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Determination of developmental stage of cervical vertebrae at menarche in female orthodontic patients in Ahwaz

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ABSTRACT

Growth modification is one of the most common treatments in orthodontics; however the success of such treatment depends on patients' growth stage and skeletal maturity. Therefore estimating patients' remaining growth potential has important values in treatment planning. The aim of the study was to determine a relationship between developmental stage of cervical vertebrae as a radiographic growth parameter and menarche as a biological parameter. Lateral cephalometric radiographs of 350 female orthodontic patients between 8-18y/o were collected. After getting informed consent, subjects were asked about menarche incidence and the exact date of onset. Subjects whose menarche have not yet happened were followed for six months afterwards so they would be included in the study when menarche occurred. Finally 96 cephalograms with high quality and complete visualization of cervical vertebrae of nonsyndromic patients were considered in the study. Included subjects had their menarche six month before or after the date of radiographic acquisition. To determine the developmental stage of subjects, each lateral cephalogram was separately traced by two professors and the Bacetti methods was used to determine the cervical vertebrae maturation (CVM) of the second, third and fourth vertebrae and were assigned to each of the six developmental stages. Then the percentages of the incidence of menarche in each of the six stages were calculated in order to determine the maximum odds of the incidence of the menarche in each stage. Highest percentage of the incidence of menarche was related to the fourth stage of CVM (37.5 %), with the minimum in the first stage (0%). The highest incidence rates of menarche were noted in the fourth and fifth stages of the development of cervical vertebrae. Consequently, it is advisable to render growth modification treatments before menarche in females.

Keyword: menarche, cervical vertebrae, orthodontics, development

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INTRODUCTION

The field of orthodontics uses different treatment modalities, all of which depend on the mechanisms of skeletal, craniofacial and dental system growth and development despite their diversities [1]. The best treatment outcomes with the least complications are achieved when treatment is initiated during the favorable growth period [2].

Due to significant differences in growth and development between individuals with identical age, chronological age is not a very valid tool for evaluating the patients' developmental stage; therefore resorting to other methods and indicators is needed.

Assessing tooth development and its relation to skeletal growth and maturation is one of the parameters that had been considered in literature [2]. Based on some studies, the calcification pattern of mandibular premolars has a high correlation with skeletal maturity [3-5]. In general, there is a higher correlation between tooth development and puberty in boys compared to girls [6, 7].

Biologic parameters are another method to evaluate growth [8].Among several biological parameters, menstruation is one of the most important ones for evaluating puberty in girls [9-12] and it is influenced by several variables including genetics, ethnicity and environmental factors [13, 14]. In past few decades, the mean age of menarche has decreased all over the world, which might be attributed to improvements in health, nutrition and socioeconomic conditions [15-17].

Skeletal maturation is another reliable parameter in determining the developmental stage of patients. In this context, a new technique has been proposed for the evaluation of the growth and development of cervical vertebrae by Baccetti et al. which is referred to as cervical vertebral maturation (CVM) [18].

Previous studies have shown that Baccetti technique is more reliable in comparison with the older technique of evaluation of the radiography of the wrist. In addition, using Baccetti technique will reduce patients' radiation dose due to elimination of the extra hand and wrist radiography [19]. In this technique, based on changes in the concavity of the inferior border, height and form of the vertebral body of the second, third and fourth cervical vertebrae, the skeletal developmental stages are divided into six stages. Studies in this context have shown that the mandibular growth spurt occurs between the third and fourth stages of development of cervical vertebrae [18, 19].

If a relationship is established between the age of menarche and skeletal development, it might be possible to use the age of menarche in girls as a parameter for rapid clinical judgment in relation to the remaining growth without any need for radiography.

Objectives

The aim of the present study was to determine the developmental stage of cervical vertebrae at menarche in girls undergoing orthodontic treatment in Ahwaz. Other aims of the study consisted of determination of the age of menarche in the population under study and evaluation of the relationship between this age and growth spurt age.

