

Validation of the Demirjian's Method for Dental Age Estimation in Korean Population

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Abstract : Dental development is valuable for age estimation of children because of its low variability and less affection by endocrine and nutritional status. Demirjian reported a new system of dental age assessment in 1973 and this method has been used in many countries. The accuracy of Demirjian's method in dental age estimation may be affected by ethnic difference. For Korean population, the population study of Demirjian technique has not accomplished yet, therefore, we investigate and analyze the validity of Demirjian's method in Korean population.

The 155 orthopantomographys which consisted of 87 boys and 68 girls were randomly selected and the age range was 5 to 16 years. The age of radiography was estimated according to criteria presented by Demirjian. Statistical analysis was performed between real age and estimated age.

In boys, there was no significant difference observed ($p=0.171$) between the real age and estimated age, however in girls, significant difference was shown ($p=0.022$) in 95% confidence interval. In both groups, there was clear overestimation tendency below 8.0 year, but over 8.0 year the difference pattern is atypical. The Pearson correlation coefficients between real age and estimated age were 0.970, 0.964 in boys, girls, respectively and showed positive relationship.

The standards of dental maturation reported by Demirjian may not be applicable in Korean children especially in girls. Establishment of new maturation scores and percentiles curves for Korean population with many samples is required for more accurate age estimation.

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Key words : Demirjian, Age estimation, Korean population, Orthopantomography

Introduction

Age estimation plays an important role in forensic medicine and for clinicians of pediatric endocrinology and orthodontics. Several studies showed that dental

development is suitable for age estimation of children for its low variability (Haavikko 1974, Hagg and Mattsson 1985). Moreover, mineralization of developing teeth is less affected by variation in endocrine and nutritional status than other growth parameters (Garn et al. 1965a, b).

Most of the methods used in dental age estimation of children is based on dental calcification measured from radiographs. Radiological methods are non-invasive and easy to apply. In 1973 Demirjian et al. reported a new system of dental age assessment and modified

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Fig. 1. An example of orthopantomography. The 7 left mandibular permanent teeth were staged and scored for dental age estimation.

by Demirjian and Goldstein in 1976. Nowadays this method applied in many countries and ethnic groups. The original method was based French-Canadian population. Many reports were announced about the validity of Demirjian's method based on their own population. Nystrom et al. (1986) found a more advanced dental maturation in Finnish children than the French-Canadian children and concluded that maturity standards must be based on studies made on the same population for which they will be applied. Mörnstad et al. (1994) concluded that the original studies gave an overestimation when used on a Scandinavian population. Koshy and Tandon (1998) founded that Demirjian's method gave an overestimation of 3.04 and 2.82 years in males and females, respectively and attempted to formulate new norms for the maturity score based on South Indian population.

Ethnic differences between various population groups were found to affect the accuracy of dental age estimation. Various studies for assessing the dental age have been done on the many ethnic groups. However, there were few studies for Korean children. The purpose of this study is to evaluate validity of Demirjian's method for Korean population.

Table 1. Number of samples per age group and gender

Age (years)	Number of samples		
	Boys	Girls	Total
5	6	6	12
6	9	7	16
7	8	6	14
8	9	6	15
9	8	7	15
10	7	5	12
11	8	7	15
12	8	6	14
13	8	5	13
14	8	7	15
15	8	6	14
Total	87	68	155

Materials and Methods

The 155 orthopantomographys were randomly selected from those stored at Dental Hospital of Yonsei University in Seoul (Fig. 1). They consisted of 87 boys and 68 girls and the age range was 5.0 to 16.0 years. In selecting radiographs, they were divided into 11 groups for males and females according to chronologic age and the difference between each group was 1 year (Table

Table 2. The definitions of developmental eight stages of teeth*

Stage	Definitions
A	Cusp tips are mineralized but have not yet coalesced.
B	Mineralized cusps are united so the mature coronal morphology is well-defined.
C	The crown is about half formed; the pulp chamber is evident and dentinal deposition is occurring.
D	Crown formation is complete to the dentinoenamel junction. The pulp chamber has a trapezoidal form.
E	Formation of the inter-radicular bifurcation has begun. Root length is less than the crown length.
F	Root length is at least as great as crown length. Roots have funnel-shaped endings.
G	Root walls are parallel, but apices remain open.
H	Apical ends of the roots are completely closed, and the periodontal membrane has a uniform width around the root.

