ORIGINAL ARTICLE

The Correlation between Chronological Age and Cervical Vertebral Maturation Stages in Adolescent Female Orthodontic Patients of South Punjab

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ABSTRACT

Objective: The aim of this study was to assess the correlation between the chronological age at menarche and peak of skeletal maturity using cervical vertebral maturation stages (CS) on lateral cephalometric radiograph in the female orthodontic patients of south Punjab.

Materials and Methods: Lateral cephalograms of 100 female patients (9-15 years) were collected from the outpatient department (OPD) of Orthodontics department, CIMS Dental College, Multan. CS stages were determined on lateral cephalometric radiograph using the latest Bacetti's CS method. The patients self-reported their menarcheal ages and were confirmed by the patients' mothers. The association between CS and chronological age at menarche was evaluated.

Results: In this study, menarche was observed to occur between the ages of 12 and 13 years, corresponding to CS3 and CS4. The correlation coefficient between chronological age and CS was found to be 0.588, indicating a moderate to strong positive correlation

Conclusion: Cervical Vertebral Maturation is correlated moderately with the chronological age. For a better assessment of peak pubertal growth in females, history of menarche should be considered.

Keywords: Adolescent, Cervical Vertebrae, Growth and Development, Puberty

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INTRODUCTION

Orthodontic treatment is indicated in both dental and skeletal discrepancies. This entails the evaluation of the patient's growth status in order to maneuver among the preventive, interceptive or corrective orthodontics. Growth is a process which starts at conception and continues throughout a person's life but at a slower rate after the 2nd decade of life. A crucial part of this routine is determination of the peak pubertal growth spurt which is significantly important for treating skeletal class II growth modification cases. There are various methods used for growth assessment. These include measurement of overall height, dental age, and chronological age, maturational and skeletal age. Skeletal age in orthodontic patients can be determined either by using hand and wrist radiography or cervical vertebral maturation staging. The advantage of the later is that no additional x-ray exposure is required as the lateral cephalogram is usually customary for orthodontic patients. In addition to being a regular diagnostic tool, lateral cephalogram, also offer the benefit of skeletal maturity assessment due to the clear visibility of the cervical vertebrae.

Along with this, data collection is easy because it is collected verbally without the need for radiography or longitudinal height measurements. Some studies confirm the reliability of cervical vertebral maturation method for determining the pubertal growth stages while others say otherwise. According to Schoretsaniti et al, for more precise growth estimation, the CVM method should be corroborated with other maturity indicators. This renders menarche as an indicator of choice for determining peak growth potential in females.

Among women, there is a stronger correlation between skeletal age and menarcheal age. In southern Punjab population of Pakistan, menarcheal data has been studied, but its relationship to skeletal maturity is still unknown. The objective of our research is to correlate the chronological age in adolescent females and their onset of menarche with the peak of skeletal growth using CS in south Punjab.

MATERIALS AND METHODS

A cross sectional research was carried out in female patients reporting in out-patient department of Orhtodontics in CIMS Dental College, Multan. The study protocol was approved by the Ethical Review Committee of the hospital. The study duration was 06 months (October 2023 to March 2024). A sample of 100 female patients was collected using convenience sampling technique. The inclusion criteria consisted of female patients within the age range of 9 to 15 years, with normal growth and development, and no systemic conditions affecting bone development, and had high-quality lateral cephalometric radiographs with good contrast. The exclusion criteria were the female patients above the age of 15 years, having any hormonal disturbance, patients with abnormal cervical vertebrae or with any syndrome. The patients were informed about the study, its importance and confidentiality of the data collected. A written consent form was signed by both the patients and parents. Lateral cephalograms were taken and the history of menarche was recorded on the same date. The menstrual status reported by the patients was further reconfirmed by asking their mothers.

