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A comparison between dental maturity in the Korean and Swedish populations by a modified Demirjian method

조선대학교 대학원
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안 복 훈

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한국인과 스웨덴인에서 modified Demirjian 방법에 의한 치아성숙도 비교

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안 복 훈의 박사학위 논문을 인준함.

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한국인과 스웨덴인에서 *modified Demirjian* 방법에 의한 치아성숙도 비교

안 복 훈
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구강내과학 전공

Dermijian방법은 북유럽을 중심으로 널리 사용하는 아동 및 청소년기에 대한 연령감정법이다. 특히 이 방법은 치아가 성숙되기 시작하는 유아로부터 치아의 성숙이 완료되는 청년기까지 치아성숙도를 계측화함으로써 연령감정을 객관화 시킨다는 장점이 있어 유럽에서는 감정실무에 자주 인용되고 있으나 국내에서는 거의 사용되지 않는 방법이다. 본 논문에서는 Dermijian방법을 한국인과 스웨덴인을 대상으로 적용하여 한국인에서 적용가능성을 모색하고 한국인과 유전적 거리가 상당히 먼 스웨덴인간의 치아성숙도의 인종 차이를 비교분석하였다.

Dermijian방법에 의한 한국인과 스웨덴인의 치아성숙도 비교결과 성장양상에는 큰 차이가 없었으나 성장속도에서는 통계적으로 유의할 만한 차이를 보였다. 남자에서는 거의 모든 연령층에서 한국인의 치아 성숙도가 스웨덴인보다 1 내지 2개월 정도 늦었으며. 반면에 여자에서는 모든 연령층에서 한국인이 스웨덴인보다 약 6개월 정도 치아성숙이 늦었고 특히 6세에서 12세 사이에 뚜렷한 차이를 보였다. 이 결과는 양 인종간의 치아성숙도에 있어서 차이가 있음을 말해주고 한국인의 치아성숙도에 의한 연령

추정시 핀란드아동 성숙표준표를 적용한다면 이 차이를 고려하여 추정연령을 산출해야 함을 의미한다.

핵심어 : 연령추정, Demirjian방법, 치아성숙, 인종차

Ⅰ. *Introduction*

The wish to improve the methods for estimation of chronological age of children by aid of their tooth development has initiated several studies. The common aim has been to develop a method with as high a reliability and validity as possible. The most used method over the last years in Europe is the one developed by Demirjian and coworkers[2,5,7,8,12,14]. Chronological age is the primary measure in assessing the development of a child. Skeletal age, secondary measures, used to bring maturation into sharper focus. Demirjian et al. have a described application of a modification of skeletal age assessment in relation to dentition[4]. Improved dental maturity assessment method of Demirjian and Goldstein is widely used internationally[3]. This method offers the possibility to access a chronological age and to describe the uncertainty around the estimate. It is based on subjectively estimated scores of development of mandibular teeth, and the subsequent translation of the obtained maturity score into an age. The method requires the presence of either all lower teeth or particular subset of them. The original method seems to give an over-estimate of up to one year when used Scandinavian population[8]. The maturity score is a measure of the dental development and corresponding chronological age can be used to estimate the age of child with missing or uncertain birth data. As populations may differ in maturity rate, the usefulness of the method in populations other than the French-Canadian one depends on the availability of tables specific for the population in question.

Several studies have examined variations in the rate of dental development in children from different populations using the Demirjian

method for age estimation in children[1]. Most of these studies have shown a more of less consistence difference between the French-Canadian population, used to construct the original Demirjian method, and the population under investigation. In most studies the Canadian population was lagging behind in the dental development, varying from a few months up to about a year, especially so between the ages of 6 and 10 years.

The reason for this difference is difficult to understand. A genuine genetic difference is unlikely, since the genetic distance between for example the Scandinavian and the French-Canadian populations is otherwise not especially pronounced.

In earlier studies on age estimation of children it appeared that the description of the original method was not detailed enough to allow exact reproducibility[12,19,20], and the shape of the curves that described the relationship between age and dental maturation differed considerably at certain ages. The original method was therefore modified by introducing a mathematical model to be used instead of the original, manually fitted, model to correlate dental development with chronological age[21]. It was found that a cubic function gave a highly acceptable model of the relationship, which, for the first time, also makes it possible to compare differences in the rate of dental development, with statistical method.

The aim of the study was to compare the rate of dental development in two geography different populations, that in Koreans and Swedes, using the modified Demirjian method.

Ⅱ. *Materials and methods*

Orthopantomographs were obtained from 980 Korean and 785 Swedish children of both genders, all being healthy and with a full set of permanent mandibular teeth.