*Modified from Demirjian et al. (1973)

1). The radiographs including missing teeth, large decayed teeth, gross pathosis and systemic endocrinal disorders were excluded. The chronologic age of radiograph was noted according to the date of birth up to time of taking of the radiograph and converted to a decimal age for a better comparison. The 7 left mandibular permanent teeth staged A to H (Table 2) were scored according to criteria presented by Demirjian et al. (1973). Each score for the 7 teeth was summed in order to obtain maturity score and this score was converted to dental age using appropriate percentiles curves for boys and girls. The investigator didn't have any information about chronologic age of the children when evaluating the radiographs.

Paired *t*-test and Pearson correlation coefficients were applied for statistical analysis between real age and estimated dental age under $p < 0.05$ for statistical significance. Scatter plots for boys and girls between real age and maturity score were made. Then percentiles curves were derived from scatter plots. The percentiles curves of present study were compared with Demirjian's original curves for French-Canadian population. The statistical analysis was performed with SPSS

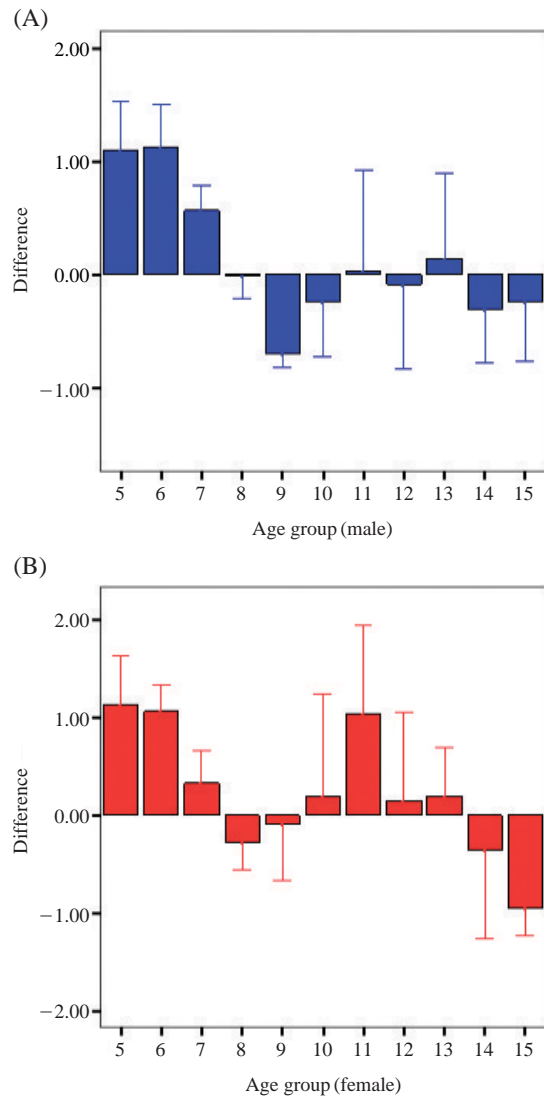


Fig. 2. The difference between real age and estimated age for each age group. (A) for boys. (B) for girls.

13.0 (Chicago, IL, U.S.A.).

