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Farklı İskeletsel Yapıdaki Bireylerde Maturasyon İndikatörlerinin Değerlendirilmesi

The Assessment of Maturation Indicators in Individuals with Different Skeletal Pattern

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ÖZ

Amaç: Bu çalışmanın amacı, Sınıf I, Sınıf II ve Sınıf III bireylerde diş yaşı, kronolojik yaş, el-bilek maturasyonu ve servikal vertebra maturasyonu arasındaki ilişkileri değerlendirmektir.
Yöntem: Bu çalışmada 8-18 yaş arası 289 kişinin (151 kız, 138 erkek) panoramik, el-bilek ve sefalometrik radyografileri değerlendirildi. Sagital iskelet maloklüzyonuna göre olgular Sınıf I, Sınıf II ve Sınıf III olacak şekilde üç ana gruba ayrıldı. Bireylerin diş yaşları Demirjian yöntemine göre belirlendi. Olguların el-bilek radyografileri Fishman maturasyon göstergeleri kullanılarak değerlendirildi. Servikal vertebra maturasyon evreleri, Bacetti ve ark. tarafından geliştirilen yöntemle değerlendirildi. Değişkenler arasındaki ilişkileri ölçmek için Spearman sıralama korelasyon katsayıları kadın ve erkek için ayrı ayrı kullanıldı.
Bulgular: Tüm gruplarda hem kadın hem de erkek bireyler için değerlendirilen tüm değişkenler arasında Spearman korelasyon katsayısında farklı düzeylerde anlamlı bir pozitif korelasyon görüldü ($p< 0.01$). En düşük korelasyon, Sınıf II grupta kronolojik yaş ile iskelet diş yaşı arasında bulundu (r: 0.413). Servikal vertebra maturasyonu ile el-bilek maturasyonu arasındaki korelasyon, tüm gruplarda her iki cinsiyet için yüksekti ($p< 0.01$).
Sonuç: Çalışmamızın sonuçlarına göre, pubertal büyüme atılımı ve gelişim evrelerini tanımlamak için; servikal vertebra maturasyonu el-bilek maturasyonu değerlendirmesine alternatif olarak kullanılabilir. Ancak, daha büyük örneklem büyüklüğüne sahip gelecek çalışmalar, diş yaşının güvenilirliği kanıtlamada yardımcı olabilir.

Anahtar Kelimeler: Kronolojik yaş, Diş yaşı, Servikal vertebra, El bilek.

ABSTRACT

Objective: The aim of this study is to evaluate the relationships among dental age, chronological age, hand-wrist maturation and cervical vertebral maturation in Class I, Class II and Class III individuals.
Method: Panoramic, cephalometric and hand-wrist radiographs of 289 individuals (151 girls, 138 boys) aged between 8 and 18 were evaluated in this study. Subjects divided into three main groups as Class I, Class II and Class III according to their sagittal skeletal malocclusion. The dental ages of the individuals were defined according to the Demirjian's method. The Fishman maturation indicators were used for evaluating the hand-wrist radiographs and the method improved by Bacetti et al. were used for evaluating the maturation stages of the cervical vertebrae. The Spearman correlation analysis was used to evaluate the relationships between the variables separately for males and females.
Results: The Spearman correlation coefficient indicated a significant positive correlation at different levels between all variables evaluated for both female and male individuals in all groups ($P< 0.01$). The lowest correlation was found between chronological age and dental age skeletal in Class II group (r: 0.413). The correlation between cervical vertebra maturation and hand-wrist maturation were highly positive for both sexes in all groups ($P< 0.01$).
Conclusion: According to the results of our study, to define the growth spurt and developmental stages, cervical vertebrae maturation could be used as an alternative to hand-wrist maturation assessment. However, additional studies with a larger sample size may be helpful in proving the reliability of the dental age.

Key words: Chronological age, Dental age, Cervical vertebrae, Hand-wrist.

