MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Dental Sciences
ISSN: 2573-8771

Correlation between Chronological Age and Cervical Vertebrae Morphology in Adolescents with Class I, II and III Malocclusions

Bozorgnia Y[1], Irani S[1], Salari S[2]*, Moghadam AE[3] and Derakhshani A[3]

[1]Department of Orthodontics, North Khorasan University of Medical Sciences, Iran
[2]Department of Orthodontics, Aja University of Medical Sciences, Iran
[3]Student Research Committee, North Khorasan University of Medical Sciences, Iran

***Corresponding author:** Soheil Salari, Department of Orthodontics, Aja University of Medical Sciences, Tehran, Iran, Tel: +989128702051; Email: soheilsalari@gmail.com

Research Article
Volume 8 Issue 3
Received Date: July 06, 2023
Published Date: August 18, 2023
DOI: 10.23880/oajds-16000375

Abstract

Background: Predicting the best treatment time is an important factor for treating different malocclusions and growth modification treatments. The aim of this study is to compare the mean age of adolescent growth spurt and duration of pubertal growth peak in Class I, Class II and Class III patients according to Baccetti's cervical vertebral analysis.

Material & Methods: In this retrospective cross-sectional study, 310 lateral cephalograms (198 girls and 112 boys) aged between 7 and 17 years were examined. The evaluation of skeletal maturation stage was performed by visual analysis of morphological features of the cervical vertebrae (C2, C3, and C4). The skeletal malocclusion was determined by Steiner analysis performed and calibrated independently by two orthodontists. The Kappa coefficient was done to calculate the intra and inter-observer error.

Results: This study showed high correlation coefficient between chronological age and skeletal age with class I and II malocclusion, in girls were 0.78 and 0.74 and in boys 0.78 and 0.70 respectively. The results of the study showed a higher correlation coefficient in class III malocclusion, both in girls and boys, (0.83 and 0.82, respectively). In girls the average duration of growth spurt was 1.5 years in class I patients, 0.9 years in class II and 3.5 years in class III patients. In boys the average duration of growth spurt was 1.4 years in class I patients, 1.1 years in class II and 2.9 years in class III patients. Pubertal growth peak occurs earlier in girls with class III malocclusion than in girls with class I and class II malocclusions.

Conclusion: The results of this study showed a high correlation coefficient between chronological age and the stages of cervical vertebrae maturation in all three malocclusions. Therefore, it is possible to use CVM to measure skeletal maturity in all three malocclusions. Girls experience adolescent growth spurt 1.3 years earlier than boys on average. Girls with class III malocclusion experience the adolescent growth spurt earlier in comparison to other malocclusions, while class II boys mature later than the others.

Keywords: Pubertal Growth; Baccetti's Cervical Vertebral Analysis

Introduction

Treatment of class II skeletal cases during the circumpubertal growth period shows the best growth response. In Class III skeletal cases, maxillary protraction and expansion is only effective when it is performed before the growth peak (CS1 or CS2); however considering mandibular manipulation, it is effective during both prepubertal and pubertal stages [1]. In orthodontics and dentofacial orthopedics, the right time to start the treatment is one of the most important aspects of patients' treatment plans and may be as important as the choice of treatment protocol itself [2]. Changes occur in the morphology of each bone during the growth spurt; the order of which is invariant for each individual [3]. Moreover, the onset and duration of the growth spurt vary from person to person [4,5]. This diversity is primarily related to the genetic background, ethnicity, nutritional status and general health [6,7].

Biological indicators of skeletal maturity are mainly related to physical changes during puberty, including the increase in body height, wrist skeletal maturity, calcification of the teeth, menarche or changes in voice, as well as changes in cervical vertebrae maturation [8].

When physiological age is used instead of chronological one, the prediction of the patient's growth potential becomes more specific. The skeletal age is more accurate and clinically more useful than the calendar age [9].

Recently, various studies have shown that the evaluation of skeletal maturity using cervical vertebrae in lateral cephalometric radiography is a reliable method and is as accurate as wrist radiography. Since lateral cephalometric radiography is routinely used in orthodontic treatment, there is no need for extra radiation exposure, in contrary to the wrist radiography [10].

The aim of this study is to compare the pubertal growth spurt duration in skeletal Class I, Class II and Class III patients according the Baccetti's cervical vertebral analysis in lateral cephalograms. This can be very helpful in diagnosis and treatment planning of these malocclusions.

