ORIGINAL RESEARCH

Correlation between Chronological Age, Dental Age and Skeletal Age among Monozygoyic and Dizygotic Twins

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ABSTRACT

Introduction: Chronological age, dental development, height and weight measurements, sexual maturation characteristics and skeletal age are some biological indicators that have been used to identify time of growth. Many researchers have agreed that skeletal maturity is closely related to the craniofacial growth, and bones of hand and wrist are reliable parameters in assessing it. The complete hand and wrist radiograph involves 30 bones and assessment of these bones is one elaborate task. The present study is therefore, undertaken to assess the correlation between the chronological age, dental age and skeletal ages among different types of twins.

Materials and Methods: The study consisted of 60 subjects (30 twins) aged 8 to 16 years, divided into group of 10 monozygotic, 10 dizygotic and 10 mixed sex twins. The sample was selected from Twin Survey- 2008 conducted by Department of Orthodontics and Dentofacial Orthopaedics, Sree Balaji Dental College and Hospital, Chennai. Their zygosity was determined by sex, blood groups and by the parent. The chronological age was measured by the date of birth given by the parents. Panoramic and hand wrist x-rays were taken. Dental age was assessed by Demerjian et al method and skeletal age by Greulich and Pyle method. The correlation among twins in dental and skeletal ages with the chronological age was assessed using Correlation Coefficient and Student's't' Test.

Results: The obtained data was fed into the computer and statistical analysis was done for the same using the SPSS version 10.0. Statistical significance was tested at $P<0.05$ level. Mean and Standard Deviation, Correlation Coefficient, Student's't' Test statistical methods were employed. The result showed highly significant 'p' value as <0.001 in all the correlations except for mixed pairs. Descriptive statistics in most of the areas demonstrated a non-significant result between zygosity groups.

Conclusion: There is a correlation existing between the individual's chronological age, dental age and skeletal age and correlation also exists in the twin pairs of the same zygosity and among each pair but no correlation exists between different zygotic twins.

Keywords: Dental Age, Skeletal Age, Chronological Age, Twin Study.

How to cite this article: Gupta M, Divyashree R, Abhilash P R, Bijle M N A, Murali K V. Correlation between Chronological Age, Dental Age and Skeletal Age among Monozygoyic and Dizygotic Twins. *J Int Oral Health 2013; 3(1):16-22.*

Source of Support: Nil **Conflict of Interest:** None Declared

Received: **26th November 2012** Reviewed: **12th December 2012** Accepted: **8th January 2013**

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Introduction

Growth biologically and histologically is a composite of morphogenetic and histogenetic changes occurring continuously over a period of time in response to genetic coding and environment influences. It is one of the most uncertain variations in nature and plays an important role in etiology of malocclusion and also in evaluation of diagnosis, treatment planning, retention and stability of any case.

The influence of genetic and environmental factors on growth and development of the dento-facial complex has been the topic of debate and controversy from ancient times till date with arguably a significant role for the case being genetic. Heredity has been investigated by racial, family-line, and twin method. The influence of heredity can be assessed by studying the family members, observing the similarities and differences between mother-child, father-child, and siblings pairs. Various studies have shown high heritability for most of the facial as well as dental parameters with vertical parameter showing a high genetic control compared with the horizontal one.[1, 2, 3] Family and twin studies have also occasionally shown the significant role of environmental factors also. Sir Francis Galton (1875) was the first person who suggested, that studies on twins would be particularly useful in defining the parts played by hereditary and environmental influence in determining the form and size of the human body.

The twin method based on the premise that, any phenotype differences between them should be the result of environmental influences, or of interaction between identical genes and different environmental factors is one of the most effective methods available for investigating genetically determined variables in orthodontics as well as other medical fields, depending on the variance in the shape and the size of the skull and teeth. Twins are special individuals who provide a wealth of information including intriguing and illuminating insights into the mechanism of human craniofacial growth and development.