The Korean sample consisted of 490 unrelated girls (mean age 10.1, range 2.9 - 18.0 years) and 490 unrelated boys (mean age 10.5, range 3.0 - 17.7 years) living in and around the city of Gwangju in the Republic of Korea. The panoramic views were storaged in Dept. of Oromaxillofacial Radiology, College of Dentistry, Chosun University. Age was evenly distributed.

The Swedish sample consisted of 397 girls (mean age 9.6, range 2.6-17.8 years) and 388 boys (mean age 10.4, range 2.8-17.7years) living in various parts of the country. The sample was collected from the files of a number of specialist clinics of orthodontics or predodontics. Part of the sample(485) has been used previously. The additional sample, collected from the Department of Oral Radiology at the Dental School, Huddinge, Sweden, Age also was evenly distributed.

The orthopantomography was examined on a light table with the aid of a magnifying glass and a pair of callipers. The development of each tooth was compared with the radiographic images, drawings and descriptions given by Demirjian et al., and given a score of A through H. This score was translated into a numerical "self-weighted score for dental development" according to the table in the updated report by Demirjian and Goldstein. These scores for the seven mandibular teeth were then added together, giving the maturity score.

Stage Description

A In both uniradicular and multiradicular teeth, a beginning of calcification is seen at the superior level of the crypt in the form of an inverted cone or cones.

B Fusion of the calcified points forms one or several cusps which unite to give a regularly outlined occlusal surface.

C a. Enamel formation is complete at the occlusal surface. Its extension and convergence towards the cervical region is seen.

b. The beginning of a dental deposit is seen.

c. The outline of the pulp chamber has a curved shape at the occlusal border.

D a. The crown formation is completed down to the cemento-enamel junction.

b. The superior border of the pulp chamber in the uniradicular teeth has a definite curved form, being concave towards the cervical region. The projection of the pulp horns if present, gives an outline shaped like an umbrella top. In molars the pulp chamber has a trapezoidal form.

c. Beginning of root formation is seen in the form of a spicule.

E Uniradicular teeth:

a. The wall of the pulp chamber now form straight lines, whose continuity is broken by the presence of the pulp horn, which is larger than the crown height.

Molars:

a. Initional formation of the radicular bifurcation is seen in the form of either a calcified point or a semi-lunar shape.

b. The root length is still less than the crown height.

The maturity score was then correlated with the chronological age with

the aid of a cubic function using the GraphPad Prism ver. 3.0 statistical program. Comparison between maturation rates in the two populations was made by comparing the entire curves using an F test. The F ratio was calculated using the following equation.

$F = (SS_{combined} - SS_{separate}) / (DF_{combined} - DF_{separate}) / (SS_{separate} - DF_{separate})$

Where $SS_{combined}$ is the sum of squares for the combined two populations, $SS_{combined}$ the total of the sum of squares for each of the two populations, $DF_{separate}$ the degree of freedom for the combined two populations, and $DF_{separate}$ the total of the degrees of freedom for each of the two populations. To determine the corresponding p values the F distribution was used with 4 degrees of freedom in the numerator for boys and girls respectively.

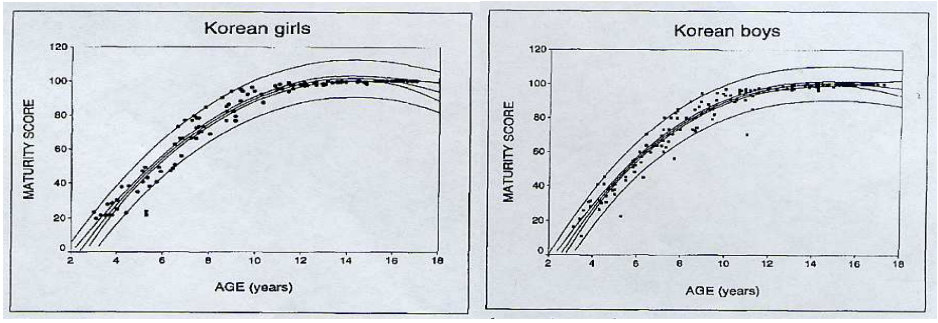
Ⅲ. *Result*

Figs. 1a-1d. show the total maturity score plotted against chronological age for the two ethnic groups separated by gender. A cubic function gave an apparently good fit of the plots in both populations, and this function therefore appeared justifiable in the study.

The constants and factors of the cubic functions, separated of ethnic group and gender, are shown on Table 1 where it appears that the square of the correlation coefficient(R) is high, and the model explains most of the correlation. There are no differences between the two populations in this respect.

In Figs. 2a and 2b the plots and the corresponding regression curves for the two populations are superimposed. The regression curves for the Korean children are consistently shifted to the right of the curves of the Swedish children indicating that there is a slight general difference in the rate of dental development between the Korean and Swedish children. The Swedish boys are 1-2 months ahead their Korean counterparts over all ages, but especially so between the ages of 6 and 12 years.