Each lateral cephalometric radiograph was assessed by tracing the odontoid process and the bodies of the second, third and fourth cervical vertebrae on an acetate paper using 4H pencils on an illuminator. It was then assigned to one of the six cervical vertebral maturation stages (CS) according to Baccetti et al's latest definition by evaluating the outline and morphological changes of these cervical vertebrae (Fig. 1). These tracings were evaluated by an independent evaluator to eliminate inter-operator error. The collected data was analysed by using SPSS (version 22). Spearman rank order correlation coefficient test was used to see the relationship between the chronological age at menarche and the CS stages. P value ≤ 0.05 was taken as statistically significant.
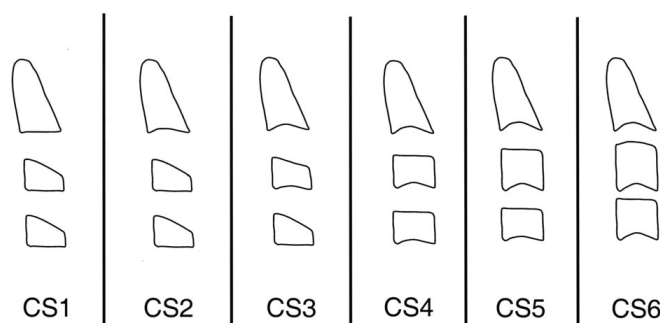

Fig.1 Six stages of cervical vertebral maturation

RESULTS

The mean chronological age and number of the 100 female subjects in each of the Cervical vertebral

maturation stages is given in table 1. Among these, 69 reported with the positive history of menarche. The mean age of the patients in this post-menarche group was 13.49 years (Table 2). All the 69 patients in the post-menarche phase had the skeletal maturation stage beyond the CS2 while the remaining 31 subjects in pre-menarche group had skeletal maturation below CS4. The distribution of the subjects according to the age at menarche is shown in table 3.

In this study, menarche was observed to occur between the ages of 12 and 13 years, corresponding to CS3 and CS4. The Spearman rank-order correlation coefficient was applied to assess the relationship between chronological age at menarche and CS stages. A p-value of ≤ 0.05 was considered statistically significant. The correlation coefficient between chronological age and CS was found to be 0.588, indicating a moderate to strong positive correlation. (Table 4)

Table No 1: Mean Chronological Age and Number of Subjects in Each of the Cervical Vertebral Maturation Stages (CS)

CVM	Mean Age	N	Std. Deviation
1.00	9.7000	10	.67495
2.00	11.7500	12	1.13818
3.00	12.8095	21	1.20909
4.00	13.4828	29	1.21363
5.00	13.6667	18	1.02899
6.00	13.7000	10	1.15950
Total	12.8100	100	1.63111

Table No 2: Mean Chronological Age in Post Menarche Group

Mean Age	N	Std. Deviation
13.4928	69	1.19587

Table No 3: CVM Maturation Stages of the Patients with Positive History of Menarche at Different Ages

		CVM					Total
		2.00	3.00	4.00	5.00	6.00	
AGE	10.00	1	0	0	0	0	1
	11.00	0	1	2	1	0	4
	12.00	0	3	3	1	2	9
	13.00	0	4	4	4	2	14
	14.00	1	4	11	9	3	28
	15.00	0	1	6	3	3	13
Total		2	13	26	18	10	69

Table No 4: Spearman Correlation Coefficient between Age at Menarche and CVM Stages

Spearman correlation coefficient	Value	Significance
	0.588	0.000

Spearman correlation = 0.588
P< 0.01 (highly significant)

DISCUSSION

Several studies have shown a positive association between chronological age and CVM stages in both genders. There is not much published literature with regards to the association between chronological age in adolescent females and cervical vertebral maturation stage.[4] We also correlated menarcheal history with these parameters to find the association of this biological indicator with other skeletal indices.