MATERIALS AND METHODS

Subject selection

In this study, the lateral cephalometric radiographs of 350 female patients with an age range of 8–18 y/o were collected from the Department of Orthodontics of Ahwaz University, the private office of the chief researcher in the present study and other radiology centers. No extra x-ray was ordered for the subjects and they already needed a cephalometric radiograph for their orthodontic treatments. The patients were provided with adequate information in relation to the study procedures and the general aims of the study and they were reassured that the information they would provide would be kept confidential and that only the results of the study would be reported without mentioning names. After obtaining the informed consent of the subjects or their legal guardian, they were directly asked if they had experienced their first period and in that case, if they remembered the exact date it began. Other subjects whose menarche have not yet happened were followed for six months after taking the radiograph so that they would be included in the study when menarche occurred.

Finally, 96 cephalograms were selected to be included in the study based on the following criteria:

- Menarche six months before or after the date on which the radiograph was taken
- No syndromic or systemic conditions in the subjects
- Normal condition of cervical vertebrae in the patients
- High quality of the lateral cephalograms taken from the right side of the patient
- Complete visibility of the second, third and fourth cervical vertebrae on the lateral cephalograms

- Exact remembrance of menarche date by the patient or her mother without any doubts

Determining the developmental stage of subjects

In the first step, each lateral cephalogram was separately traced and assigned to one of the six cervical vertebral maturation stages (CVMS) according to Baccetti method by evaluating the outline and morphologic changes of the second, third and fourth cervical vertebrae (C2, C3, C4). (8) (Figure 1). To ensure the correct diagnosis of CVM, each tracing was confirmed by two professors in the Department of Orthodontics. Each professor was unaware of the results of tracing by the other professor when he/she determined the CVM in one of the six stages. Such a procedure was repeated twice by each professor. In the case of disagreement, a third professor was asked to give his opinion, and the three of them reached an agreement on the developmental stage.

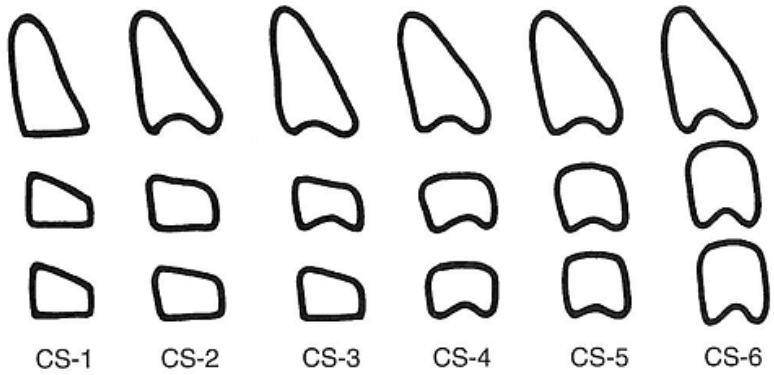

Figure 1: Bacceti's method of determining six developmental stages of vertebrae

Data analysis

The data above were analyzed, and the percentages of the incidence of menarche in each of the six stages of the development of cervical vertebrae were calculated in order to determine the maximum odds of the incidence of menarche in each stage. In addition, the mean age of menarche was determined in each stage and in the sampled population.

RESULTS

96 female orthodontic patients between ages 8-18 y/o were selected according to the specific criteria mentioned before. The incidence of menarche during each developmental stage of cervical vertebrae was evaluated among the subjects. Based on the data collected; the percentages of menarche in each developmental stage of cervical vertebrae are as follows. The highest percentage of the incidence of menarche was related to the fourth stage of the development of cervical vertebrae (37.5 %), with the minimum in the first developmental stage of cervical vertebrae (zero percent). (Table 1)

Also the average age of menarche in the studied sample, CS3 stage and CS4 stage was 12.43 y/o, 11.75 y/o and 12.50 y/o, respectively. (Table1)

