

Accuracy of skeletal maturation with chronological age and gender of children aged 7 – 15 Years

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Abstract

Background: Skeletal maturation has been used as a way to evaluate growth and development and its accuracy with the chronological age of a child. Cervical Vertebrae Maturation method (CVM), assessing changes in the concavity of the inferior border and the shape of the cervical vertebrae C2, C3, C4 which is currently a reliable method. The aim of this study is to analyze the accuracy of skeletal maturation by chronological age and gender in children Aged 7-15 Years.

Material and methodology: Cross-sectional study using cephalometrics radiographs of 100 children who were recently undergoing dentoskeletal treatment at the Pediatric Dental Specialist Clinic, RSKGMP Universitas Airlangga Surabaya, 54 girls (mean age 10.91 ± 2.09) and 46 boys (mean age 10.49 ± 1.84) in the age group 7-15 years. Skeletal maturation was analyzed using the Cervical Vertebrae Maturation method by Baccetti. Statistical analysis to examine the differences between chronological age and skeletal maturation using Mann-Whitney.

Results: There was a significant difference ($p < 0.05$) in skeletal maturation between boys and girls in the age group 12-12.9 ($p = 0.02$) and 13-13.9 ($p = 0.01$) years.

Conclusion: Skeletal maturation differs in boys and girls with girls maturing earlier.

Keywords: Skeletal Maturation; Growth; Development; Chronological Age; Cervical Vertebrae Maturation

1. Introduction

The stages of growth and development of children are very important things to be understood by every pediatric dentist because the treatment of children's teeth is carried out comprehensively, continuously and requires a certain period of time. A child in his development period goes through several stages. Knowing each of these stages can be used as consideration in determining the diagnosis, plans, goals and outcomes to be achieved in treatment [1].

Factors that influence the process of growth and development include genetic, racial, nutritional, and systemic (endocrine system) and environmental factors. There are many factors that influence it, making it difficult to analyze children's growth and development accurately. To analyze age development in children, several parameters can be used such as chronological age, somatic maturation, sexual maturation, dental maturation (tooth calcification) and skeletal maturation (bone maturation) and chemical biomarkers [2].

Chronological age is the age calculated based on the year from birth to the present which is seen through the child's date of birth. Chronological age is easy to determine. Several studies state that chronological age cannot be used as a single parameter in analyzing the level of development and maturation of a child. As dentists, another parameter that we can easily use is to analyze dental maturation and skeletal maturation [3].

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Skeletal maturation was analyzed based on bone ossification. Several bone areas can be used such as the feet, ankles, palms (metacarpals) and cervical vertebrae. Skeletal maturation analyzed of the metacarpal bones by hand-wrist radiography is the gold standard. However, the use of hand-wrist radiographs is currently being considered because from the point of view of pediatric patient safety, it causes pediatric patients to receive additional radiation with the stochastic effect of radiation also increasing [4].

Another skeletal method that has been used and is being investigated further is Cervical Vertebrae Maturation (CVM) which is seen through radiographs of cervical bones C2, C3, C4 and is said to be a reliable alternative method. This method analyzes maturation using cephalometric radiographs which are routinely performed before starting dentoskeletal care in children so that they do not require additional radiation [5].

Knowing the skeletal maturation can help determine the priority scale of treatment, the right time to start certain treatments, the type of preliminary treatment at the right time, indications for the use of functional appliances, the selection of orthodontic retention because the optimization of interceptive orthodontic treatment in infancy results in better malocclusion correction [1].

Aims and objectives

This study is aimed to analyze the accuracy of skeletal maturation by chronological age in children aged 7-15 Years. The result from this current study also expected to assist in analyzing the growth rate in patients with indications for dentoskeletal growth and development treatment and to provide scientific information on aspects of growth and development to see the suitability of the chronological age of children in terms of skeletal maturation that can be used for comprehensive treatment in pediatric dentistry.

2. Material and methods

2.1. Study Area

The type of research carried out is analytical observational with study design used was a cross-sectional approach carried out at the Pediatric Dental Specialist Clinic RSKGMP Universitas Airlangga Surabaya

2.2. Study Population and Design

The population studied was 100 cephalometric radiography of 54 girls (mean age 10.91 ± 2.09) and 46 boys (mean age 10.49 ± 1.84) in patients aged 7-15 years who were new and undergoing dentoskeletal treatment at the Pediatric Dental Specialist Clinic RSKGMP Universitas Airlangga Surabaya.

2.3. Exclusion Criteria

- a. Aged between 7-15 years and willing to perform cephalometric radiography
- b. Never had orthodontic treatment before
- c. No history of systemic disease that interferes with normal growth and development of bones and teeth
- d. Never experienced facial trauma or surgery on facial structures
- e. No congenital dental abnormalities
- f. No syndromes or growth anomalies of facial structures

2.4. Statistical Analysis

Data analysis was done using Mann-Whitney test on Statistical Package for the Social Sciences (SPSS) version 22.