Materials and Methods

This retrospective cross-sectional study was done to estimate the onset and duration of puberty growth peak in different malocclusions; and was approved by local esthetic committee. 310 lateral cephalograms of patients aged 7-17 years (198 girls and 112 boys) were collected from a private radiology clinic archives, in North Khorasan, Bojnurd.

Radiographs were first traced to determine the type of malocclusion using ANB angle according to Steiner analysis and the results were then approved by Witt's analysis. The samples were divided in three skeletal malocclusions:

a) Skeletal Class I: ANB angle ≥1° and ≤4° (n= 91 patients)
b) Skeletal class II: ANB angle more than 5° (n= 144 patients) and
c) Skeletal class III: ANB angle less than 0° (n= 75 patients). Each group was divided chronologically to 11 age group from 7 to 17 years old. Cervical vertebrae stages of each patient were determined.

The stages of cervical vertebra maturation were determined by modified Bacceti's method. In this method, the maturation stages of the cervical vertebrae (CVM) are determined by lateral cephalograms based on the morphology of the second, third and fourth cervical vertebrae. This is typically done by observing the presence or absence of concavity in the lower borders of C2, C3 and C4. The differences in the shape of the cervical vertebrae are divided into six stages (CS1, CS2, CS3, CS4, CS5 and CS6) and the patient's growth potential is estimated (1). This method was applied in the present study due to its wide use and applicability for several populations. Classification of vertebrae stages were done by visual inspection of the three cervical vertebrae morphology (C2, C3, C4). According to this method, the onset of pubertal growth spurt was at CS3 stage where concavity in lower borders of C2 and C3 are detected and their body shapes are both rectangular. Growth spurt occurs between CS3 and CS4. CS4 is the end of pubertal growth spurt and is identified by concavity in the lower border of C4. Vertebrae bodies of C3 and C4 are almost square.

To increase the accuracy of the research and the reliability of the results, cephalometric tracings and skeletal stages of maturity were performed by two orthodontists and any disagreement was resolved by verbal discussion.

All the cephalograms having acceptable quality from patients 7 to 17 years old were included in this study, which second, third and fourth cervical vertebrae could be visualized. Patients with any history of orthodontic treatment or orthognathic and/or vertebrae surgery, trauma, craniofacial syndromes or any osseous disease that may impact the skeletal development were excluded.

Statistical Analysis

Data were analyzed by SPSS statistical analysis software version 23. Descriptive statistics were done for the mean age of the patients with different skeletal malocclusion at skeletal maturity stages (CS3 and CS4). The Kruskal-Wallis test was done to compare each mean age of CVM between girls and boys and in each malocclusion respectively. P-value

of <0.05 was considered statistically significant.

To examine the intra and inter- observer agreement in assessing the CVM status, the lateral cephalograms of 20 patients were re-analyzed by the first and second orthodontist at two different intervals. The Kappa coefficient for intraexaminer and interexaminer to determine the cervical stages were 0.94 and 0.75 respectively.

Results

The results of this study showed high correlation coefficient between chronological age and skeletal age (determined from the morphology of cervical vertebrae) with class I and II malocclusion in girls were 0.78 and 0.74, respectively and in boys were 0.78 and 0.70, respectively. The results of the study showed a higher correlation coefficient in class III malocclusion, both in girls and boys, (0.83 and 0.82, respectively).

In skeletally class I girls, the average chronological age at the onset of pubertal peak was 12±0.75 years, and the pubertal peak ended at 13.5±1.9 years. The onset of pubertal peak for skeletal class II patients was 11.9 ±0.8 years and it ended at 12.8 ±2.4 years. The onset of pubertal peak for skeletal class III cases was 11±1.3 years and ended at 14.5±2.5 years (P<0.001).

In boys the average chronological age at onset of pubertal peak in skeletal class I cases was 13.2±1.1 years and pubertal peak ended at 14.6±2.5 years. The onset of pubertal peak in skeletal class II cases was 13.7±1.6 years and it ended at 14.8 ±1.7 years. Finally, the onset of pubertal peak for skeletal class III cases was 12.3±1.3 years and ended at 15.2±1.8 years (P<0.001) (Table 1).

