International Journal of Applied Dental Sciences 2022; 8(4): 113-116

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2022; 8(4): 113-116

www.oraljournal.com
Received: 13-08-2022
Accepted: 17-09-2022

Dr. Altaf Hussain Chalkoo
Professor, Head of the Department, Oral Medicine and Radiology, Govt. Dental College, Srinagar, Kashmir, India

Dr. Bazila Illahi
Postgraduate Student Department of Oral Medicine and Radiology, Govt. Dental College, Srinagar, Kashmir, India

Corresponding Author:
Dr. Altaf Hussain Chalkoo
Head of the Department, Oral Medicine and Radiology, Govt. Dental College, Srinagar, Kashmir, India

Cervical vertebral bone age estimation and its correlation to chronological age

Dr. Altaf Hussain Chalkoo and Dr. Bazila Illahi

DOI: https://doi.org/10.22271/oral.2022.v8.i4b.1635

Abstract
Introduction: Cervical vertebrae are used as a reliable tool to assess the skeletal maturation of an individual and predict the maximum growth potential.
Aim and objective: This study aimed to estimate bone age by measuring 3rd and 4th cervical vertebrae (C3, C4) dimensions on cephalometric radiographs.
Materials and Methods: A total of 100 girls in the age group of 7-15 years were taken into consideration. Using cephalometric radiographs, we measured the cervical vertebral bodies and using a regression formula, cervical vertebral bone age was obtained based on the ratios of measurements in the third and fourth cervical vertebral bodies. It was then correlated with the chronological age.
Results: The Spearman correlation coefficient between chronologic age and cervical vertebrae skeletal maturation was 0.695, with a (p-value < 0.001) which was statistically significant.
Conclusion: The cervical-vertebrae maturation stages are considered clinically useful maturity indicators of the pubertal growth period.

Keywords: Cervical vertebrae, chronological age, skeletal age, females

Introduction

The growth of a human being is characterized by variation in the amount, rate, time, pattern, and progression towards maturity. In growth modulation procedures and dentofacial orthopedics, evaluation of individual growth status, and predicting periods of accelerated growth, such as the pubertal growth spurt, is essential for treatment planning and can influence treatment outcomes [1].

Assessment and monitoring of growth and development is a prime concern in caring for the growing child and adolescent, especially when growth modification is needed. The terms biological age, skeletal age, bone age and skeletal maturation are nearly synonymous terms used to describe the stage of maturation of a person. Among these, sexual maturation characteristics, chronologic age, dental development, height, weight and skeletal development are some of the more common means used to identify stages of growth. Because of individual variations in timing, duration and velocity of growth, skeletal age assessment is crucial in formulating workable treatment plans. Skeletal maturation describes the degree of development of ossification in bone [2].

Chronological age alone is unreliable for assessment of developmental status because of the significant diversity and wide variation in timing and duration of the pubertal growth spurt and other developmental stages [3].

To reduce both radiation exposure and diagnostic expense to the patient, assessment of cervical vertebral maturation, as seen in routine lateral cephalograms, has been explored. Lamparski [4] was the first to suggest that morphological changes occurring in cervical vertebral bodies throughout growth could be used to assess the skeletal maturation of an individual. He discovered that this technique was a reliable and valid alternative to radiographic evaluation of hand-wrist bones for determination of skeletal age [1].

For evaluation, various objective methods have been developed by certain authors using regression formulae based on ratios of measurements in the third and fourth cervical vertebral bodies [5, 6]. However, these formulae have shown variation with gender and racial origin [3].

Aims and Objectives

1. To calculate the cervical vertebral bone age in female subjects in the Kashmiri population.
2. To establish the correlation between chronological age and skeletal age.

Material and Methods

A retrospective study was done on the lateral cephalometric radiographs obtained from the archives of the Department of Oral Medicine and Radiology, Govt. Dental College and Hospital, Srinagar. These radiographs were required for the diagnosis and treatment planning.