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1. INTRODUCTION

In orthodontic treatment applications, it is essential to determine at which stage of the physiological growth and development periods individuals are, how much growth is left, and in which direction the growth will take place. Especially; since understanding the growth stages has a significant impact on the diagnosis and orthodontic treatment plan, it should be taken into consideration to achieve optimal results in the treatment of the individual (1). Skeletal development is at lower levels before and after a pubertal growth spurt (2). It is also possible to benefit from different stages of puberty for the growth modification of individuals with different skeletal structures. Several studies indicate that functional appliances used in the treatment of skeletal Class II malocclusions give more effective results during puberty (3,4). Yet, in skeletal Class III malocclusion, treatment is recommended at an early stage such as the prepubertal growth phase (5,6).

Many biological indicators such as chronological age, secondary sex characteristics, height and weight gain, tooth development periods, and bone age are used to determine the growth and development of individuals (7,8). The dental age of the child can be determined through the calcification and eruption stages of the teeth (9). Although the relationship between skeletal maturation and dental maturation has been studied quite a lot, the results are inconsistent (9-12). This inconsistency may have arisen due to the diversity of assessment methods and the racial differences of the populations studied (13).

Hand-wrist radiographs, which are frequently preferred for determining bone age, are classically accepted as the best method (14-16). However, there is a need for an additional radiograph, which is not used in routine orthodontic practice, for the hand-wrist evaluation. The use of cervical vertebrae to evaluate skeletal maturity among orthodontists has become popular since lateral cephalometric radiographs are routinely taken for the orthodontic treatment plan. Thus, radiation exposure, cost, and duration are reduced without the need for second radiography (17-20). In 1972, Lamparski (17) studied the development of the cervical vertebrae and demonstrated the validity of this method. The index, which was revised by Hassel and Farman (19) and associated with the stages in the Fishman hand-wrist method (14), was most recently renewed by Bacetti et al. (18), providing ease of application with the updated method.

Although the above-mentioned methods have been compared among themselves in studies evaluating growth and development in the literature, the results are inconsistent, and there are no studies that assessed the relationship of all these methods in individuals with different sagittal skeletal craniofacial growth. In the light of this information, this retrospective study aims to evaluate and compare the relationships between dental age, chronological age, and hand-wrist maturation and cervical vertebral maturation in children and adolescents with different sagittal skeletal malocclusions. The null hypothesis was that there would be no correlation between dental age, chronological age, and hand-wrist maturation and cervical vertebral maturation in children and adolescents with different sagittal skeletal malocclusions.

2. METHOD

This retrospective study protocol was approved by the local ethical committee in Aydın Adnan Menderes University Faculty of Dentistry (ADÜDHF2021/021). All patients had a signed constent form allowing use of their data for scientific purposes. The design of the study

was retrospective and no additional radiation was given to patients for the aims of this research. Panoramic, hand-wrist, and lateral cephalometric radiographs taken routinely on the same day from patients for pre-orthodontic diagnosis and treatment planning, available in the 2016-2020 archive of Aydın Adnan Menderes University Faculty of Dentistry, Department of Orthodontics, were evaluated. The patients who did not have any known systemic disease, no anomalies or syndromes, no congenital or extraction-related permanent tooth deficiency, had clear images of teeth and bones in X-rays, clear lower edges of the first four cervical vertebrae on lateral cephalometric radiographs, and no previous orthodontic treatment, were included in the study. A total of 289 (151 female, 138 male) patients between the ages of 8-18 who met the necessary criteria were included in the study. Lateral cephalometric radiographs were used to determine the sagittal skeletal malocclusion type and groups. ANB angle was used for anteroposterior jaw relationship (Class I: 0° <ANB 4°, Class II: ANB 4°, Class III ANB 0°). Class 1 group consists of 57 girls and 45 boys; Class 2 group of 51 girls and 46 boys; Class 3 group of 43 girls and 47 boys.

All radiographs were taken with the same device (Planmeca Promax, Planmeca, Helsinki, Finland) with positioning and irradiation settings in accordance with the manufacturer's instructions. The dental age of individuals was determined on panoramic radiographs, using an eight-stage scale according to the Demirjian method. Central and lateral incisors, canines, first and second premolars, first and second molars in the left mandible were used in the evaluation. Based on the developmental stage, the appropriate stage in the scale was assigned for each tooth, and a numerical value was attributed to these stages using separate standard tables for male and female individuals. Afterward, the total score was obtained by summing the numerical values, and the matching dental age was determined from the standard tables. Each X-ray was examined in duplicate to minimize possible evaluation errors. In case of a difference between the first and second evaluation results, the lower developmental stage was always preferred.