The status of development of a child is usually assessed in relation to events that take place during progress of growth. Thus chronological age, dental development, height and weight measurements, sexual maturation characteristics and skeletal age are some biological indicators that have been used to identify time of growth.[4] The chronological age have a role in assessment of maturational status of a child since it is governed by various factors like genetic, epigenetic, environmental, nutritional, hormonal, etc. Children vary in the age at which they attain stages of physical development. Height and weight measurements are one of the powerful tools in growth assessment but are impractical in clinical orthodontics as it requires longitudinal data and needs time and repeated observations. In an effort to determine a child's developmental age, method of assessment using skeletal (bone) age have been devised based on the presence of recognizable stages of ossification.

Many researchers have agreed that skeletal maturity is closely related to the craniofacial growth, and bones of hand and wrist are reliable parameters in assessing it. The complete hand and wrist radiograph involves 30 bones and assessment of these bones is one elaborate task. The present study is therefore, undertaken to assess the correlation between the chronological age, dental age and skeletal ages among different types of twins.

Materials & Methods

The twins used in this study were selected from Twin Survey - 2008 conducted by Department of Orthodontics and Dentofacial Orthopaedics, Sree Balaji Dental College and Hospital, Chennai. Their zygosity was determined by sex, blood groups and by the parent. The twins between 8 and 16 years of age who were willing to participate in the study were included following consent. All the parents were informed of the protocol of the study.

Inclusion Criteria:

1. Subjects with zygosity known to the parents.

2. Physically and mentally healthy without any history of congenital or developmental disturbances
3. No previous history of any orthodontic treatment.
4. No previous history of any trauma or injury to the hand and wrist region.

Panoramic and hand wrist x-rays of 36 twins were taken. After examination of the radiographs, twin pairs of whom at least one member had a maximum dental age score (full maturation of all seven teeth), or where the radiograph was unclear due to moving of the child during exposure, were excluded. The final sample consisted of 30 twins: 10 pairs of monozygotic (MZ) twins, (5 male and 5 female) 10 pair of dizygotic (DZ) twins (5 males and 5 females) and 10 opposite sexed. Their mean age was 12.7 years with a range between 8.5 and 16.83 years. The chronological age was measured by the date of birth of the twins given by the parents.

Hand Wrist Radiographs:

Hand wrist radiographs with a PA view were taken by placing the left hand on a cassette holder with film size 8′ x 10′ (Konica) with fingers slightly separated and the forearm placed in a straight line. The target to the source distance of 40′ was maintained. All radiographs were taken with the same machine, at the same place (ORTHO PAN DENTAL XRAYS LABORATORY) and by the same operator. The exposure time for the hand and wrist was kept as 0.3 seconds and at 70 KVP and 15 ma settings. The film were developed for about 1-2 minutes at 65F and dried. Each hand–wrist radiograph was assigned a skeletal age by comparing it with the standard plates in the *Radiographic Atlas of skeletal Development of hand and wrist.* (Greulich and Pyle, 1959).

Panoramic Radiographs

Keeping the technical characteristics in similar configuration radiographs were taken with a cassette holder with film size 5′ x 11′ (Konica). For age determination, one does not rely on the last stage of tooth formation but on the entire process of dental mineralization. This renders the estimation of age more accurate. The procedure can be used for the entire deciduous and mixed dentition period, and is not influenced by early loss of deciduous teeth. The calculations are made using point evaluation system. Each tooth is given a point value according to its stages of development. Calcification stages were evaluated as described by Dermirjian et al. in which eight stages of formation A to H are described for the formation of the mandibular teeth. The dental age was determined on panoramic radiographs by the method of Demirjian (Demirjian et al 1973; Demirjian and Goldstein, 1976). [5-9]The radiographs were traced using acetate paper and the developmental stage of the individual tooth was attained. The individual scores obtained by the radiograph were added and converted into a maturation and dental age score.