In Figs. 3a and 3b the plots have been removed to display the regression curves together with their 95% confidence interval at group and individual levels. The F tests showed a statistically significant difference between the two populations at $p<0.005(F=3.79)$ and $p<0.0001(F=15.97)$ for boys and girls respectively.



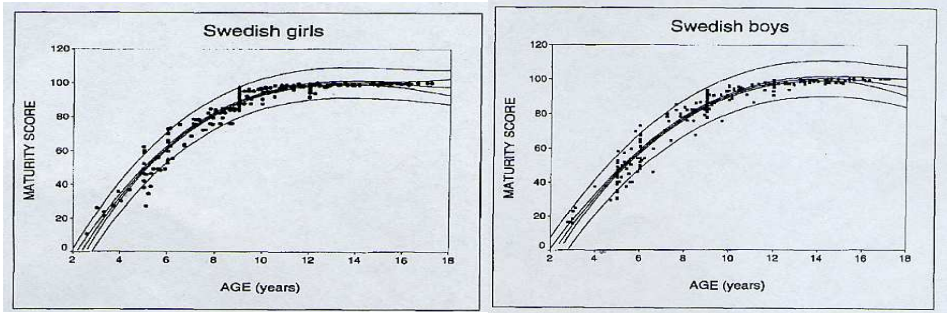


Fig. 1a-1d. Scatterplots of maturity score aginst chronological age using a cubic function

($y = a + bx + cx^2 + dx^3$)

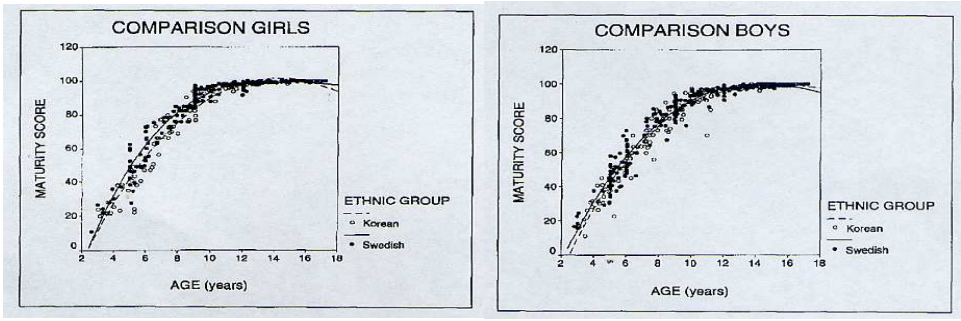
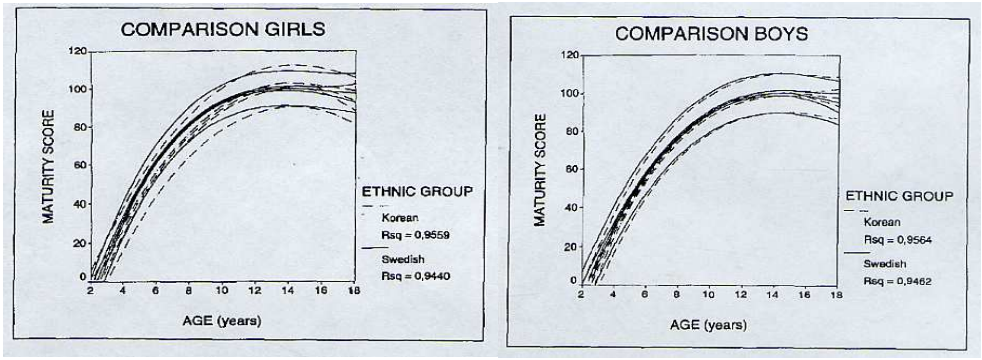


Fig. 2a and 2b. Comparison of scatterplots of maturity score against chronological age for girls and boys respectively.



Figs. 3a and 3b. Same as 2a and 2b, where the individual plots have been removed to disply the lines for predictions. Inner pair of lines denotes mean regression prediction and outer pair individual regression prediction at a confidence.