Fishman maturation indicators were used to determine the skeletal maturation level (HWM) on hand-wrist X-rays of individuals. In the evaluation of cervical vertebral maturation (CVM), the method developed by Bacetti et al. (18) was preferred.

Statistical Analysis

The statistical package program IBM SPSS Statistics 22.0 (IBM Corp., Armonk, New York, USA) were used to evaluate the data. The mean and standard deviation values were calculated for the chronological age and dental age variables. Percent distribution of stages was determined for CVM and HWM. The normal distribution of the data was evaluated with the Shapiro Wilk test of normality. Spearman correlation analysis was used to assess the relationships between the variables. $P<0.01$ value was considered statistically significant.

3. RESULTS

The intra-group correlation data, in which the consistency and reproducibility of the measurements were assessed, revealed a high correlation between the pairwise evaluations of each variable made at 1-week intervals (0.953-0.995). The gender and mean chronological age of the individuals according to the groups are shown in Table 1.

Table 1. Gender Distributions and Chronological Age Averages According to Groups

Groups	Gender	N	Chronological age (Mean years)
Class I	**Female**	57	13.97 ± 2.04
	Male	45	14.39 ± 1.59
Class II	**Female**	51	14.08 ± 1.56
	Male	46	13.86 ± 1.79
Class III	**Female**	43	14.27 ± 2.17
	Male	47	14.83 ± 2.93

Table 2. Correlation Between Variables in Females and Males in Class I, Class II and Class III Groups

Gender		CA	DA	HWM	CVM
		r	r	r	r
Class I					
Female	**DA**	0.557**	1	0.529**	0.549**
	HWM	0.543**	0.529**	1	0.822**
	CVM	0.536**	0.549**	0.822**	1
Male	**DA**	0.464**	1	0.536**	0.604**
	HWM	0.446**	0.536**	1	0.791**
	CVM	0.443**	0.604**	0.791**	1
Class II					
Female	**DA**	0.413**	1	0.535**	0.586**
	HWM	0.487**	0.535**	1	0.763**
	CVM	0.446**	0.586**	0.763**	1
Male	**DA**	0.464**	1	0.561**	0.588**
	HWM	0.410**	0.561**	1	0.809**
	CVM	0.392**	0.588**	0.809**	1
Class III					
Female	**DA**	0.535**	1	0.617**	0.645**
	HWM	0.549**	0.617**	1	0.722**
	CVM	0.586**	0.645**	0.722**	1
Male	**DA**	0.617**	1	0.561**	0.574**
	HWM	0.663**	0.561**	1	0.749**
	CVM	0.637**	0.574**	0.749**	1

CA, chronological age; DA, dental age; HWM, hand-wrist maturation; CVM, cervical vertebral maturation; r, correlation coefficient; **, $P<0.01$

The correlation coefficients between CA, DA, CVM, and HWM were calculated separately for men and women in each group. In the correlation analysis, the Spearman correlation coefficient indicated a significant positive correlation at different levels between all variables evaluated for both female and male individuals ($P< 0.01$) (Table 2).

In the Class I group, the lowest moderate correlation was found between HWM and DA in girls (r: 0.529). In boys, the lowest moderate correlation was found between CVM and CA

(r: 0.443). Correlation values of 0.822 and 0.791 between HWM and CVM in girls and boys revealed a perfect correlation between the variables (Table 2).

In the Class II group, the lowest moderate correlation in girls was found between CA and DA (r: 0.413) (Table 2). In boys, the lowest moderate correlation was found between CVM and CA (r: 0.443) (Table 2). Correlation values of 0.722 and 0.809 between HWM and CVM in girls and boys revealed a perfect correlation between the variables (Table 2).

In the Class III group, the lowest moderate correlation in girls was found between HWM and DA (r: 0.535) (Table 2). In boys, the lowest moderate correlation was found between HWM and DA (r: 0.561) (Table 2). Correlation values of 0.763 and 0.749 between HWM and CVM in girls and boys revealed a perfect correlation between the variables (Table 2).

