

Radiographic Assessment of Short Stature

Amir Ali K¹, Shahla Momeni Danaie², Mohammad Sadegh Nazari³, Maryam D⁴, Mohammad Hosein Kalantar Motamedi^{5*}, Hamid Reza R⁶ and Ali Ebrahimi⁷

¹*Semnan Dental School, Semnan University of Medical Sciences, Iran*

²*Shiraz Dental School, Shiraz University of Medical Sciences, Iran*

³*Department of Dentistry, Tehran Azad University of Dentistry, Iran*

⁴*Department of oral and maxillofacial surgery, Trauma Research Center, Baqiyatallah University of Medical Sciences, Iran*

⁵*Department of Statistics, Trauma Research Center, Baqiyatallah University of Medical Sciences, Iran*

⁶*Researcher, Trauma Research Center, Baqiyatallah University of Medical Sciences, Iran*

⁷*Department of plastic surgery, Trauma research center, Baqiyatallah University of Medical Sciences, Iran*

***Corresponding Author:** Mohammad Hosein Kalantar Motamedi, Department of Statistics, Trauma Research Center, Baqiyatallah University of Medical Sciences, Iran.

Received: January 06, 2016; **Published:** May 05, 2016

Abstract

Objective: The aim of this research was radiographic assessment of craniofacial structures in Short-Stature.

Materials and Methods: A total of 178 (90 girls - 88 boys) patients referred to us for assessment of short-stature and growth problems. They comprised 76 patients (38 girls, 38 boys) and un-familial short-stature of other causes comprised 102 patients (52 girls, 50 boys) who were assessed for craniofacial structural evaluation; 50 Short-statured patients (25 boys and 25 girls) were compared to two normal groups divided according to their malocclusion.

Results: Radiographic assessment of craniofacial indexes of short-statured patients indicated that the male short-statured patients have significantly shorter cranial base length and more convex profiles ($P < 0.05$).

Conclusion: Evaluation of craniofacial indexes showed that short-statured patients have more convex profiles and more vertical growth.

Keywords: Craniofacial; Short-stature

Introduction

It is essential to know the modality of a normal growth. For this purpose, several growth indicators have been using such as body fitness, skeletal growth, dental development and puberty [1,2]. Some of the important indicators are evaluation of skeletal growth and the child's growth pattern assessment based on gender and age [3]. However, children in the same calendar age do not have similar biological age with similar growth rates. Considering the growth pattern, a child showing a reduction in growth rate, will be considered as an abnormal individual in terms of growth [2]. Some studies show that patients with short-stature have a bone age lower than normal [4]. A child is considered as growth stunted when the stature is below the 3% of the average growth percentage curve [3]. Short-stature may be primary or secondary to the other causes; but the majority of causes are related to chromosomal disorders, and skeletal dysplasia.

Several studies show that the functional orthopedic treatments should be done prior to puberty in order to have the most efficacy through the puberty growth spurt period [5-8].

It is worth noting that the child's physical growth rate plays an important role predicting the treatment. Up until now, several studies have been carried out to evaluate the mandibular and cranial base morphology and determine the correlation between development and dental eruption; and, all reported that the appropriate time of dentofacial therapy is relevant to determination of growth periods. Knowing the fact that an individual's calendar age is not that accurate to assess the growth potential, it is suggested to take advantage of treatments by knowing the exact time of the puberty growth spurt [9].

Spinal developmental evaluation is the most useful index to determine bone maturity. The idea of lateral cephalometric cliche changes simultaneously through growth is completely accepted [3,8] and morphological changes through the body of the spinal column during puberty can be used to assess the bone maturity and bone age [4]. Lamparski, in a study on the cervical vertebrae showed the effect of CVM (Cervical Vertebral Maturation) method on evaluation of skeletal age [10]. O'Reilly and Yanniolo compared the sextuplet phases of the growth of neck vertebrae with mandibular development and found a correlation between phases of CVM and mandibular growth [11]. In 1995, Hassel and Farman brought forward a new index of CVM containing six phases based on the lateral view of the second, third and fourth vertebrae. Based on these viewpoints, some vertebral metamorphosis like a notch on the inferior ridge of vertebrae and its eminence can determine the skeletal age and remaining growth [12]. On the other hand, studies have shown high response to functional appliances designed for jaw disorders in puberty [13-15]. Therefore, application of a credible biological index to determination the growth spurt in the mandible can be a definite diagnostic tool for justification and accomplishing the treatment plan in class II malocclusion patients with a lower amount of growth in the mandible. There has been several researches carried out to show the high correlation between lateral cephalometric and mandibular growth indices, however, up until now, this correlation has not been tested for short-statured patients. The aim of this study is to determine the size and position of the mandible in short-statured patients utilizing lateral cephalometric radiography without extra radiation.