Results

The mean difference between chronologic age and

Table 3. Deifference between chronologic age and estimated age by using Demirjian et al. in total in boys (M) and girls (F)

Sex	<i>n</i>	Mean	S.D.	<i>P</i>
M	87	-0.118	0.795	0.171
F	68	-0.246	0.864	0.022*

Where S.D. : standard deviation; *n* : number of samples; *P* : probability

*Correlation is significant at the 0.05 level

estimated age was -0.118 for boys and -0.246 for girls. In both boys and girls, there was clear overestimation tendency below 8.0 year, but over 8.0 year, the difference pattern is atypical (Fig. 2). In boys, there was no significant difference observed between the real age and estimated age, however in girls, significant difference was shown ($p < 0.05$) in 95% confidence interval (Table 3). The Pearson correlation coefficients between real age and estimated age were 0.970, 0.964 in boys, girls, respectively and showed positive relationship. Obtained scores were plotted against Demirjian's original curves for boys and girls (Fig. 3). In younger age groups (both boys and girls aged 5.0~8.0), the scores obtained in present study were located above Demirjian's curves.

Discussion

Age estimation of child is based on the determination of child's growth and development. Therefore, the accurate estimation is important not only in forensic human identification but also in orthodontics and pediatrics. Demirjian et al. (1973) presented standards for estimation of dental ages based on French-Canadian population. This method is widely employed in predicting age and maturation for many ethnic groups. However the validity of this method was different in various populations. In Korea, such population study had not been done yet. The aim of this study was to validate Demirjian's method for evaluating the dental

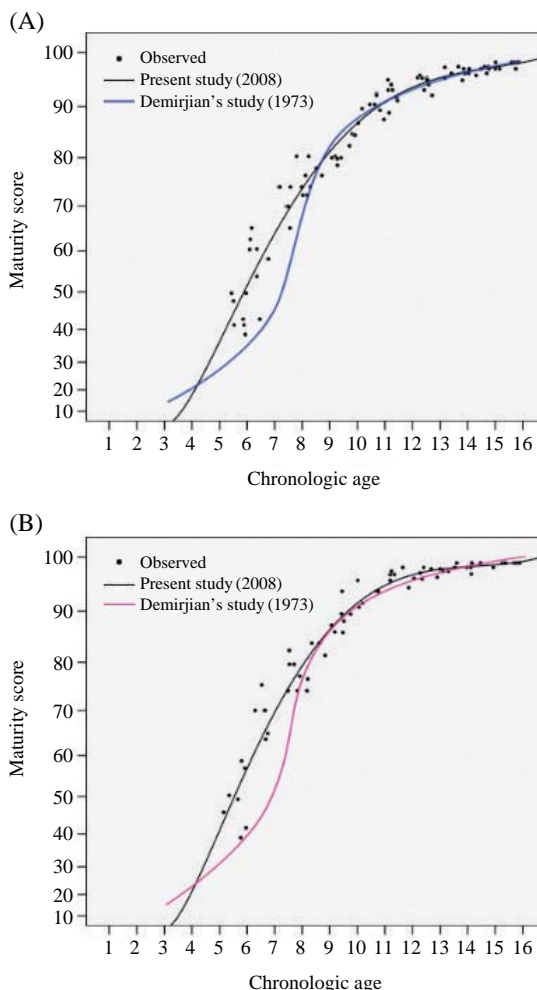


Fig. 3. Comparison of percentiles curve of present study and Demirjian's original curve for French-Canadian population. (A) for boys. (B) for girls.

age in Korean children.

Overestimation have been recently observed in British (Liversidge et al. 1999), German (Frucht et al. 2000), Swedish (Mörnstad et al. 1994, Teivens et al. 1996), Finnish (Nystrom et al. 1986), south Indian (Koshy and Tandon 1998), northern Turkish (Tunc and Koyuturk 2008), Belgian (Willems et al. 2001) and central Polish population (Różyto-Kalinowska et al. 2008)

when applying Demirjian's method to their own population. This results can be explained by a positive secular trend during the last 30 years (Liversidge et al. 1999). When compared with previous population for which the standards were made, present children are generally greater height and body weight and earlier sex maturation due to different economical status and availability of nutrition. In present study, the overall overestimation was not observed in both genders. However, in age groups under 8.0 years the overestimation were observed and the discrepancy between chronologic and dental age was larger than other age groups in both genders. Similar observations were made in other studies (Liversidge et al. 1999, Rózyto-Kalinowska et al. 2008). Loevy and Goldberg (1999) explained this situation with growth prediction uncertainties in younger age group children. The overestimation tendency in Korean population may be more definite with studying larger samples.