Table 1. Correlation Table : Dependent variable=maturity score, independent variable=age

Korean	girls	.956	133	960.47	.000	-49.043	23.0579	-1.0121	.0095	4006
Swede	girls	.944	238	1336.79	.000	-63.638	31.6849	-1.9543	.0396	4918
Korean	boys	.956	169	1235.64	.000	-60.314	27.3991	-1.5056	.0261	4318
Swede	boys	.946	239	1401.23	.000	-49.486	25.1161	-1.3161	.0204	6500
Combined popilations	girls	.942	375							10460
	boys	.949	412							11220

Ⅳ. *Discussion*

The method by Demirjian and co-workers[3,4] for age estimation in children was an important development when published more than 30 years ago. It has been used world-wide since then, but a series of studies[2,5,8,12] has demonstrated that the ages of the individuals in the tested populations will be regularly over-estimated, which would mean that of the French-Canadian children on which the method was originally constructed. These findings, together with the fact that the description of the original method is not detailed enough to allow exact reproducibility, made it important to look further into the relationship between the dental development(here described as maturity score) and chronological age. Mörnstad[12] found that a cubic function could be used as a model for this relationship and therefore could be suitable for the comparison of different populations. But Liversidge et al[10,11] reported that there was no difference between London children of Bangladeshi and white Caucasian(English, Welsh and Scottish) origin aged between 4 and 9 years. Differences in dental maturation between the two ethnic groups were not significant. British children as a group were dentally advanced compared to the Canadian standards. The standards of dental maturation described by Demirjian et al. may not be suitable for British children. Apex closure of the first molar was significantly later in children from Quebec and this might explain differences found in the dental maturity score. These results suggest no major differences in the timing of tooth formation stages between these children. This fails to explain previous findings of differences using Demirjian's dental maturity method[13,15-18].

A model based on a mathematical function also has the advantage of describing confidence intervals around an estimate, and thus comparing different populations with established statistical methods. International

Demirjian's method is high efficient for forensic purposes. Nevertheless, this method is less accurate than Demirjian's method developed for a specific country, because of the inter-ethnic variability. There are inter-ethnic differences classified in three major groups.

It seems that the present results, using the cubic function, are scientifically better founded than are most of the results of earlier studies[5,8,12,19] using the original Dermirjian method[3,4]. For the first time differences can be examined over the whole age scale, and not only as a mean value over several years, or only at certain ages. When comparing the Korean and Swedish populations with the modifies method it was found that both Swedish boys and girls are earlier in their development than their Korean counterparts. The difference was only 2-3 months for boys, but up to half-a-year for girls, especially between the ages of 6 and 12 years.

Further studies have to confirm whether it is possible to demonstrate the difference between the French-Canadian children and most other populations with this modified method. It is possible that the shape of the maturity curve differs between populations, in which case other models have to be searched for. Unfortunately the French-Canadian population used in the original study cannot be tested since the raw data have never been published.

It seems like unlikely that the difference, although statistically significant, between populations would be particularly important at individual level, since the individual variation is so large that it may mask smaller ethnic differences. It has been shown[10] that there are individual variations of up to two years around a certain stage of developmental stage(on the scale A though H)of an individual tooth may vary up to five stages at a certain age.

In conclusion, using a cubic function to describe the relationship between dental development and chronological age, it seems that there are only minor, although statistically highly significant, differences in the rate of dental development between Korean and Swedish children. The Korean girls seem to be, on average, six months later of the Swedish girls between the ages of 6 and 12 years, and the boys a couple of months later. However, these ethnic

differences are much smaller than the individual variations within the populations. So when Demirjian method is applied to Korean children, this difference should be considered. .

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저작물 이용 허락서

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	영어 : A comparison between dental maturity in the Korean and Swedish populations by a modified Demirjian method				

본인이 저작한 위의 저작물에 대하여 다음과 같은 조건아래 조선대학교가 저작물을 이용할 수 있도록 허락하고 동의합니다.

- 다 음 -

1. 저작물의 DB구축 및 인터넷을 포함한 정보통신망에의 공개를 위한 저작물의 복제, 기억장치에의 저장, 전송 등을 허락함
2. 위의 목적을 위하여 필요한 범위 내에서의 편집·형식상의 변경을 허락함. 다만, 저작물의 내용변경은 금지함.
3. 배포·전송된 저작물의 영리적 목적을 위한 복제, 저장, 전송 등은 금지함.
4. 저작물에 대한 이용기간은 5년으로 하고, 기간종료 3개월 이내에 별도의 의사 표시가 없을 경우에는 저작물의 이용기간을 계속 연장함.
5. 해당 저작물의 저작권을 타인에게 양도하거나 또는 출판을 허락을 하였을 경우에는 1개월 이내에 대학에 이를 통보함.
6. 조선대학교는 저작물의 이용허락 이후 해당 저작물로 인하여 발생하는 타인에 의한 권리 침해에 대하여 일체의 법적 책임을 지지 않음
7. 소속대학의 협정기관에 저작물의 제공 및 인터넷 등 정보통신망을 이용한 저작물의 전송·출력을 허락함.

동의여부 : 동의(v) 반대( )

2007 년 2 월 일

저작자: 안 복 훈 (서명 또는 인)

조선대학교 총장 귀하