Sex	CVM stage	Mean ± STD			P-value
		Skeletal Cl I (n=91)	Skeletal Cl II (n=144)	Skeletal Cl III (n=75)	
Girls	CS3	12±0.75	11.9 ±0.8	11±1.3	<0.001
	CS4	13.5±1.9	12.8 ±2.4	14.5±2.5	
Boys	CS3	13.2±1.1	13.7±1.6	12.3±1.3	<0.001
	CS4	14.6±2.5	14.8 ±1.7	15.2±1.8	

Table 1: The mean chronological age at the onset and the end of pubertal peak in different malocclusions in boys and girls.

The duration of pubertal peak in girls in skeletal class I cases was 1.5 years, in skeletal class II cases was 0.9 year and in skeletal class III cases was 3.5 years. Duration of pubertal peak in boys in skeletal class I cases was 1.4 years, in skeletal class II cases was 1.1 year and in skeletal class III cases was 2.9 years.

All these results show that the onset of pubertal growth in girls is sooner than boys (P<0.001). In addition, the duration of pubertal peak in skeletal class II cases is the shortest in comparison to other malocclusions and in skeletal class III cases it lasts longer than the others.

Discussion

In this study, using the CVM method, the onset of developmental spurt in girls and boys in all three malocclusions was calculated. The high correlation coefficient in this study shows that the age significantly affects the body shape of the cervical vertebrae in children and adolescents of 7-17 years old.

In this study, in order to increase the accuracy of the analyses, all measurements (determining the type of malocclusion and the stage of maturation of the vertebrae) were analyzed simultaneously by two orthodontists to minimize the possibility of any probable error and to avoid personal interferences. We used the modified Baccetti method; the method of determining the stages of vertebral maturation according to the morphology of the second, third and fourth cervical vertebrae by two orthodontists. Twenty lateral cephalometric radiographs were re-analyzed again in a different period to reduce all the probably errors.

In this study, which was performed on 198 girls and 112 boys in the age range of 7-17 years, the mean age at which the growth spurt occurred was determined according to the Baccetti method. The results showed that the growth spurt in girls was 1.2 years earlier than boys.

In the present study we concluded that growth spurt in Class II girls occurs about 1.3 months earlier than Class I girls, and also that growth spurt in Class II boys occur about 6 months later than Class I boys. The results of the study also showed that in patients with class III malocclusion, growth spurt starts earlier than the other malocclusions.

Jeelani [11] reported that girls enter the adolescent growth spurt around 1.5 years earlier than boys and also the Class II girls enter the adolescent growth spurt 7.5 months

earlier than the Class I girls. In contrary, The Class III boys enter the adolescent growth spurt 10.5 months later than the Class I boys. Girls enter the final stage of the adolescent growth spurt (CS6) on average 1.3 years earlier than boys. No significant differences were noted in the time of completion of the adolescent growth spurt among children with different skeletal classes. The results of the study about the time of growth spurt in class II and class I girls are in accordance with the results of the present study. The Jeelani study considered a larger sample size. The differences in race, geography and nutritional conditions between the two studies could be the cause of different results.

According to the study of Laila Baidas [3], which has been done on a sample of 214 patients (110 females, 104 males) between 7-17 years, a high correlation was found between skeletal maturation assessed by CVM and chronological age. There was also high correlation in both sexes, in accordance with the current study, but the correlation was significantly higher for females than males.

In another study done by Akheshteh, et al. [12] on 480 lateral cephalograms of patients from both genders aged from 8 to 16 years, a high correlation was found between chronological age and CVMS. There was a statistically significant correlation of CVMS and gender in class II and III malocclusions. However, like our study there was no significant difference between CMVS and gender in class I cases. In contrary to the current study, the correlation coefficient between skeletal age and chronological age was higher in females, which could be due to the bigger sample size, differences in race, geographical environment and nutritional conditions in the two studies [13].

In a study of Uysal, et al. in Turkey [9], a high correlation coefficient was reported between chronological age and the stage of maturity of the cervical vertebrae, which is in accordance to the results of our study. In this study, the maturation stage of the vertebrae was evaluated by Hassel and Farman method. The existence of high correlation coefficient in the two studies shows that different methods of assessing the stage of vertebral maturation in the human population have had similar results and the use of vertebral morphology with any of the above-mentioned methods can be a good indicator for assessing biological age. However, we should bear in mind that the Uysal study considered a wide age range (5 years and 3 months to 24 years and 1 month). This issue has been noted in the present study by selecting the age range of 7 to 17 years.