Results

The obtained data was fed into the computer and statistical analysis was done for the same using the SPSS version 10.0. Statistical significance was tested at $P<0.05$ level. Mean and Standard Deviation, Correlation Coefficient, Student's't' Test statistical methods were employed.

The result showed highly significant 'p' value as <0.001 in all the correlations except for mixed pairs (Table 1). The students't' test comparison was used to find the correlation among the chronological age, dental age and skeletal age among the twins. The twins with the similar sex and different zygosity were analyzed. Descriptive statistics in most of the

Table 1: Co-relation Co-efficient Values with Significance

Group	Monozygotic Pairs	Dizygotic Pairs	Monozygotic Males	Monozygotic Females	Dizygotic Males	Dizygotic Females	Mixed Sex Pairs
Chronological Skeletal in years	0.001** (0.968)	0.001** (0.859)	0.001** (0.742)	0.001** (0.992)	0.001** (0.968)	0.001** (0.955)	0.001** (0.898)
Chronological Dental in years	0.001** (0.861)	0.001** (0.945)	0.001** (0.935)	0.001** (0.939)	0.001** (0.995)	0.001** (0.959)	0.209^{NS} (0.434)
Skeletal Dental in years	0.001** (0.898)	0.001** (0.798)	0.001** (0.688)	0.001** (0.957)	0.001** (0.955)	0.001** (0.887)	0.044* (0.645)

**** 'p' value significant at 1% , NS - Not Significant , () – Correlation Values**

areas demonstrated a non-significant result between zygosity groups. (Table 2, 3, 4, 5).

Discussion

This study was designed with a purpose to equip the orthodontists with new evaluation criteria which would enable them to accurately evaluate the dental and skeletal age in a single clinical visit using information on chronological age. One of the most challenging aspects of orthodontic treatment is that being mediator in the craniofacial growth process.

Skeletal and dental age assessment will guide us to predict the correct age and use growth guide to predict the growth spurts for stability of orthodontic treatments. There are wide numbers of growth assessment methods as suggested by many authors but the key question is reliability. The present scenario in clinical orthodontics requires an accurate method with well-defined age and easily identifiable stage which could be interpreted in cross – sectional study without requiring long observational periods. The method should also be non- invasive, safe and economical with no elaborate armamentarium required and should be such as to easily be used in day to day orthodontic practice.

The chronological age was included in the study and it formed an important part of case history as it was a tool to assess the twins. The date of birth common to the twins gave us a check of selecting and grouping the samples. Though it is a poor indicator of maturity as been clearly demonstrated by number of investigators like Fishman[10], but when it is compared with a reliable skeletal or dental maturity indicator, it may help the clinician to predict the time of growth of an individual. Thus, whether the similar amount of growth occurs at the same time in twins can be predicted.[11] Various authors like Greulich and Pyle[12], Fishman[10], Kapoor DN[13]; Mauricio FR[14] have concluded that the skeletal maturity of craniofacial region is most closely related to bones of hand and wrist and plays a vital role in assessing it. The developmental status of a child may be best assessed not by chronologic age but by such parameters.

The results obtained from the study showed highly significant 'p' value as <0.001 in all the

Table 2: Descriptive Statistics of Monozygotic and Dizygotic Twins						
Group	**ZYGOSITY**				**t value**	**p value**
	Monozygotic		**Dizygotic**			
	Mean	**SD**	**Mean**	**SD**		
Chronological age in years	13.74	2.16	12.06	2.50	2.57	0.013*
Dental age in years	12.83	2.59	11.98	3.00	1.07	0.288 (NS)
Skeletal age in years	13.90	2.29	12.60	3.29	1.58	0.119 (NS)
NS - Not Significant, * 'p' value significant at 5% level						