Materials and Methods

This study assessed 178 (90 girls, 88 boys) patients referring for consultation for short-stature and growth problems stature under the 5% of the NCHS's (National Center for Health Statistics) [16] growth curve was considered as an entrance criterion in this study. In case of dento-alveolar problems, patients were sent for lateral cephalometric x-ray. All the radiographies were taken in the Natural Head Position (NHP) by the Proline-CC Cephalostat (KV=85 2002 CA and CM) and PM (Planmecaoy) devices at a Radiology clinic. The patients were categorized into two familial and non-familial groups. Also, patients were categorized to several groups by calendar age and by different developmental stage of lateral cephalometric radiology. Group 1 consisting of 76 (38 girl, 38 boy) individuals with familial short-stature problems. Group 2 consisted of 102 (52 girls, 50 boys) individuals with un-familial short-stature problems from other causes of this problem based on the equal skeletal and calendar age in group 1. Lateral cephalometric developmental phases were determined based on Farman and Hassel method. The data gathered for each individual was recorded. For skeletal age determination, 6 phases were indicated by Farman and Hassel [12]. After preparing lateral cephalometric clichés of 50 short-statured patients, for craniofacial evaluation, 13 points including S (Sella), N (Nasion), A (A point), B (B point), POG (Pogonion), ME (Menton), GO (Gonion), GN (Gnathion), ANS (Anterior Nasal Spine), PNS (Posterior Nasal Spine), CO (Condylion), PO (Porion) and OR (Orbitale), and SNA, SNB, ANB, S-N-POG, Y-axis, Basal, FMA, GO-GN-SN angles, and the SN plane length in two dimensions vertical and sagittal were measured. For further precision and calibration of the data were gathered for each patient. Results from data analysis of the evaluation of morphological characteristics of the patients were compared with two normal control groups 1 and 2 of 11 to 13 years old. The normal group 1 consisted of 147 (74 girls, 73 boys) individuals with normal growth state and class I malocclusion and the normal group 2 consisted of 184 (90 girls, 94 boys) individuals with normal growth state and class II malocclusion.

The criteria considered as normal group 1 were a straight or slightly convex profile, class I occlusal relation, normal over jet and over bite, crowding less than 5 millimetres, normal ANB (1-4 Degree) and normal Wit's (-1±1). The criteria considered as normal group 2 consisted of class II malocclusion without signs of short-stature problem, convex profile, molar and canine class II relation and over jet more than 4 millimetres.

In order to survey the discrepancies between short-statured craniofacial indexes and normal individuals which had class I and II malocclusion, in age group 12-13, the analysis of variance followed by the post hoc test was used. Also, for testing the normality of the distribution of the craniofacial indexes the one-sample Kolmogorov-Smirnov test was used. For statistical analysis the significance level of 0.05 was considered.

Results

Among 76 familial short-statured patients (38 girls, 38 boys), the highest frequency in girls was related to the 11-year-old age group with the value of 6 (7.9%) and 12-year-old age group with the value of 6 (7.9%) and in boys the highest frequency was related to the 14-year-old age group with the value of 6 (9.2%).

Also, the least frequency in girls related to two age groups of 14 and 17-year-olds each of them with a value of 2 (2.6%) and in boys was related to 10 and 11-year-old age group each of them with a value of 2 (2.6%). In un-familial short-statured patient evaluations, the results are as below. Among 102 (52 girls 51% and 50 boys 49%) short-statured patients, the highest frequency for girls was related to 8-year-old age group with a value of 8 (8.7%) and for boys the highest frequency was related to 15-year-old age group with the value of 8 (8.7%). The least frequency for girls was related to 17-year-old age group with a value of 3 (2.9%) and in boys the least frequency was related to 11-year-old age group with a value of 3 (2.9%).