Determination of sample size

Using GPOWER software (Version 3.0.10), it was estimated that the least number of subjects required with 80% power, 5% significance level and an effect size of 0.243 is 100.
In the present study, a total of 100 girls in the age group of 7 - 15 years were taken into consideration who met the inclusion criteria: having good image quality for visibility of 2nd, 3rd and 4th cervical vertebrae (C2-C4), radiographs of children, or adolescents with an unremarkable medical history, being free from any inherited or acquired craniofacial deformities, and having no previous craniofacial trauma and not having received any previous orthodontic treatment. Radiographs from subjects on long-term drug use or medication, or with syndromes, congenital anomalies (such as absence of pedicle, cleft lip and/or palate), metabolic or developmental disorders or nutritional problems that may have an impact on craniofacial and vertebrae development, were excluded from the study.

Methodology

On the lateral cephalometric radiographs, linear measurements on the third and fourth cervical vertebrae were taken into consideration and the following parameters were measured - the anterior vertebral body height (AH), posterior vertebral body height (PH), and the anterioposterior vertebral body length (AP). These values were measured using NNT Dicom version 8.0.0.0 software.

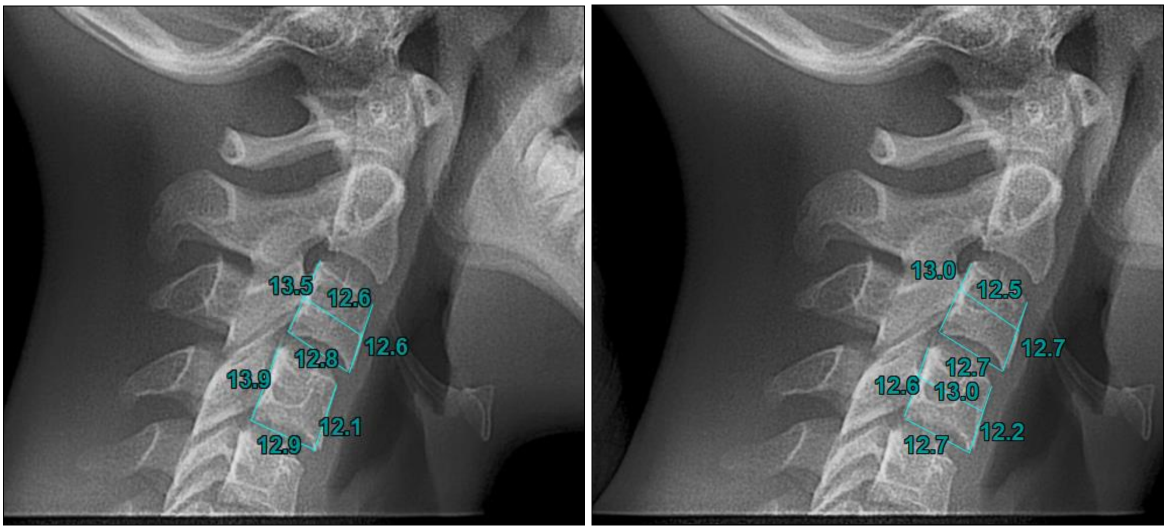

Fig 1: Measurement of anterior height (AH), anteroposterior height (AP), and posterior height (PH) of third and fourth cervical vertebrae in two different cases on lateral cephalometric radiographs.

Statistical methods

The sampled and recorded data were compiled and entered into a Microsoft Excel spreadsheet and exported to SPSS Version 20.0 data editor (SPSS Inc., Chicago, Illinois, USA). Categorical variables were summarized as frequencies and percentages and continuous variables were expressed as Mean± SD. Correlation analysis with relevant statistical tests was employed to analyze the data. A P-value of less than 0.05 was considered statistically significant.

Results

The ratios of these parameters were calculated (AH_3/AP_3, and AH_4/PH_4) and were used in the formula for obtaining cervical vertebral bone age derived by the stepwise regression analysis done by Toshinori Mito *et al*. [5].The formula used was:

Cervical vertebral bone age = $- 0.20 + 6.20 \times AH_3/AP_3 + 5.90 \times AH_4/PH_4 + 4.74 \times AH_4/PH_4$

The skeletal age obtained from the above formula was compared with the chronological age and a correlation was determined.