Nykänen et al. (1998) reported the mean difference between chronologic age and dental age estimated from French-Canadian standards was 0.2 years in boys and 0.3 in girls. The difference were small when compared with studies from other population therefore the author concluded that Demirjian's method could be suitable for Norwegian children. However the author also mentioned that in some age groups, the differences were higher than mean difference. In this study, the mean difference were 0.12 years in boys and 0.25 years in girls and the difference between chronologic age and dental age was statistically significant in girls but not in boys. But when comparing in each age group, there were many age groups showed somewhat high difference in boys. For example, in the 5 years group and 6 years group, the mean difference were over 1.0 years. This result means that the Demirjian's method may not be suitable for Korean population although the statistically insignificant result in boys.

The Comparison of percentiles curve of present study and Demirjian's original study for French-Canadian

population showed quite different pattern. Therefore, in order to apply Demirjian's method to Korean population the factors which constitute Demirjian's method should be corrected. Willems et al. (2001) created the specialized maturity score which expressed in years for Belgian population. Koshy and Tandon (1998) presented regression equations for correction with the chronologic age taken as the independent variable and the total maturity score as the dependent variable. Rózyto-Kalinowska et al. (2008) modified percentile curves with non-linear regression analysis for central Polish population. Future research should be needed to decide the appropriate way of revising Demirjian's method for Korean population with more subjects and modified method for Korean population must be established for accurate age estimation and growth determination.

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한국인에 대한 나이추정에 있어 Demirjian 방법의 유효성 연구

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간추림 : 치아의 발달 정도는 개체사이 변이가 작고 영양이나 내분비적 상태에 따른 영향이 적어 나이추정에 많이 이용된다. Demirjian은 1973년에 치아를 이용한 나이추정 방법을 발표하였으며 현재 많은 국가에서 널리 사용되고 있다. 여러 연구들에서 인구집단의 차이에 따른 Demirjian 방법 정확도의 상이함이 보고되었으나 한국인집단을 대상으로 한 연구는 아직 시행된 바 없다. 이에 Demirjian 방법의 한국인집단 적용에 대한 타당성을 조사하기 위해 본 연구를 시행하였다.

5~16세 아이의 파노라마 방사선사진 155장(남자 87장, 여자 68장)에 나타난 아래턱 왼쪽 간니를 Demirjian이 제시한 방법에 따라 분석하여 나이를 추정하였으며 실제나리와 추정나이 간의 차이를 대상으로 통계적 분석을 수행하였다.

실제나리와 추정나이 간의 차이는 95% 신뢰구간에서 남자는 유의할 만한 차이가 관찰되지 않았으나($p=0.171$) 여자는 유의할 만한 차이가 관찰되었다($p=0.022$). 남, 여 모두 8세 이하에서는 명백한 과추정이 관찰되었으나 그 이상에서는 비정형적이었다. 피어슨 상관계수는 남자에서는 0.970, 여자에서는 0.964로 계산되어 높은 상관관계를 보였다.

위의 결과들로 미루어 보아 Demirjian이 발표한 나이추정 기준을 적용하기 위해서는 보다 많은 연구대상을 통해 한국인에 맞는 성장점수 혹은 백분위곡선을 정립하여야 할 것으로 사료된다.

찾아보기 낱말 : Demirjian, 나이추정, 한국인집단, 파노라마 방사선사진