Lateral cephalometric evaluations of familial short-statured patients (38 girls, 38 boys) showed that the highest frequency for girls related to phase 2 with a value of 9 individuals (11.8%) and the least frequency was related to phases 5 and 6 individuals with a value of 5 (6.6%). The highest frequency for boys was related to phase 2 with a value of 8 individuals (10.5%) and the least frequency was related to phase 6 with a value of 4 individuals (5.3%).

CMW Group Sex	1	2	3	4	5	6	Total
Female	6 (7.9%)	9 (11.8%)	6 (7.9%)	7 (9.2%)	5 (6.6%)	5 (6.6%)	38 (50%)
Male	7 (9.2%)	8 (10.5%)	6 (7.9%)	6 (7.9%)	7 (9.2%)	4 (5.3%)	38 (50%)
Total	13 (17.1%)	17 (22.4%)	12 (15.8%)	13 (17.1%)	12 (15.8%)	9 (11.8%)	76 (100%)

Table 1: Distribution of Frequency of Developmental Stages According to Lateral Cephalometry Radiography in Assessment Patients with Familial Short-Stature.

Lateral cephalometric evaluations of un-familial short-statured patients (52 girls, 50 boys) showed that the highest frequency for girls was related to phase 1 with a value of 13 individuals (12.7%) and the least frequency was related to phases 3, 4 and 6 individuals with a value of 7 (6.9%). The highest frequency for boys was related to phase 1, 2 and 3 with a value of 10 individuals (9.8%) and the least frequency was related to phase 4 and 6 with a value of 6 individuals (5.9%).

CMW Group Sex	1	2	3	4	5	6	Total
Female	13 (12.7%)	9 (8.8%)	7 (6.9%)	7 (6.9%)	9 (8.8%)	7 (6.9%)	52 (51%)
Male	10 (9.8%)	10 (9.8%)	10 (9.8%)	6 (5.9%)	8 (7.8%)	6 (5.9%)	50 (49%)
Total	23 (22.5%)	19 (18.6%)	17 (16.7%)	13 (12.7%)	17 (16.7%)	13 (12.7%)	102 (100%)

Table 2: Distribution of Frequency of Developmental Stages According to Lateral Cephalometry in Patients with Short-Stature with Other than Familial Etiology.

Craniofacial evaluation of short-statured patients showed that the short-statured boys have a significantly shorter cranial base length and more convex profile compared to the individuals with normal growth and class I malocclusion ($P < 0.05$).

In addition, class II malocclusion with downward and posterior mandibular rotation was seen significantly in this group of patients ($P<0.05$). Short-statured boys have shorter cranial base length significantly compared to the individuals with normal growth and class II malocclusion ($P<0.05$); however in class II malocclusion individuals, mandible positioned posteriorly and vertical growth pattern was higher ($P<0.05$).

Craniofacial evaluation of short-statured patients showed that the short-statured girls have significantly shorter cranial base length with more forward position maxilla compared to the normal growth individuals with class I malocclusion ($P<0.05$), however the position of the mandible in cranial base was normal ($P=0.33$). In addition, class II malocclusion and vertical growth pattern were more frequently seen among girls ($P<0.05$). The short-statured girls have shorter cranial base length and more front side projection of the maxilla compare to the normal growth individuals with class II malocclusion ($P<0.001$). Normal patients significantly have more posterior mandibular position, but vertical growth pattern of patients with class II malocclusion was higher ($P<0.001$).

Parameters	Patients		Controls			
	Male	Female	Cl.I		Cl.II	
			Male	Female	Male	Female
SN	70.48	67.44	72.6**	69.3*	73.8***	71.5***
SNA	84.36	84.6	83.6	82.3**	83.8	82.7***
SNB	79.88	78.56	80.4	79.1	77.3***	77.2*
ANB	4.48	5.12	3.2**	3.2***	6.5***	5.5
S-N-Pog	78.88	79.16	81.3***	80.3	78.4	77.4***
y-axis	60.24	60.64	59.2*	58.3***	61.8***	62.3***
Basal angle	27.6	29.12	27.3	24.9***	29.2*	26.3***
FMA	27.28	29.16	26.7	24.4***	28.9*	25.1***
Go-Gn-SN	33.6	37.04	33.5	33.8***	35.1**	34.3***

Table 3: Comparison of Craniofacial Indexes of Boys and Girls with Short-Stature in Proportion to Persons with Normal Growth with Class I & II Malocclusion.

