Evaluation of dental and bone age in iron-deficient anemic children of South India

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Abstract

Aims and Objectives: Dental and bone age is very essential for the dental practitioner in planning treatments and is an extra source of information for the pediatrician, orthopedician, and endocrinologist. There are few published data regarding collation between dental age, bone age, and chronological age in iron-deficiency anemic children. This study has been undertaken to evaluate and compare dental age, bone age, and chronological age in children with iron-deficiency anemia. Materials and Methods: One hundred iron-deficiency anemic children were selected in the age group of 8–14 years. Chronological age of the child was recorded by asking birth date from parents or checking school records. Dental age was calculated by Demirjians method and bone age was evaluated using Bjork, Grave, and Brown’s method. Unpaired student’s t-test and Pearson’s correlation coefficient were the two statistical tests applied to compare dental, bone, and chronological age. Results: Dental and bone age was significantly lower (P < 0.001) compared to chronological age. The correlation between the three ages was positive in both sexes. Conclusion: Dental and bone age retardation was a significant feature in our sample of 100 iron-deficient anemic children. Bone age and dental age are valuable parameters in assessing the overall growth of the child. Further studies are required to corroborate our findings.

Key words: Bone age, Demirjian, dental age, growth, iron-deficiency anemia

INTRODUCTION

Growth is a distinctive aspect in the life of a child that differentiates him or her from an adult. Growth activity begins from the time of conception and continues till the child becomes a full-fledged adult. Growth signifies enlargement in the size of tissues, in contrast to development, which designates maturation of functions. Genetic, environmental, societal, emotional, gender, and nutritional factors together or independently affect growth to large extent in an individual. Iron-deficiency anemia causes poor growth rate and developmental delay in animals and humans.
Bone age signifies the physiological development of a person. Bone age refers to the overall skeletal maturation of a person. The appearance and amalgamation of various calcification centers follows a certain order and timetable from birth to full maturation. The radiographic study of these calcification centers provides a definite clue regarding the amount of bone maturity in an individual.

Many childhood diseases and disorders, particularly those causing growth problems, show characteristic relation between bone and chronological age. The bone age is, thus, a useful element in confirming a diagnosis. Hormonal deficiencies, notably those of thyroid and growth hormone, usually cause the most severe degrees of bone age retardation, however, depend, of course, on the duration of the deficiency; moreover, there may be greater disparities with increasing age of the untreated child. Most chronic disorders that impair growth, as a consequence of metabolic causes or undernutrition, will, however, also result in a variable degree of retardation of bone age.

Teeth development is an essential element in the overall maturation of an individual. Dental age determination depends on the quantity of mineralization of tooth buds and the particular order of their eruption in the mouth. Rate of mineralization of teeth is a constant activity, which is a more desirable physiologic development of an individual than teeth eruption. Various systems are in practice to determine the dental age depending on the amount of teeth calcification. Demirjian system has been extensively practiced by many scientists to determine the dental age.

To expand the opportunity of reasoning regarding the impact of growth process on dental maturation and to refine the clinical wisdom, a complete investigation of teeth maturation is very important. Dental and bone maturation is crucial for dentists in formulating treatment plan, and is also convenient as supportive data for various medical specialties.

The association of dental age, bone age, and chronological age is useful for determining the level of growth in various tissue systems of an individual. Ample data is not available in the Indian literature regarding the growth failure in dental and bone development in anemic children, hence, this investigation was undertaken to estimate and compare dental age, bone age, and chronological age in a group of south Indian children affected with iron-deficiency anemia.

**MATERIALS AND METHODS**

The study participants were chosen from the Pedodontics department. The children who had clinical symptoms of anemia were referred to a pediatrician for confirmatory diagnosis of iron-deficiency anemia. After confirmation through clinical and laboratory tests, which included serum ferritin, transferrin, iron and hemoglobin level, as well as morphology of red blood cells (RBCs) and hemoglobin, the children were included in the study. Prior to the commencement of the study, ethical clearance was obtained from the Institutional ethical clearance committee of the college.

Parents were explained about the importance and process of the study, following which the informed consent was obtained from them. One hundred study participants comprising 58 males and 42 females were selected among the age group of 8–14 years, with the help of random sampling. Sample size was calculated based on the formula $n = \frac{z^2 \times pq}{d^2}$ where $z$ is the normal standard variable value [2 for 94% confidence interval (CI)], $p$ the prevalence, $q$ the alternative prevalence, and $d$ the permissible error in the prevalence rate.

