nasal morphology and CVM were significantly correlated and hence it can be derived that nasal morphology is a reliable diagnostic tool for growth prediction. In this study, it was found that the nasal morphology is mainly affected by the underlying bone. The nasal growth follows the growth of the underlying bone. CVM staging have shown strong correlation with the nasal morphology and the growth of the underlying bone. Thus helping us in providing the easier, newer and simpler methods for growth prediction for diagnosis and treatment planning. Hence, lateral cephalogram and clinical examination can be effective for growth prediction. This research can be established by more research work with larger samples of the same age group in different parts of the world.

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