4. DISCUSSION

In the treatment of an individual with a skeletal orthodontic malocclusion in its etiology, it is possible to prevent or direct the development and growth of the jaws with the devices used. However, the timing of treatment is crucial to achieve optimal results. It has been reported that managing the timing of intervention of preventive and functional orthodontic treatments is a critical issue for determining success or failure in the treatment of various types of malocclusion (20,21). For this purpose, many biological indicators such as chronological age, secondary sex characteristics, dental development, hand-wrist maturation, and cervical vertebra maturation can be used. Many previous studies have investigated possible relationships between these methods (9-12,22). In this study, the relationships between CA, DA, CVM, and HWM in children and adolescents with different sagittal skeletal malocclusions were assessed.

Various methods used in the determination of dental age are available in the literature. Steinberg stated that the data obtained by measuring the degree of calcification of the teeth are more reliable/significant in the evaluation of the relationship between dental age and chronological age; emphasized that the calculation of dental age relying on the early or late eruption of teeth is not significant (23). Olze et al. (24) reported that the Demirjian method had the highest consistency between different researchers and in repeated measurements; and that it was the method by which the closest values were obtained in terms of chronological age and estimated age. Therefore, the eight-stage Demirjian method was preferred in the present study. This method has been preferred as it does not require linear measurement and is simple and easily applicable. In addition, since this method is used in most of the recent studies, it was thought to be useful for comparing our findings.

It has been reported that growth and development do not show significant differences in genders until puberty, but with the onset of puberty, significant differences arise between boys and girls (25). Considering this difference, we evaluated both genders separately in our study.

In our study, moderate correlation was found in all three groups for chronological age and skeletal maturation, and CA showed the lowest correlation values with other parameters. The null hypothesis of no significant correlation dental age, chronological age, and hand-wrist maturation and cervical vertebral maturation was rejected. Uysal et al. (26) reported a high correlation between the degree of skeletal maturation, determined by both hand-wrist and cervical vertebra methods, and chronological age. On the other hand, Fishman (22) stated that there is no specific relationship between these two variables. The study of Alkhal et al. (27)

emphasized that the correlation between CA and both CVM and HWM is low, and hence chronological age cannot be used in the assessment of skeletal maturation. The difference in the findings may have arisen due to the diversity of assessment methods and the racial differences of the populations studied.

In the literature, different results have been reported in studies evaluating the relationship between an individual's dental age and skeletal maturation. Sağlam et al. (12) reported that the relationship between dental and skeletal maturation was not sufficient to use dental maturation as an alternative to skeletal maturation. Krailassiri et al. (9) found a statistically significant relationship between the dental and hand-wrist maturation periods in girls and boys in their study. In the current study, a moderate correlation was found between DA and CVM and HWM in both girls and boys in all groups. The differences between the findings of the studies can be attributed to the different methods used in the evaluation of dental and skeletal maturation and the different teeth evaluated. In addition, factors such as differences in the sample size used in the study, age and ethnicity, climate, and nutrition may be other reasons for the different results.

Many studies evaluating skeletal development detected a moderate/high degree of correlation between the developmental periods of the cervical vertebrae and hand-wrist (28-30). Flores-Mir et al. reported that although the correlation between the two techniques was moderately high, the degree of correlation was affected by the level of skeletal maturation (28). In our study, a perfect correlation was found between CVM and HWM in all groups, consistent with studies in the literature; the amount of correlation did not differ according to gender. In our study, even though the high degree of correlation between the cervical vertebral and hand-wrist periods gives information about whether the mandibular growth spurt has started clinically or not, it cannot provide information about the duration of the transitional periods between the stages and the duration of mandibular growth. This is due to the fact that our study was planned as cross-sectional rather than longitudinal.

5. CONCLUSION

The correlation between cervical vertebra maturation and hand-wrist maturation were highly positive for both sexes in all groups. According to the results of our study, cervical vertebrae maturation could be used as an alternative to hand-wrist maturation assessment to define the growth spurt and developmental stages. On the other hand, additional studies may be helpful in proving the reliability of the dental age.

Ethical Consideration of the Study

This retrospective study protocol was approved by the local ethical committee in Aydın Adnan University Faculty of Dentistry (ADÜDHF2021/021).

Conflict of interest statement

None declared.

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