Table 1 : frequency of each developmental stage of cervical vertebrae in female orthodontics patients in Ahwaz

developmental stage of cervical vertebrae	frequency	Percentage (%)	Average menarche age (y/o)
CS1	0	0	0
CS2	12	12.5	11.25
CS3	12	12.5	11.75
CS4	36	37.5	12.50
CS5	27	28.1	12.88
CS6	9	9.4	13.33
TOTAL	96	100	12.43

DISCUSSION

It is very important to determine the developmental stage in each orthodontic and dentofacial orthodontic patient. Of all the parameters suggested to determine that, evaluation of skeletal maturation of patients is a valid and reliable technique. In recent years, evaluation of the developmental stage of cervical vertebrae has been suggested as a reliable method for the evaluation of skeletal development [2]. Furthermore, biologic parameters have also been suggested for the evaluation of patients' developmental stage. Menstruation is an important biologic parameter in girls.

The aim of the present study was to determine the developmental stage of cervical vertebrae at menarche in female orthodontic patients in Ahwaz. In order to decrease the error rate, the subjects were selected at intervals of six months before and six months after the menarche. This six-month interval was selected for two main reasons: First, based on previous studies and physiology and histology textbooks, a period of six to eight months is necessary for new bone to form with sufficient density to be visible on radiographs [20]. Therefore imperceptible changes will occur in cervical vertebrae during a period of six months. Second, growth rate is at the highest within six month before and after menarche.

It should be noted that data on the age of menarche in the present study was collected by the subjects themselves and confirmation by their mothers. Similar studies have shown that questioning the patients is a reliable technique because individuals remember the precise date of their menarche even after 30 years [2].

96 lateral cephalograms of female patients were collected from different centers in Ahwaz for the purpose of this study. Since there was no need for linear measurements and only the general shape of the vertebrae were evaluated, there was no need to collect the lateral cephalograms from one center, with the same magnification; the only requirements were using standard radiographic method and producing good quality image of vertebrae.

Statistical analyses showed that the maximum menarche cases occurred during the CS4 stage, followed by the CS5 stage. However no menarche cases were observed during the CS1 stage.

In a study by Chang et al on Taiwanese girls the maximum incidence of menarche occurred during the fifth stage of the development of cervical vertebrae. Similar to the present study no cases of menarche occurred during the CS1 stage.

The mean age of the menarche was calculated at 12.43 y/o in the present study. In the study by Chang et al this mean was reported 11.97 years in Taiwanese girls. The difference between the present study and the study above might be attributed to differences in environmental and genetic conditions between the two study populations.

Based on previous studies [21, 22] the highest odds of growth spurt are between the third and fourth stage of CVM and menarche occurs after this stage. The results of the present study showed that the highest odds of the incidence of menarche were in the CS4 stage which is in good agreement with these studies.

As demonstrated, the mandibular growth spurt happens in CS3 and CS4. Hence we compared the mean menarche age of these two stages with the average menarche age of the sample in order to evaluate the relationship of menarche age and growth spurt. The mean age of CS3/CS4 and mean age of menarche in the sample were calculated at 12.12 and 12.43 years, respectively. Therefore, based on these calculations, menarche occurred almost three months after the peak growth spurt. In the study carried out by Chang et al on Taiwanese girls menarche was reported to occur one year after the growth spurt. Such a difference between the results of these two studies might be attributed to different environmental and genetic conditions between the two study populations.

It should be noted that due to the cost of orthodontic treatment, the subjects of our study most likely have high socioeconomic status and their general living condition might affect the menarcheal age of the sample and it might not be representative of the whole population. Therefore further studies on general population might be helpful in the future.

CONCLUSION

In the present study the highest incidence rates of menarche were noted in the fourth and fifth stages of the development of cervical vertebrae. Menarche occurred approximately three months after the growth spurt. Therefore, it is advisable to render growth modification treatments before menarche in girls.

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