It was observed that the mean chronological age was around 12.17 years whereas the mean skeletal age was around 12.70 years showing a difference of only 0.53 years and a standard deviation of 1.76 (Table 1.).

Table 1: Difference between mean and standard deviation of chronological age and skeletal age

	Mean	SD
Chronological age (CA)	12.17	2.23
Skeletal age (SA)	12.70	2.01
Difference (SA vs CA)	0.53	1.76

The correlation coefficient between the cervical vertebral bone age and the chronological age was statistically significant (0.695) with p value < 0.001. (Table 2. Figure 2.)

Table 2: Correlation between chronological age (CA) and skeletal age (SA)

	Correlation coefficient (r-value)	P-value
CA and SA	0.695	<0.001*

*Statistically Significant Correlation (P-value<0.05)

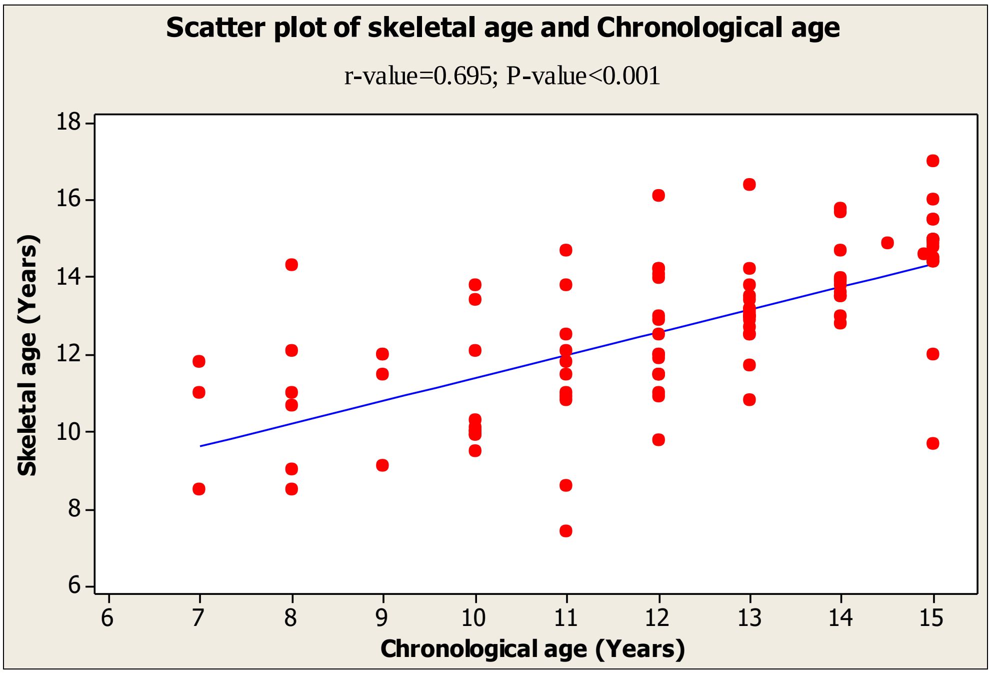

Fig 2: Scattergram of cervical vertebral bone age and chronological age

Discussion

Cervical vertebral measurements to assess individual skeletal maturity have received increasing attention in the literature [7]. Conventional cervical vertebral maturation method for skeletal maturation assessment relies on subjective assessment of the shape and dimensions of the cervical vertebrae [8]. Calculation of cervical vertebral bone age offers the increased advantage of objectively evaluating the skeletal maturity from lateral cephalometric radiographs by measuring the dimensional parameters of C3 and C4 (5). In this study, a statistical model was derived using the regression equation of T.Mito *et al*. [5] to estimate the cervical vertebral bone age in a group of growing Kashmiri female children utilizing the ratios between vertebral body dimensions of C3 and C4 cervical vertebrae.