Table 3: Descriptive Statistics of Monozygotic and Dizygotic Female Twins						
Group FEMALES	**ZYGOSITY**				**t value**	**p value**
	Monozygotic		**Dizygotic**			
	Mean	**SD**	**Mean**	**SD**		
Chronological age in years	13.18	2.78	12.20	2.59	0.82	0.423 (NS)
Dental age in years	12.45	3.28	12.94	2.76	0.36	0.722 (NS)
Skeletal age in years	13.60	3.13	12.70	3.40	0.62	0.546 (NS)
NS - Not Significant, * 'p' value significant at 5% level						

Table 4: Descriptive Statistics of Monozygotic and Dizygotic Male Twins						
Group MALES	**ZYGOSITY**				**t value**	**p value**
	Monozygotic		**Dizygotic**			
	Mean	**SD**	**Mean**	**SD**		
Chronological age in years	14.30	1.21	11.05	2.57	3.62	0.002**
Dental age in years	13.20	1.77	10.75	3.34	2.05	0.055 (NS)
Skeletal age in years	14.20	1.03	11.30	3.13	2.78	0.012*
* 'p' value significant at 5% level, ** 'p' value significant at 1% level, NS - Not Significant						

Table 5: Descriptive Statistics of Mixed Sex Twins						
Group MIXED PAIR	**SEX**				**t value**	**p value**
	FEMALE		**MALE**			
	Mean	**SD**	**Mean**	**SD**		
Chronological age in years	12.49	2.47	12.49	2.47	0.00	1.000 (NS)
Dental age in years	12.11	2.90	12.12	3.02	0.01	0.994 (NS)
Skeletal age in years	13.20	3.61	13.20	3.12	0.00	1.000 (NS)
NS - Not Significant , * 'p' value significant at 5% level						

correlations in both monozygotic and dizygotic pairs. These results are in confirmation with the studies conducted by Garn and Rohmann[15], Seymour Chertkow[4], Christer Engstrom[16], Krailassiri et al[17]. The value of significance was at 1% level (Table 1). When individual categories results were take into consideration the correlation existed in all the categories at 'p' value <0.001 (Table 1). The results of the mixed sex pair showed no significance with the correlation in chronological age and dental age and 5% correlation between chronological and skeletal age (Table 1). These results were in confirmation with the studies conducted by Heinrich[18] (1986).

The students't' test comparison was used to find the correlation among the chronological age, dental age and skeletal age among the twins. The twins with the similar sex and different zygosity were analyzed. The result showed correlation between the chronological age among monozygotic and dizygotic pair with the p <0.013 statistically significant at 5% level. Thus, revealing that the sample ages in both the monozygotic and dizygotic twins groups were comparable. There was no significance between the dental age p<0.0288 and skeletal age p<0.119 (Table 1). Thus twins of different zygosity showed no correlations with dental and skeletal ages with the same aged twins.

The result of the test for the females group comparing monozygotic females and dizygotic females showed no significance in all the three categories. The values were chronological age p<0.423, dental age p<0.722 and skeletal age p<0.546 (Table 3).

The students 't' test comparison results showed correlation between the chronological age amongst monozygotic and dizygotic male pair with the p <0.002** highly statistically significance at 1% level. There was no significance between the dental age p<0.055 and skeletal age showed significant value p<0.012* at 5% level (Table 4). The result of the test for the mixed pair group comparing dizygotic males and females showed no significance in all the three categories. The values were chronological age p<1.000, dental age p<0.994 and skeletal age p<1.000(Table 5).

Thus, definitely there is a correlation existing between the individuals between chronological age, dental age and skeletal age and correlation also exists in the twin pairs of same zygosity and among each pair but no correlation exists between different zygotic twins.

Conclusion

There is a correlation between chronological age, dental age and skeletal age among twins of the same zygosity whereas; no correlation exists between mixed sex pair and different zygotic twins. However, there is definitely a need for further study with a larger sample as it can show much higher correlation than the readings we have seen in this study, and hence can affirm and confirm to say whether there is any correlation between the chronological, dental and skeletal ages in twins.

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