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by Alfira Putriana Dewi

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A comparison of the accuracy of the cervical vertebrae maturation stage method and Demirjian's method on mandibular length growth

Allira Putriana Dewi, Seno Pradopo, Sindy Cornelia Nelwan

Department of Pediatric Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

ABSTRACT

Background: Malocclusion is one of the most familiar dental problems, with a high prevalence among the population. Understanding the patient's craniofacial growth and development is crucial in diagnosis, as are the planning and subsequent success of the treatment. Malocclusion needs to be treated early to optimise the outcome achieved by the treatment. One of the most common types of malocclusions observed in clinics is crowding. The craniofacial bone relevant to the treatment of crowding is the mandible, defined as the mandibular length from the condylin to gnathion areas. When planning treatment, clinicians may experience difficulties in determining the biological age of patient, particularly when supporting diagnostic tools are not available. The indicators of biological age can be observed by the assessment of bone maturation using the cervical vertebrae maturation (CVM) method and by the analysis of tooth maturation using Demirjian's method. However, limited studies are available regarding the accuracy of these methods as diagnostic tools. **Purpose:** This study aims to analyse the accuracy of the CVM method compared with Demirjian's method concerning mandibular length growth. **Methods:** An analytic research method and a cross-sectional design are employed. The research sample comprised 50 lateral cephalometric and panoramic photos of children aged 8-16 years. Data were collected by analysing the maturity level of the cervical vertebrae and the teeth, and measuring the mandible length of the children in the photos. The statistical test used was the Wilcoxon test. **Results:** The results of the Wilcoxon test for the asymptotic sign had a p-value of 0.116 > 0.05, indicating no significant difference between the CVM and Demirjian methods. **Conclusion:** Both of the methods noted above yielded equally accurate results for determining mandibular length growth.

Keywords: biological age; CVM; Demirjian's method; malocclusion; mandibular length growth

Correspondence: Seno Pradopo, Department of Pediatric Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Jl. Mayjen Prof. Dr. Moestopo No. 47 Surabaya, 60132, Indonesia. Email: seno-p@fkg.unair.ac.id

INTRODUCTION

Malocclusion is the most common dental problem in paediatric dentistry, with a prevalence of 20%–100%. The most common malocclusions observed in paediatric dentistry clinics include a deep overbite, an excessive overjet, midline deviation, an anterior crossbite, crowding, and an open bite.¹ When planning treatment, it is necessary to know the patient's age, which can be determined using chronological age and biological age. The chronological age only provides general information about the patient's development, whereas the biological age has more significance for the planning of treatment. To evaluate

biological age, the developmental level of the teeth and bones must be assessed.² Several biological factors such as an increase in height, weight gain, cervical vertebrae maturation (CVM), and tooth development must be taken into account.³

During growth and development, the bones, such as cervical vertebrae, undergo changes that can be detected radiographically as wrist radiographs, which can be used to assess bone maturation. However, this technique requires additional X-ray exposure in orthodontic patients already undergoing lateral and panoramic cephalograms. Considering these shortcomings, the assessment of CVM and changes in the shape and size of cervical vertebrae

are suggested as alternatives to the assessment of skeletal age.³ The stages of CVM are determined based on the morphology of cervical vertebrae bodies (C), namely C2, C3, and C4, which are visualised in a two-dimensional lateral cephalogram, i.e. an analysis of the development of the depression on the inferior edges of C2, C3, and C4 is conducted, and changes in the body shape and size of C3 and C4 are recorded. The bodies of these vertebrae change shape in a characteristic order, progressing from trapezoid to rectangular-horizontal, then to square, and then to rectangular-vertical.^{2,4}

Indicators of biological age can also be found in the dental maturity of growing children. Demirjian's method is the most accepted approach for estimating tooth age. The assessment of tooth maturation is based on the classification stages of each tooth. This assessment is divided into eight stages, taking into account the development of the permanent incisors, permanent canines, permanent first and second premolars, and the mandibular first and second permanent molars on the left.^{5,6}

As previously stated, malocclusion is one of the most familiar dental problems, with a high prevalence among the population. An understanding of the patient's craniofacial growth and development is very important when making a diagnosis and in the planning success of the treatment. It is necessary to treat malocclusion early to obtain optimal results from the treatment. One of the most common types of malocclusions observed in clinics is crowding. The craniofacial bone relevant to the treatment of crowding is the mandible, as measured by the mandibular length.⁷⁻¹⁰

Recent studies showed that cervical vertebral growth is closely related to mandibular maturation and growth. In particular, mandibular growth peaks have been reported to occur concurrently in CVM stages 3 and 4. Regarding tooth maturation, Demirjian's method was presented as an alternative to bone maturation assessment. Although several studies have reported that tooth maturation can be used as an indicator of development, it has a relative relationship with the occurrence of peak mandibular growth.^{11,12} This study aims to analyse the accuracy of the CVM method and Demirjian's method when applied to mandibular length growth.

MATERIALS AND METHODS

This research combined analytic observation with a cross-sectional design. The population group observed in the study comprised paediatric patients aged from 8–16, who were treated at the Airlangga Dental and Oral Hospital, which is part of the Airlangga University Faculty of Dental Medicine. The sample inclusion criteria were the availability of clear and sharp lateral cephalometric and panoramic photos, as well as the patient having all their limbs without ever having experienced a fracture. The sample in this study required 50 samples using the total sampling technique. The ethical clearance certificate

number is 436/HRECC.FODM/VII/2021, assigned by the Ethical Clearance Commission of the Faculty of Dental Medicine Health Research, Airlangga University.

