Evaluating Period of Accelerated Skeletal Maturation in Gujarati Children between Ages 8+ and 14+ Years

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ABSTRACT

Assessment of growth status of dentofacial skeleton is important during orthodontic diagnosis and treatment planning procedures particularly in young children having skeletal malocclusion. Genetic and epigenetic factors have a marked effect on the growth status of a child thus the need for the orthodontist to use various skeletal maturation indices to determine period of accelerated growth.

Aims and objective: In the present study, an attempt was made to assess the level of skeletal maturation and period of accelerated growth in 70 boys and 70 girls between the ages (8+) and (14+) years using CVMS index.

Materials and methods: Lateral cephalogram of 140 individuals were selected, i.e. 70 girls and 70 boys, each of age group from 8+ to 14+ years. It is observed that CVMS index used is highly significant for this purpose. It is observed that this index is highly effective for this purpose.

Conclusion: Females’ vertebrae mature earlier than males at each stage. The maturation rate is not constant between the various stages and period of accelerated growth is experienced at different ages and levels in males and females. Need arises to confirm that early maturation in females is not because of their smaller sized vertebra. Further, the time duration recorded between the two subsequent stages is different not because the changes required to be done by nature is different. Longitudinal growth studies of the jaws proper are desired to be conducted for this purpose.

Keywords: Growth spurt, Maturation, Cervical vertebrae, Age.


INTRODUCTION

Orthodontic diagnosis and treatment planning in young growing patient obviates the need to correctly assess the growth status for a definitive treatment plan and its successful outcome. Growth progression follows a variable rate with certain periods of accelerated growth, popularly known in orthodontic literature as growth spurts. The clinical significance of assessing the growth spurt is to relate with the ideal time of growth modification in order to intercept the underlying skeletal problem. Various skeletal maturation indices are used for this purpose among which one of the most popular is improved version of ‘cervical vertebral maturation stage (CVMS)’. Morphological and structural changes can be seen in cervical vertebrae with the advancement of age from childhood to adulthood. It becomes mandatory to evaluate the changes in CVMS index with advancement of age in order to assess the rate and pattern of skeletal maturation in males and females.

Present study is conducted for the assessment of rate of skeletal maturation in Gujarati children between age 8+ years of a child and 14+ years to assess the growth pattern, growth rate and period of growth spurt in both male and female groups.

Objectives of this study were:
1. To find out the effectiveness and accuracy of CVMS index for the assessment of skeletal maturation of an individual.
2. To understand the pattern of variation in growth rate in relation to increasing age of a child.
3. To estimate the period of rapid accelerated growth (growth spurt) by CVMS in males and females.

MATERIALS AND METHODS

The lateral cephalograms of 140 individuals (70 males and 70 females) were randomly selected from the patient’s records of the department of Orthodontia at KM Shah Dental College and Hospital, Piparia, Vadodara. These 140 individuals of Gujarati origin have been divided into seven sets as per their chronological age.

These seven sets are grouped age-wise from 8+ to 9 years, 9+ to 10 years...up to 14+ to 15 years. Each set is comprised of 10 males and 10 females.

Other criteria for sample selection are as follows:
- No past history of major illness or trauma.
- No clinical/radiological evidence of developmental anomaly.
- No past history of orthodontic treatment taken.

Radiographic Evaluation

Stages of improved version of cervical vertebral maturation index were recorded from lateral cephalograms for each...
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The various stages are differentiated on the basis of size, shape and curvatures of surfaces of the bodies of the cervical vertebrae as shown in Figure 1.

The data for each age group for males and females were tabulated to derive the conclusions.

RESULTS

Tables 1A and B depict the cervical vertebral maturation stages of both male and female subjects at different age groups.

Tables 1A and B show variation in the rate of cervical vertebral maturation in both males and females. It is clearly understood that, both in males and females, the cervical vertebrae are in their initial stage of maturation till age 8 years.

At 9 years of age, greater percentage of females in comparison to males show stage II. Further by 10 years, there is increase in percentage of males reaching CVMS stage II, however no one (0%) reaches up to stage III. On contrary, 10% of females reach stage III with corresponding increase in stage II. By 11 years of age, there is a minimal increase in percentage maturation of both males and females reaching to CVMS stage III.

Considerable increase in percentage maturation to stage III has been observed in both the sexes at 12 years of age.

Stage IV of CVMS at 13 years of age shows less number of males in comparison to females of the same age group. By this time, no male has entered to stage IV. Results of the last age group, i.e 14 years, show that 60% of females are in CVMS stage IV, 30% are in stage III and only 10% have reached to their final stage V of maturation. As against this, in males, we observe that 80% are still in stage III while only 10% has reached to stage IV and V respectively. Thus, it can be interpreted from above tables that, in males, the growth is completed at slower rate than that in females.