In a recent study by Qureshi, et al. 787 cephalograms in a range of CS2-CS5 CVM stages, were considered as the sample group. There was no significant difference in the mean age of boys and girls at each CVM stage; which is in contrary to our study. This could be due to the different age distribution of patients and sample size. The class III boys in Qureshi study have significantly delayed maturity during the pubertal spurt at CS4 compared with girls and showed pubertal peak duration was shorter in class II patients compared to other classifications which is in line with current study. Moreover, pubertal peak duration was longer for boys in class III patients compared to girls [14].

Since none of the maturation markers are fully capable of detecting different stages of growth, it is recommended that dentists should be aware of the limitations of existing methods and use several markers to assess growth stages to treat the patients with different malocclusions.

Due to the shortage of patients with class III malocclusion, it is recommended that in future studies malocclusions be selected with equal frequency to minimize the possibility of any failure.

Conclusion

A high correlation between chronological age and skeletal maturity was determined using cervical vertebrae morphology in both sexes and in all three malocclusions. Chronological age is a weak indicator of maturity.

The correlation was higher in girls and boys with class III malocclusion. The mean age of boys at each stage of skeletal age was higher than girls which means growth spurts occur earlier in girls than boys. In both genders, the growth spurt begins earlier in class III malocclusion. Class II girls have the shortest duration of the pubertal peak and class III girls have the longest one. Growth spurt period lasts much longer in class III cases compared to other malocclusion classifications.

References

1. Baccetti T, Franchi L, McNamara JA (2005) The Cervical Vertebral Maturation (CVM) Method for the Assessment of Optimal Treatment Timing in Dentofacial Orthopedics. Seminars in Orthodontics 11(3): 119-129.

2. Abesi F (2015) The Agreement of Chronological Age and Cervical Vertebrae Morphology in Lateral Cephalogram in a Selected Iranian Population. Journal of Mashhad Dental School 39(1): 61-70.

3. Baidas L (2012) Correlation between cervical vertebrae morphology and chronological age in Saudi adolescents. King Saud University Journal of Dental Sciences 3(1): 21-26.

4. Marshall WA, Tanner JM (1969) Variations in pattern of pubertal changes in girls. Arch Dis Child 44(235): 291-

303.

5. Marshall WA, Tanner JM (1970) Variations in the pattern of pubertal changes in boys. Arch Dis Child. 45(239): 13-23.

6. Rogol AD, Clark PA, Roemmich JN (2000) Growth and pubertal development in children and adolescents: effects of diet and physical activity. Am J Clin Nutr 72(2 Suppl): 521-528.

7. Parent AS, Teilmann G, Juul A, Skakkebaek NE, Toppari J, et al. (2003) The timing of normal puberty and the age limits of sexual precocity: variations around the world, secular trends, and changes after migration. Endocr Rev 24(5): 668-693.

8. Lai EH, Liu JP, Chang JZC, Tsai SJ, Yao CCJ, et al. (2008) Radiographic assessment of skeletal maturation stages for orthodontic patients: hand-wrist bones or cervical vertebrae? J Formos Med Assoc 107(4): 316-325.

9. Uysal T, Ramoglu SI, Basciftci FA, Sari Z (2006) Chronologic age and skeletal maturation of the cervical vertebrae and hand-wrist: is there a relationship? Am J Orthod Dentofacial Orthop 130(5): 622-628.

10. Kiran S, Sharma V, Tandon P (2012) Correlative and comparative study of Fishman's skeletal maturity indicators with CVMI and chronological age in Lucknow population. European Journal of General Dentistry 1: 161.

11. Jeelani W, Fida M, Shaikh A (2016) The duration of pubertal growth peak among three skeletal classes. Dental Press J Orthod 21(5): 67-74.

12. Akheshteh V, Purabdolahi M, Mollabashi V, Shokri A, Saati S, et al. (2017) Relationship of Skeletal Age and Chronological Age Based on Lateral Cephalograms in the Treatment of Different Malocclusions. Avicenna J Dent Res 9(4): 15584.

13. Alkhal HA, Wong RW, Rabie AB (2008) Correlation between chronological age, cervical vertebral maturation and Fishman's skeletal maturity indicators in southern Chinese. Angle Orthod 78(4): 591-596.

14. Qureshi T, Duggal R, Chaudhari PK (2021) Correlation between chronological age and skeletal maturity in different malocclusions: A retrospective study. International Orthodontics 19(3): 453-461.