The period of physical and psychological development known as adolescence typically lasts from puberty to maturity. During adolescence, growth rate accelerates and reaches a peak velocity then it decreases till adulthood.[4] Skeletal maturity indices are commonly used in orthodontics as these are closely related to somatic and sexual maturity.[4] Fishman has stated that in normally growing patients, maturational indicators provide more reliable information than chronological age, so the skeletal age should be used.[4]

Eddie Hsiang-Hua Lai studied association between menarcheal age and skeletal maturation indices in Taiwanese female Orthodontic patients.[4] They found that a large number of girls had already achieved peak of growth before the onset of first menstruation. Their findings suggested that menarche usually follows the pubertal growth spurt by about 1 year and occurs after

Cervical Vertebral Maturation stage III (CVMS III). Maria Inês Magalhães et al in their systematic review and meta-analysis estimated the average age in years, corresponding to each of Baccetti's CVM staging.[4] Their results showed average age at CS3 and CS4 is 12 to 13.4 years. This result is close to our findings as well. Numerous studies confirmed that girls usually mature earlier as compared to boys with an average difference of two years.[4] In addition to maturing later than girls, boys also exhibit a notably higher growth velocity peak scale. Menarche or the onset of menstruation marks the start of fertility and is a crucial indicator of a girls' sexual maturity. The mean menarcheal age of Pakistani girls is between 12 to 14 years with the mean age being 11.73 years.[4,10] The mean menarcheal age of the females of Multan was found to be 12.72 years.[4] Menarcheal onset age is affected by the socioeconomic status, nutritional conditions and environmental influences.

Lateral cephalometric radiograph is a routine investigation in all orthodontic patients. The change in cervical vertebrae's shape and size in growing individuals has been used as a biological indicator for last few decades. Using the cervical vertebral maturation stages method does not need an extra radiograph i-e- hand and wrist because lateral cephalometric radiograph serves this purpose as well. The prediction of pubertal growth spurt makes it possible to estimate the ideal timing for the treatment especially in orthodontic growth modification.[10] At present, cervical vertebral maturation stages (CS) have been used to evaluate the skeletal growth potential with special regard to mandibular growth.[11] The growth changes in superior and inferior surfaces of each vertebra, modifies the vertebrae's size and form. Baccetti at al revised the original Hassle and Farman CVMS method. This methodology was used in our study due to its broad application and acceptability.[12] Six developmental stages are categorized, which are determined by certain physical traits of the 2nd, 3rd and 4th cervical vertebrae. These attributes include the height, form, and inferior border contour of their vertebral bodies. The mandibular growth spurt, according to studies conducted in this regard, takes place between the CS3 and CS4.

Our results show the correlation between chronological age and skeletal maturation evaluated by CS method was 0.588. Sierra also found the relationship between chronological and skeletal age assessment which proved to have high correlation (0.58 to 0.71).[11] This moderate to high significant correlation implies that when an orthodontic female patient is presented in the age of 12-13 years with a positive history of menarche, she has attained the peak pubertal growth.

Our study emanated that female patients' average age at menarche was 12-13years and menarche on average occurred between CS3 and CS4. This association indicates that functional jaw orthopaedics can be started in female patients after attaining menarche with a predictable residual growth.[11]

As the patient data was collected from one hospital and sampling was carried out using convenience sampling technique, our data may not reflect the whole female population of southern Punjab. It is advised that more research be done using a more diverse sample collection to examine the longitudinal links between the age of menarche and the stages of skeletal development in Pakistani women.

CONCLUSION

Cervical Vertebral Maturation is correlated moderately with the chronological age. For a better assessment of peak pubertal growth in females, history of menarche should be considered.

DISCLAIMER

None to declare.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

ETHICAL STATEMENT

Ethical approval was taken from Ethical Committee of Armed Forces of Dentistry Rawalpindi (Ltr no: 918/Trg Dated 13 May 2020)

AUTHORS CONTRIBUTION

Conception and design of the study: A. Akram
Acquisition of data: M. A. Rana, M. Mushtaq
Analysis and interpretation of data: M. K. Mahmood, R. Anwar

Drafting of the manuscript: A. Akram, R. Anwar
Critical review of the manuscript: M. Mushtaq, M. K Mahmood, M. A. Rana
Approval of the final version of the manuscript to be published: A. Akram, M. A Rana, R. Anwar, M. K. Mahmood, M. Mushtaq

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