Children undergoing the treatment for iron-deficiency anemia were excluded from the study. Orthopantomograms (OPG), handwrist radiographs, and X-ray viewers were the materials used for the study. Date of birth of the child was known through school birth records or by parental statement. The age of the child was calculated with the help of birth date. The age obtained with the birth date is known as chronological age.

**Dental age estimation**

Dental age calculation depends upon the level of tooth calcification. Demirjian et al. selected 7 left permanent mandibular teeth starting from the central incisor to the 2nd molar (in case of missing tooth contralateral tooth was taken into account). Demirjian et al. split the tooth maturation into 8 calcification levels starting from A to H.

Demirjian's dental calcification (developmental) levels [Figure 1] are as follows:

- Stage A: Start of calcification of cusps
- Stage B: Union of cusps
- Stage C: Dentin deposition starts
- Stage D: Crown fully formed up to cementoenamel junction
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Stage E: Root is smaller than crown height
Stage F: Root is equal or more than crown length
Stage G: Tooth formation completed but apex is open
Stage H: Tooth formation completed with apical closure.

After obtaining OPGs [Figure 2] for the study participants, they were carefully visualized under the X-ray viewer to check the level of tooth calcification of 7 teeth in accordance with the Demirjian system [Figure 1]. The calcification levels of 7 teeth were evaluated, and each tooth was designated with a certain score as per the Demirjian table [Tables 1 and 2]. The summation of scores of 7 teeth is known as the maturity score of an individual. The maturity score was transformed into the dental age with the help of a conversion chart.

Maturity score = Calcification scores of 31 + 32 + 33 + 34 + 35 + 36 + 37

31: Left Mandibular central incisor
32: Left Mandibular lateral incisor
33: Left Mandibular canine
34: Left Mandibular 1 premolar
35: Left Mandibular 2nd premolar
36: Left Mandibular 1st molar
37: Left Mandibular 2nd molar

Bone age calculation

Bone age determination was performed by taking hand-wrist radiographs of the study participants. Bjork, Grave, and Browns method[11] was followed to calculate bone age. As per this method, hand-wrist bones were split into 9 calcification levels. Each level constitutes a different bone age.
After obtaining hand-wrist radiographs of the study participants, each radiograph was viewed under an X-ray viewer [Figure 3]. The calcification level of hand-wrist bones was evaluated as per Bjork, Grave, and Brown’s Method. The suitable age for that particular calcification level was taken as the bone age. Statistical tests were applied to the data. The comparison of 3 ages was done with the help of students t-test and Pearson’s correlation coefficient.

RESULTS

Among the 100 study participants, 58 were males and 42 females. After comparative evaluation of the three ages among females [Tables 3 and 4], we found that chronological age was significantly ahead of bone and dental age. Dental age was significantly lagging behind bone age. The correlation of the three ages in females was significantly positive [Table 5].

Comparative assessment of the three ages in males [Tables 3 and 6] showed significant increase of chronological age in comparison to bone and dental age. Between bone age and dental age, we found that the bone age was ahead of dental age. After correlating the three ages in males, we discovered that all three ages were significantly positive [Table 7].

DISCUSSION

Dental and bone age determination always assumes greater importance in Dentistry and Medicine. Bone and dental age are important parameters to assess the overall growth and development of an individual. Many systemic diseases affect growth failure in children. Iron-deficiency anemia is one of the systemic diseases, which causes growth failure in children. Bandhu et al.[12] discovered that iron-deficiency anemia in children caused significant physical and mental growth retardation.[12] Aukett et al.[13] found that growth failure can be reversed in iron-deficiency anemia children. Moffatt et al.[14] discovered that iron therapy in an iron-deficiency child could bring back the psychomotor development.

In our investigation, we assessed the level of bone maturation and dental maturation in order to compare chronological age in iron-deficiency anemic children of the south Indian group.