Table 2 and Graph 1 depict the rate of growth of maturation of cervical vertebrae in both males and females. At 8 years of age, both males and females are at the same status. Thereafter at an interval of each year, when level of skeletal maturation is assessed it appears slightly higher in females than in males. This difference appears to its maximum level at the age of 13 years which is due to the greatest degree of slope of the graph at the age 11 years in females suggestive of onset of growth spurt. This rapid growth rate becomes average between 13 to 14 years. In males, we find that the slope of the graph starts increasing from 11 years onward however between 11 and 13 years. it is similar to one between the ages 8 and 9 years. Males show rapid rise from the age of 13 years.

Similarly, Table 3 and Graph 2, comparing mean age at which particular maturation stage is acquired in females and males, females reach higher maturation stage earlier than males which is remarkable at stage III. This suggests that skeletal maturation rate is higher in females between the stages II and III. Later, the males cover up this difference between the stages IV and V.

<table>
<thead>
<tr>
<th>Age above years</th>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
<th>Stage IV</th>
<th>Stage V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;8 years</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>&gt;9 years</td>
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<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>&gt;10 years</td>
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<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>&gt;11 years</td>
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<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>&gt;13 years</td>
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<td>3</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>10</td>
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<tr>
<td>&gt;14 years</td>
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<td>0</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>10</td>
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</tbody>
</table>

Total 21 27 20 1 1 70

Highly significant Chi-square value = 74.68/significant at probability p < 0.001 and r = 0.97

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<th>Stage IV</th>
<th>Stage V</th>
<th>Total</th>
</tr>
</thead>
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<td>8</td>
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<td>2</td>
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<tr>
<td>&gt;12 years</td>
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<td>3</td>
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<td>6</td>
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<td>10</td>
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</tbody>
</table>

Total 19 22 15 13 1 70

Highly significant Chi-square value = 88.36/significant at probability p < 0.001 and r = 0.96. The girls are more sensitive in this distribution than males.
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DISCUSSION

During the developmental phase, different organs of human body develop at different time intervals and their rate of growth also varies. All the tissues and organs do not develop at the same time and hence the orthodontist is always interested to know the period of active and accelerated growth of the craniofacial structures. Literature reveals that earlier hand-wrist radiographs were used for this purpose.\(^5\,^6\) From the value of carpel index, skeletal maturation status of a child was judged along with overall growth.\(^7\,^10\) Later Richard J Smith\(^5\) discussed that hand-wrist radiographs may provide some information of value with male patients, however the radiographic exposure is not justified for most of the females as there is consistent sex difference in the relationship between skeletal age and facial growth between males and females. Brent Hassel and AG Farman\(^2\) concluded in their studies that shape of vertebrae changes with maturation. Lamparski\(^1\) first time utilized the cervical vertebrae and correlated cervical vertebrae to skeletal age. It was also found that cervical vertebrae were as reliable and valid as the hand-wrist radiographs for assessing the skeletal age for both males and females which is in accordance to our study.

Garcia Franchi\(^12\,^13\) demonstrated the validity of the method of cervical vertebrae maturation for the evaluation of skeletal maturity and for the identification of the pubertal peak in craniofacial growth rate in individual subjects. Present study also reveals that each stage of cervical maturation is attained little early in females than in males. The rate of growth varies between the different time intervals in both males and females; however, the average growth rate is faster in females than in males. Females show acceleration in growth rate (spurt) at around 11 years with high velocity which ceases down by 13 years. In males, there is slight acceleration in growth rate at age 11, however, it attains peak velocity (growth spurt) at around 13 years. KC Grave\(^11\) has reported that the peak growth velocity occurs at 11.8 years in girls and 13.8 years in boys which is similar to our study results. A significant correlation between mandibular growth changes and maturation of cervical vertebrae has been observed by Hagg and Taranger using maturation indicators, thus concluding that skeletal development is more advanced in girls than boys of the same age at the beginning and peak of pubertal growth spurt. He found significant correlation between mandibular growth changes and maturation of cervical vertebrae.

Thus, the present study along with the support from previously done studies concludes that the cervical vertebrae mature and grow faster in females than in males suggesting early onset of growth spurt. Literature supports the fact that ‘female bones are usually smaller and more slender than their male equivalents,’\(^14\) which could be a possible reason for the early maturation of cervical vertebrae of females.

CONCLUSION

The rate of growth and maturation of cervical vertebrae in females is earlier and faster in comparison to males of the same age group leading to advanced skeletal development at the beginning as well as at the peak of growth spurt period, which can be implicated orthodontically while formulating a treatment plan.

REFERENCES