Only female subjects were taken into account for this study to avoid any gender-related variations in growth pattern and timing of maturational changes of cervical vertebrae [4]. The age group of the sample was chosen based on the observed morphological changes in the cervical vertebral body dimensions during this growth period. The C3 and C4 were chosen for examination in this study because of the difficulty in identifying and measuring morphological body changes in the first two vertebrae and the usual lack of appearance of the lower cervical vertebrae in routine lateral cephalometric radiographs. The use of ratios between the vertebral body dimensions in statistical model development was to negate any possible magnification effect in the radiographic technique. The high intra-observer reliability of the measurement method observed in this study reflects the strong predictability and usefulness of this technique in clinical practice [9].

All the vertebral body parameters of C3 and C4 vertebrae showed an increased spike during the examined growth period except for the AP parameter which remained almost constant beyond the age of 12 years. This conclusion is consistent with the observation done by Mito *et al*. [5] who observed a minor change in the AP dimension of both C3 and C4 after the age of 12 years. However, the study by Caldas Mde *et al*. [6] reported an accelerated increase in the AP3 parameter from 12 to 15 years in the sample taken exclusively from males.

The chronological age has been considered an unreliable tool for skeletal maturity [10, 11]. However, this study found a strong correlation between the CVBA and the chronological age (Table 2). Similar results have been reported in previous relevant studies [5, 6]. This strong correlation and association between chronological age and the skeletal maturity indices, established by the various methods reported in this study and other similar studies suggest that chronological age can be used clinically in the studied population groups as an acceptable general indicator of skeletal maturation [9].

Conclusion

The results of this study indicate that the bone age evaluated by cervical vertebrae on cephalometric radiographs is a reliable tool to determine the skeletal maturity. This method is useful in providing a broad estimation of chronological age and needs to be used in combination with other measurements to provide a comprehensive calculation of chronological age.

Acknowledgement

Not available

Author's Contribution

Not available

Conflict of Interest

Not available

Financial Support

Not available

References

1. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P. Development and validation of a formula for objective assessment of cervical vertebral bone age. Prog Orthod. 2020 Oct 12;21(1):38.
2. Prasad CK, Reddy VN, Sreedevi G, Ponnada SR, Priya KP, Naik BR. Objective evaluation of cervical vertebral bone age' its reliability in comparison with hand-wrist bone age: by TW3 method. J Contemp Dent Pract. 2013 Sep 1;14(5):806–13.

3. Caldas M de P, Ambrosano GMB, Haiter-Neto F. Use of cervical vertebral dimensions for assessment of children growth. J Appl Oral Sci. 2007 Apr;15:144-7.
4. Lamparski DG. Skeletal age assessment utilizing cervical vertebrae; c1975.
5. Mito T, Sato K, Mitani H. Cervical vertebral bone age in girls. Am J Orthod Dentofac Orthop Off Publ Am Assoc Orthod Its Const Soc Am Board Orthod. 2002 Oct;122(4):380-5.
6. Caldas M de P, Ambrosano GMB, Haiter Neto F. New formula to objectively evaluate skeletal maturation using lateral cephalometric radiographs. Braz Oral Res. 2007 Dec;21:330-5.
7. Gandini P, Mancini M, Andreani F. A Comparison of Hand-wrist Bone and Cervical Vertebral Analyses in Measuring Skeletal Maturation. Angle Orthod. 2006 Nov 1;76(6):984-9.
8. Baccetti T, Franchi L, McNamara JA. The Cervical Vertebral Maturation (CVM) Method for the Assessment of Optimal Treatment Timing in Dentofacial Orthopedics. Semin Orthod. 2005 Sep 1;11(3):119-29.
9. Alhadlaq AM, Al-Maflehi NS. New model for cervical vertebral bone age estimation in boys. King Saud Univ J Dent Sci. 2013 Jan 1;4(1):1-5.
10. Fishman LS. Chronological versus skeletal age, an evaluation of craniofacial growth. Angle Orthod. 1979 Jul;49(3):181-9.
11. Hägg U, Taranger J. Maturation indicators and the pubertal growth spurt. Am J Orthod. 1982 Oct;82(4):299-309.

How to Cite This Article
Dr. Altaf Hussain Chalkoo and Dr. Bazila Illahi. Cervical vertebral bone age estimation and its correlation to chronological age. International Journal of Applied Dental Sciences 2022; 8(4): 113-116.