Original Study

RELATIONSHIP BETWEEN CHRONOLOGICAL AGE AND MANDIBULAR GROWTH SPURT IN IRANIAN ADOLESCENTS

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ABSTRACT

Aim: Such timing of treatment predominantly depends on determining the time of pubescence because orthodontic treatment during this period is much easier and is completed in a shorter time. On the other hand. Functional appliances are the principal tools for the treatment of mandibular deficiency that should be used during the mandibular growth spurt period for the best outcomes; therefore, determination of chronological age and its association with peak growth spurt of the mandible is of utmost importance.

Materials & Method: Sixty cephalograms (30 boys and 30 girls) in the CS_3–CS_4 stage were selected based on Baccetti classification. The chronological ages were determined based on their birth dates. T-test and Kolmogorov-Smirnov test used to determine the relationship between the chronological age and mandibular growth spurt.

Results: The mean age of the girls who were in the mandibular growth spurt period was 10 years and 9 months ($p<0.05$), with the mean age of boy in this period being 12 years and 6 months ($p<0.05$). The minimum age was related to a girl (8 years and 9 months) and the maximum age was related to a boy (13 years and 4 months).

Conclusion: The mean ages of boys and girls who were in the mandibular growth spurt period were different. Therefore, treatment of patients with Cl II malocclusion to mandibular deficiency can be accomplished in appropriate time with lower costs. In addition, given the mean ages calculated, treatment of girls should be initiated earlier than that of boys.

Key words: Chronological, Mandible, Cl II malocclusion.

Introduction

The timing and treatment plan have a great role in the success of orthodontic treatment. Such timing relies on determination of the time of pubescence and maturation because during this period there is an increase in skeletal changes, facilitating orthodontic treatment during a shorter period of time.[1-4]

However, there is no active growth in adults and it has almost ended in such patients. Therefore, corrective treatments in such individuals mainly consist of tooth movements or surgery in complicated cases.[5-8] On the other hand, based on available statistics, Cl II malocclusion due to mandibular deficiency is the most common skeletal problem in whites.[8–10] Functional appliances are the most important tools used for the treatment of mandibular deficiencies.[10] These appliances should be used during growth spurt period to achieve the best treatment results.[6,11,12–14] Therefore, it is important to determine the patients' chronological age that coincides with the mandibular growth spurt peak.[8,15] A biological index is required to determine the time of maximum mandibular growth. To date, a large number of biologic markers have been introduced to determine the time of growth spurt, including the characteristics associated with sexual maturation, facial growth and its rate of increase in length, chronological age, tooth development, the width and height of the mandibular body, maturation of hand fingers and maturation of cervical vertebrae. Of all these indexes, two are the most important ones: [16,17]

1. Hand-wrist method (HW)
2. Cervical vertebra maturation (CVM)

The HW radiographic technique, which was used for the first time by Lamparski (1972) to determine the time of mandibular growth spurt, relies on the ossification pattern of hand and wrist bones.[18] CVM is a new technique introduced by Baccetti *et al* (2007), in which the stages of skeletal growth are divided into 6 stages (CS_1–CS_6) based on changes in the morphology of cervical vertebrae on lateral cephalograms.[6, 15, 19-21] The mandibular growth spurt occurs between CS_3 and CS_4 stages. Given the advantages of the CVM technique over the HW technique, nowadays use of the CVM technique is recommended to determine the time of mandibular growth spurt. These advantages include low cost, low exposure, no need for a separate radiographic technique because the cervical vertebrae are visible on the same routine lateral cephalograms used in orthodontic treatment, and the proximity of the growth time of cervical vertebrae to that of the mandible compared to the hand and wrist bones given the cephalocaudal growth pattern of the human body.[4,15] The aim of the present study was to determine the chronological age based on the skeletal development and maturation of cervical vertebrae so that patients with CL II malocclusion can be more effectively and easily treated at shorter periods of time with the use of functional appliances.

Materials & Methods

Eighty patients (40 boys and 40 girls) referring to the Department of Orthodontics, Jundishapur University of Medical Sciences, who had already undergone lateral cephalometric radiographic techniques for orthodontic treatment, were selected. The chronological ages of the subjects were determined and then the cervical vertebrae C2, C3 and C4 in all the samples were carefully traced based on the CVM method.

Based on this method, the maturation of cervical vertebrae is divided into 6 general categories. This method has two basic principles:

1. Presence or absence of concavity at the lower borders of C2, C3 and C4.
2. Differences in the morphology of cervical vertebrae with aging; the body changes from trapezoid to a transverse rectangle to a vertical rectangle.