3. Results

Distribution of Chronological Age and Skeletal Maturation of children aged 7-15 years who came to the Pediatric Dental Specialist Clinic RSKGM P Universitas Airlangga Surabaya found skeletal maturation in girls with CS4 of 19 children while boys with CS4 of 4 children. Skeletal maturation in girls earlier than in boys.

Table 1 Distribution of Chronological Age and Skeletal Maturation by Gender

	Skeletal Maturation										Total
	Boys					Girls					
	CS1	CS2	CS3	CS4	CS5	CS1	CS2	CS3	CS4	CS5	
7-7,9	4	0	0	0	0	2	1	0	0	0	7
8-8,9	3	3	0	0	0	3	2	1	0	0	12
9-9,9	5	4	3	0	0	0	7	2	0	0	21
10-10,9	1	2	4	1	0	0	2	8	2	0	20
11-11,9	0	2	4	1	0	0	0	3	0	0	10
12-12,9	0	0	4	0	0	0	0	0	3	1	8
13-13,9	0	1	1	0	0	0	0	0	8	0	10
14-14,9	0	0	0	2	1	0	0	0	3	2	8
15-15,9	0	0	0	0	0	0	0	0	3	1	4
Total	13	12	16	4	1	5	12	14	19	4	100

Table 2 Differences in Chronological Age and Skeletal Maturation by Gender

	Gender	N	Asymp. Sig. (2-tailed)
Skeletal Maturation	Boys	46	0.001*
	Girls	54	
	Total	100	

*there are significant differences

The results of the Mann-Whitney test showed there was a significant difference ($p < 0.05$) in skeletal maturation between boys and girls.

Table 3 Differences in Skeletal Maturation in Each Age Group by Gender

Age Group	Asymp. Sig. (2-tailed)
7 – 7,9	0.47
8 – 8,9	0.66
9 – 9,9	0.25
10 – 10,9	0.41
11 – 11,9	0.64
12 – 12,9	0.02*
13 – 13,9	0.01*
14 – 14,9	1.00

*there are significant differences

The results of the Mann-Whitney test showed that there were significant differences ($p < 0.05$) in skeletal maturation of 12-12.9 years and 13-13.9 years between boys and girls

4. Discussion

Maturation is the process of changing from an immature state to complete development over a certain period of time. Child growth and development can be analyzed using chronological age, somatic maturation, sexual maturation, skeletal maturation, dental maturation and chemical biomarkers.

The results of the study showed that the analysis of chronological age and skeletal maturation using the Cervical Vertebrae Maturation (CVM) method by Baccetti in children aged 7-15 years who came to the Pediatric Dental Specialist Clinic RSKGMP Universitas Airlangga Surabaya showed that the sample's skeletal maturation increased in accordance with the chronological age of both boys and girls and the statistical test results found a significant difference in skeletal maturation between boys and girls where the skeletal maturation of girls was known to be earlier than boys.

The results of this study are in line with the results of research by Kraillasiri et al. Howell, J. L, Montasser, M.A., et al. [1, 6, 7] who also analyzed skeletal maturation using the Cervical Vertebrae Maturation (CVM) method and found that there was a significant difference in skeletal maturation between the sexes where skeletal maturation in girls occurred earlier than in boys.

In this study, it was explained that these differences occurred due to differences in hormones or the endocrine system in the two gender. Androgen, progesterone and estrogen hormones are the cause of growth acceleration because they affect the secretion and function of growth hormone, where this process is a complex interaction mechanism [8]. In another study by Stafford, D.E [8] using an ultrasensitive bioreceptor assay for estradiol (the detection limit was 100-fold lower than that of the conventional test), Klein, et al [9] found that prepubertal girls had eightfold higher estradiol levels than prepubertal girls. boys, so it is known that there is a difference in the production of sex steroids before puberty and the timing of the onset of puberty and the acceleration of growth in girls is earlier.

There are differences in skeletal maturation in the 2 age groups of children 12-12.9 and 13-13.9 years in the sample of boys and girls in this study, due to the fact that in that age range the children are experiencing growth spurts. This is known as the pubertal phase or growth spurt. The results of this study are according to Rao, A [3] in girls aged 11-13 years and boys at the age of 14-16 years experiencing a growth spurt called the Adolescent growth spurt period. In this period there are proportional changes in the body, girls become slightly taller and heavier than boys and changes in the cervical spine, not only in size but also in size.

The same study conducted by Emelie & Lars [10] which analyzed a period of maximum growth rate, called the peak height velocity (PHV) that occurs during the late stages of puberty, namely at CS 4, in girls around the age of 12 years and in boys. around the age of 14 years

5. Conclusion

Accurate skeletal maturation with chronological age was obtained in both boys and girls at the age of 7-15 years and skeletal maturation in girls is obtained earlier than in boys. Finally, further research may be developed with a larger number of samples and comparing various races/ethnicities/tribes in Indonesia.

Compliance with ethical standards

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Statement of Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this document.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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