In this study, the independent variable was the age of the child, while the dependent variables were the stage of CVM for C2, C3, and C4, as well as the stage of estimating the age using Demirjian's method, and the mandibular length growth. Data were collected by selecting lateral cephalometric and panoramic photos that were clearly visible, and analysing each photo for cervical vertebra bone maturation through CVM, for tooth maturation using Demirjian's method, and by measuring the mandibular length from the condylion point to the gnathion point. Each group was determined by the average value of cervical vertebral bone maturation, tooth maturation, and mandibular length. The Wilcoxon difference test was conducted to determine which method is more accurate between the CVM method and Demirjian's method for measuring the mandibular length. The statistical analysis test used in this study was Wilcoxon's non parametric difference test.

RESULTS

Table 1 shows that the average CVM method is 11.43 and Demirjian's method is 11.73; this meant that the standard deviation of the CVM method was 2.47 and that of the Demirjian's method was 2.02. The average between CVM and Demirjian's method showed a difference of 0.3 and the standard deviation had a difference of 0.45. From the statement, this data demonstrates that there is no significant difference, and that it is necessary to retest the difference. The original data were initially tested for normality. Table 2 shows that the CVM method obtained a significance value of 0.000 because a significance value lower than from 0.05 inferred that the data were not normally distributed.

Table 1. The average method of cervical vertebrae maturation and Demirjian's method.

	CVM	Demirjian
Mean	11.43	11.73
Standard Deviation	2.47	2.02

Table 2. The results of the Kolmogorov–Smirnov normality test.

Group	Significance	Description
CVM	0.000	Not Normal
Demirjian	0.200	Normal

Table 3. The results of the Wilcoxon difference test.

	Mean rank
Demirjian	24.97
CVM	25.82
Asymptotic Significance (Demirjian – CVM)	0.116

Regarding Demirjian's method, a significance value of 0.200 was obtained because a significance value higher than 0.05 inferred that the data were normally distributed. Table 3 shows that Demirjian's method had a mean rank value of 24.97 and the CVM method had a mean rank value of 25.82. The mean rank value differed by 0.85, which can be observed in the asymptotic significance (Demirjian and CVM). Asymptotic significance was the probability value (p-value) of the Wilcoxon test, and was compared with the alpha value, i.e. 0.05. The results would then show that there was either a significant or no significant difference between the data of the two data methods being compared. A p-value of > 0.05 would refer no significant difference, while a p-value of < 0.05 would indicate a significant difference. In this research, a p-value of 0.116 was found for a result higher than 0.05; this indicated that there was no significant difference between the results obtained using the CVM method and using Demirjian's method.

DISCUSSION

Malocclusion is the most common dental problem in paediatric dentistry, with a prevalence of 20%–100%. When planning treatment, it is necessary to know the patient's age. Biological age is more significant than chronological age in the planning of treatment. Several biological factors can be used to determine developmental age, e.g. CVM and tooth maturation.^{1,3}

During growth and development, the bones undergo changes that can be detected radiographically in the form of lateral cephalometric radiographs and by observing the maturation of the cervical vertebrae using the CVM method. The stages of CVM were determined based on the body morphology of C2, C3, and C4, i.e. the analysis of the development of the inferior edge basins of C2, C3, and C4, as well as changes in body shape and the sizes of C3 and C4. Indicators of biological age can also be observed in the maturity of the teeth using Demirjian's method. The assessment of tooth maturation is based on the classification stages of each tooth. This assessment is divided into eight stages, which are observed using panoramic radiographs.^{2,3,5}

In previous studies, CVM was evaluated using the CVM index, which is applied to observe the concavity of the inferior edge and the shape of the cervical vertebrae, which are subsequently grouped into six stages. These changes are related to the morphological modification of the vertebral shape, as well as the estimated time interval from the peak mandibular growth. In particular, peak mandibular growth has been reported to occur concurrently with CVM stages 3 and 4. The assessment of tooth maturation using Demirjian's method was presented as an alternative to bone maturation assessment. Although several studies have reported that tooth maturation can be used as an indicator of development, tooth maturation has a relative relationship to the occurrence of peak mandibular growth.^{11,12}

This study also demonstrated that there is a difference of only 0.3 in the average of the CVM method and that of Demirjian's method, meaning that the standard deviation of the CVM method and Demirjian's methods also had a difference of only 0.45. Considering these results, it can be stated that no significant difference was found, and that it is necessary to retest this method. The non-parametric Wilcoxon test was applied as a statistical test in the current study because the CVM method included data that was not normally distributed. The results of the Wilcoxon difference test indicated that there was a difference in the mean rank value of only 0.85 between Demirjian's method and the CVM method; accordingly, the asymptotic significance (Demirjian and CVM) had a p-value of 0.116 for result higher than 0.05, demonstrating that there was no significant difference between the results obtained from the CVM method and Demirjian's method. In conclusion, the two methods discussed herein yielded equally accurate results for determining mandibular length growth. Additional research is necessary to determine which of the two methods is the most accurate.

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