* Significant at level <0.05

** Significant at level <0.01

*** Significant at level <0.001

Discussion

Craniofacial indexes' evaluations in two vertical and sagittal dimensions showed that short-statured boys compared to normal growth group with class I malocclusion, in spite of having a similar growth pattern, have shorter anterior cranial base length and more convex profile due to the downward and posterior rotation of the mandible. However, the vertical growth pattern rate is lower compared to the normal growth group with class II malocclusion. It can be concluded that the functional appliances are more efficient in these types of patients. Craniofacial indexes' evaluations in two vertical and sagittal dimensions showed that short-statured girls compared to normal growth group with class I malocclusion have shorter anterior cranial base length, more convex profile and more vertical growth pattern. However, because the convexity is more related to the front sided maxillary bone, using maxillary growth control appliances like head-gear is more efficient.

Patients with deficiency in anterior part of the pituitary gland are more prone to craniofacial complex growth disorders. Familial short statured patients' evaluations in sagittal dimension showed that short-statured children have shorter anterior cranial base length in com-

parison to the normal growth groups [17]. Moreover, based on this study, short statured boys have posterior sided mandible with more convex profile. This result is similar to the study conducted by Spiegel., *et al.* [18], Konfino., *et al.* [19] and Spiegel., *et al.* [18] showed that either boy or girls with hormonal deficiencies show more discrepancies to evaluate the linear facial measurements and have growth delay in the mandible. They had shown that in short-statured boys all the linear measurements such as posterior face height, anterior cranial base length, posterior cranial base length and total cranial base length were decreased. Short statured girls' anterior cranial base lengths were normal but posterior cranial base growth faced delay.

Spiegel., *et al.* [18]'s study is more of significant because it evaluates different craniofacial structures in relation to different endocrine disorders. Their study showed that even idiopathic short statured patients seems to have discrepancies in growth and development such as decrease in posterior face length and delay in growth in spite of skeletal growth rate. Their study showed that open bite disorder has been seen in almost all of the patients with different endocrine disorders. However, in this study open bite situation was seen only in girls ($p < 0.001$) which can be the result of the decrease in condylar growth, although the general mandibular growth was normal.

Also, Konfino., *et al.* [19] in study on 10 short-statured patients have shown that the cranial base length is shorter and mandible is in the posterior position. Moreover, more tendency to have vertical growth was reported. Cranial base length shortening speaking, the result of their study is matched with the results of the present study, which can be the consequence of early synchondrosis of cranial base in short-statured patients. However, in terms of the growth pattern, the results were reverse, and in short-statured boys, decrease in vertical growth was not seen. Accordingly, it seems that condylar growth has not been affected, so that using growth inducing devices like functional appliances is more effectual in the case group study of short-statured boys.

In the present study, there was no significant difference between SNA angle degree of short-statured boys and the normal growth group, so, this result is inconsistent with Konfino., *et al.* [19] and Spiegel., *et al.* [18] reports. It seems decrease in cranial base length followed by early synchondrosis has no impact on anterior part of the maxillary bone but impacts maxillary vertical growth since it caused an open bite situation. Also, the study conducted by Kjellberg., *et al.* [20] in 2000 on 48 patients with or without short-statured situation showed that mandible was in posterior position in short-statured patients, also, they showed the maxillary bone was in the posterior position in short-statured patients which is in contrast to the present study. In present study, in the case group not only was the maxillary bone not located at the posterior position, but also was at the anterior position more significant in girls rather than boys though. Therefore, it seems that in short-statured girls of our group study, mandible bone was not affected considerably. Hence, vertical evaluation of short-statured boys compared to normal growth group with class I malocclusion showed that short-statured boys had similar growth pattern, which was contrary to Spiegel., *et al.* [18], Konfino., *et al.* [19] and Kjellberg., *et al.* [20] reports. In studies mentioned above, lack of growth had perceptible effect on condylar growth, while in the present study, condylar growth was not affected. Evaluations in sagittal dimension showed that short-statured girls compared to normal growth group with class I malocclusion had shortage in cranial base length. Also, short-statured girls had more convex profile matched with the result reported by Konfino., *et al.* [19]. Spiegel., *et al.* [18] reached similar results; they found that in girls, mandibular position was slightly posterior but it was statistically non-significant.

Evaluation in vertical dimension showed that short-statured girls compared to normal growth group with class I malocclusion had more vertical growth and confirmed the result reported by Spiegel., *et al.* [18] and Konfino., *et al.* [19].