Radiographic method of assessment of the level of mineralization in hand wrist bones is a highly reliable method of bone age estimation in an individual.[15] To estimate bone age, we have performed radiographic assessment of calcification levels of hand-wrist bones following Bjork Grave, and Brown method.[11]

Iguma et al.[16] found that both Martins and Sakima and Grave and Brown methods proved to be valuable for the determination of bone age with the help of hand-wrist radiographs. Dental age is a very useful parameter to investigate the overall maturation of an
individual. Dental mineralization is more reliable to
assess dental age when compared to dental eruption.
Tooth mineralization is a constant process which can
be determined by radiographs whereas tooth eruption
is a fluctuating event where its exact time is difficult to
analyze.[6]

We have used Demirjian’s method in our investigation.
Hagg and Matsson,[17] Nanda and Chawla,[18] and
Hegde and Sood[19] suggested that the Demirjian method
offers more precise and greater reliability for dental age
estimation.

Advancement of chronological age in comparison
with dental and bone age was our finding in both the
sexes. Our observations are in conformity with that of
Vallejo‑Bolanos et al.,[8] Takano et al.,[19] Keller et al.,[20]
Sarnat et al.[21] and Vallejo‑Bolanos et al.[22]

Vallejo‑Bolanos et al.[8] observed retardation of dental
and bone maturation in a sample of 54 familial
short‑statured children. Sarnat et al.[21] found lagging of
dental age in both growth hormone deficiency patients
and Laron type dwarfism (LTD) patients.

Our investigation proved a significant decrease in dental
and bone age in both genders, which is in accordance
with the findings of Vallejo‑Bolanos et al.[22] Aissaoui
et al.[23] evaluated the utility of the Demirjian method
for dental age assessment among Tunisian children and
stated that the method was not suitable for Tunisian
children and each population deserves a separate set of
standards to assess the chronological age. Patel et al.[24]
assessed the accuracy of various age estimation methods
and concluded that the Willems’s method (Modified
Demirjians) can be used to calculate chronological age
in 6–16 year old Gujrati children.

Alshihi et al.[25] conducted a study to evaluate the use
of the London Atlas of Human Tooth Development and
Eruption for age estimation in Saudi Arabian children
and adolescents (aged 2–20 years), and concluded
that there was variation in age estimates that may have
significant impacts on results.

Monifard et al.[26] radiographically assessed the
third molar development in relation to dental and
chronological age and found a strong correlation
between left third molars and dental age in males.
The study also highlighted the importance of third
molar calcification stage as an important phase in age
prediction for all the mandibular teeth in both the
genders.

As per our observation, we found that the dental, bone,
and chronological ages were positively correlated.
These findings are supported by related studies such as
those of Vallejo‑Bolanos et al.[8] Green,[2] Hegde and
Sood,[7] Prabhakar et al.,[6] and AlQahtani et al.[27]

Many previous studies have also validated that different
growth maturation tissue systems exhibit positive
relationship.

CONCLUSION
Dental age and bone age retardation are important
findings in our study sample. Estimation of bone
maturation and dental maturation is a valuable
investigation to observe the growth status of different
tissues in the body. Bone age and dental age is very
helpful in dentistry to plan dental treatment and is also
useful in medicine as supportive information. Our
findings validate that growth failure has an impact on
dental and bone maturation in iron‑deficiency anemic
children. Future studies with larger sample size are
required in order to support our observations.

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Conflicts of interest
There are no conflicts of interest.

| Table 5: Correlation between chronological age, dental age, and bone age in females |
|-----------------------------------------------|------------------|
| Correlation coefficient (value)  | Inference     |
| Chronological age-dental age        | 0.624          | Significant |
| Chronological age-bone age          | 0.382          | Significant |
| Dental age-bone age                 | 0.502          | Significant |

| Table 6: Comparison of chronological, dental age, and bone age in males |
|-----------------------------------------------|------------------|
| Mean difference (years)                      | 95% confidence interval for mean difference | t  | P         | Inference |
| Chronological age-dental age                 | 2.62            | 1.50-2.88 | 11.22 | <0.001    | Significant |
| Chronological age-bone age                   | 1.56            | 0.72-1.79 | 6.59  | <0.001    | Significant |
| Dental age-bone age                          | -1.06           | 0.77-1.32 | 4.99  | <0.001    | Significant |
Table 7: Correlation between chronological age, dental age, and bone age in males

| Correlation coefficient (value) | Inference          |
|---------------------------------|--------------------|
| Chronological age-dental age     | 0.657 Significant   |
| Chronological age-bone age       | 0.569 Significant   |
| Dental age-bone age              | 0.611 Significant   |

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