In order to trace the cervical vertebrae, first a number of landmarks were selected on the cervical vertebrae and then these points were connected to each other to reach a general form. Three landmarks were selected for the second vertebrae: [6,15] the middle inferior, the anterior inferior and the posterior inferior points. Five landmarks were selected for the 3rd and 4th vertebrae: [6,15] the anterior superior, the posterior superior, the anterior inferior, the middle inferior and the posterior inferior points. Then based on Baccetti classification the skeletal maturation status of each subject was determined.[15]

Based on this classification, the skeletal maturation is divided into 6 general categories (CS1–CS6) and the mandibular growth spurt occurs between the 3rd and 4th stages. After tracing the cervical vertebrae, the subjects who were in this stage based on skeletal maturation were selected, which added up to 60 subjects (30 boys and 30 girls). The final subjects were analysed by paired t-test. Wilcoxon's paired-sample test was used for qualitative control of the results and also analysed SPSS (IBM spss statistics 21).

Results

Given the aim of the present study to determine the relationship between the chronological age and skeletal age in boys and girls, the following statistical analyses were carried out:

1. Statistical analysis of male adolescents: The youngest boy that participated in this study has 10 years and 9 months old and the oldest has 13 years and 5 months old. The results for boys are presented.
2. Statistical analysis of female adolescents: The youngest girl that participated in this study has 8 years and 9 months old and the oldest has 12 years and 3 months old. The results for girls are presented.
3. Statistical analysis of all the samples: The means for the boys was 12years and 6 months and the variances was 0.46. Also the means for the girls was 10years and 9 months and the variances was 0.95. P resents the results of the analyses carried out for all the samples. The two male and females groups were compared in relation to means, variances and other statistical indexes and all the 60 subjects in the present study underwent statistical analyses altogether.
4. Comparison of the boy and girl groups: The Kolmogorov-Smirnov test was used to evaluate the normality of the age parameter. In this test the null hypothesis is the normality of the data .T-test was used to compare the two genders in relation to age. Mann-Whitney test was used to compare the parameters which had been measured, based on which the two genders were compared in relation to age.

The median ages of the two groups were compared in relation to the null hypothesis of the equality of medians. The results showed significant differences in age medians between girls and boys ($p<0.05$). Finally, a 95% confidence interval was created for mean differences of age between boys and girls. Based on the results the mean age of boys was at least 1 year and 3 months and at most 2 years and 2 months higher than that of girls at 95% CI. The mean age of girls who were in the growth spurt period in relation to the maturation of cervical vertebrae was 10 years and 9 months. In boys, this mean age was 12 years and 6 months.

The youngest girl who exhibited growth spurt was 8 years and 9 months old and the oldest girl was 12 years and 3 months old. In addition, the youngest boy was 10 years and 9 months old and the oldest boy was 13 years and 5 months old. The mean age of boys was 2 years higher than that of girls.

Discussion

Lamparski (1972) concluded that use of cervical vertebrae exhibits accuracy comparable to that of hand-wrist radiographic technique, with advantages such as low cost and low radiation exposure.[18] In addition, Reily (1988) compared the maturation of the vertebral column, hand and wrist bones and the mandible and reported that their growth and development were coordinated.[5] Baccetti *et al*.(2005) introduced a new technique to determine the time of mandibular growth spurt with the use of cervical vertebrae. [15] In addition, Yongu *et al*.(2007) determined the amount of growth during each stage of maturation of cervical vertebrae by placing implants in the jaws.[7] Both Yongu and Baccetti (2001) reported that the mandibular growth spurt occurs during the CS3 and CS4 stages, consistent with the results of a study by Michalska *et al*. (2010).[2]

By bearing this background in mind and by considering the fact that timing of orthodontic-orthopedic treatment is an important as the treatment plan for the success of orthodontic treatment, it is important to be aware of the mean ages of adolescent girls and boys who are in their growth spurt period of their mandible to increase the success of treatment of patients with Cl II malocclusion due to mandibular deficiency with the use of functional appliances during the best and shortest period because during pubescence significant physical changes occur in the dentofacial structures, including transition from the mixed dentition to permanent dentition. In this context, the differential growth of the jaws comes to an end with an increase in the overall growth of the face.[5, 22] Such consideration will prevent costly and more complex orthosurgery treatment mentalities[1, 15] because after the mandibular growth spurt period the treatment of such patients will require costly, long and complex procedures such as orthosurgery techniques.[15] Nonetheless, such procedures might not yield favourable results. In fact,

treatment of mandibular deficiency during the growth spurt period might yield the best therapeutic results with minimum cost in the shortest time period. Therefore, the present study was undertaken for the first time to evaluate the relationship between the chronological age and maturation of cervical vertebrae in a sample of Iranian adolescences to determine the overall age interval for boys and girls in Iran.

Conclusion

By considering all the data at one interval, the adolescent girls in Ahwaz are in the mandibular growth spurt period from approximately 10 years and 9 months. It is 12 years and 6 months for adolescent boy's. It is advisable to render treatment for micrognathia with the use of functional appliances during these age periods. In addition, the mean age of boys was 2 years higher than that of girls, indicating that treatment in girls should be initiated at a younger age in under to benefit from the growth spurt.

Finally, considering the effect of the environment and genetics on the skeletal maturation it is suggested that similar evaluations be carried out in other body parts and in other ethnic groups and the results be compared with each other.

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