Evaluations in sagittal dimension showed that the normal growth group with class II malocclusion had more convex profile with more retro gnathic chin position. Also, class II malocclusion patients had more vertical growth which means despite tendency of short-statured patients to have vertical growth, decrease in mandibular growth and convex profile, the effect of short-stature on facial growth pattern and profile was not as much as class II malocclusion. Nonetheless, in short-statured patients the anterior cranial base length is significantly shorter and this measurement in short-statured patients was significantly lower compared to class I malocclusion.

Conclusion

Craniofacial indexes evaluation showed that short-statured patients had more vertical growth pattern and more tendencies to have convex profiles.

Bibliography

1. Reiter EO and Witt MF. "Physical Growth and Development". In Braham RL, Morris ME. Textbook of Pediatric Dentistry. Baltimore: Williams and Wilkins (1985): 2-23.
2. Tillman V, *et al.* "The Relationship between Stature, Growth and Short-Term Changes in Height and Weight in Normal Prepubertal Children". *Pediatric Research* 44.6 (1998): 882-886.
3. Reiter EO and Rosenfeld RG. "Normal and Aberrant Growth". In Larsen PR, *et al.* Williams Textbook of Endocrinology. Philadelphia: Saunders, 11st edition (2008): 849-967.
4. Sato K, *et al.* "An Accurate Method of Predicting Mandibular Growth Potential based on Bone Maturity". *American Journal of Orthodontics and Dentofacial Orthopedics* 120.3 (2001): 286-293.
5. Hagg U and Pancherz H. "Dentofacial Orthopedics in Relation to Chronological Age, Growth Period and Skeletal Development, an Analysis of 72 Male Patients with Class II Division 1 Malocclusion Treated with the Herbst Appliance". *European Journal of Orthodontics* 10.3 (1988): 169-176.
6. Sierra A. "Assessment of Dental and Skeletal Maturity: A New Approach". *The Angle Orthodontist* 57.3 (1987): 194-208.
7. McNamara JA Jr, *et al.* "Skeletal and Dental Changes Following Functional Regulator Therapy on Class II Patients". *American Journal of Orthodontics* 88.2 (1985): 91-110.
8. Sato K and Mitani H. "Evaluation of Growth Potentialities of Maxilla and Mandible by Use of TW2 Method and Ossification Events in Skeletal Class III". *The Journal of Japan Orthodontic Society* 57 (1998): 1-9.
9. Grave KC and Brown T. "Skeletal Ossification and the Adolescent Growth Spurt". *The American Journal of Orthopedics* 69.6 (1976): 611-619.
10. Lamparski DA. "Skeletal Age Assessment Utilizing Cervical Vertebrae". Pittsburg, Penn: Department of orthodontics, the university of Pittsburg: 1972.
11. O'Reilly MT and Yanniello GJ. "Mandibular Growth Changes and Maturation of Cervical Vertebrae- A Longitudinal Cephalometric Study". *The Angle Orthodontist* 58.2 (1988): 179-184.
12. Hassel B and Farman AG. "Skeletal Maturation Evaluation Using Cervical Vertebrae". *American Journal of Orthodontics and Dentofacial Orthopedics* 107.1 (1995): 58-66.
13. McNamara JA Jr. "Neuromuscular and Skeletal Adaptations to Altered Function in the Orofacial Region" "Neuromuscular and skeletal adaptations to altered orofacial function, monograph 1, Craniofacial Growth Series, Ann Arbor, 1972, 64.6 (1973): 578-606.
14. McNamara JA Jr, *et al.* "Skeletal and Dental Changes Following Functional Regulator Therapy on Class II Patients". *American Journal of Orthodontics* 88.2 (1985): 91-110.
15. Baccetti T, *et al.* "Treatment Timing for Twin Blocks Therapy". *American Journal of Orthodontics and Dentofacial Orthopedics* 118.2 (2000): 159-170.
16. www.cdc.gov/growthcharts.

17. Thilander B. "Basic Mechanisms in Craniofacial Growth". *Acta Odontologica Scandinavica* 53.3 (1995): 144-151.
18. Spiegel RN, *et al.* "Cephalometric Study of Children with Various Endocrine Diseases". *American Journal of Orthodontics* 59.4 (1971): 362-375.

Volume 4 Issue 3 May 2016

© All rights reserved by Amir Ali K., *et al.*