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The Effectiveness of Age Estimation Method by Occlusal Tooth Wear in Temporomandibular Disorder(TMD) Patients

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The purpose of this study was to estimate occlusal tooth wear and bruxism severity in TMD patients, and evaluate the effectiveness of the present age estimation method by occlusal tooth wear in TMD patients. Takei's age estimation method was applied to 163 subjects(56 controls, 107 TMD patients). The author analyzed the degree of occlusal tooth wear from the difference between estimated age and actual age. The obtained results were as follows:

1. In all age group, occlusal tooth wear in TMD patients is higher than those in asymptomatic controls. In 20's age group, a statistically significant difference was found.
2. In both gender, occlusal tooth wear in TMD patients is higher than those in asymptomatic control. In male, a significant difference was found.
3. Occlusal tooth wear in TMD patients with bruxism is significantly higher than that in control.
4. We found no significant difference in bruxism severity and occlusal tooth wear among the RDC/TMD subgroups.
5. Application of Takei's method would be still useful for age estimation in Korean.

In case of age estimation of TMD patients using occlusal tooth wear, evaluation of the bruxism severity and appropriate correction according to age, sex and difference of geographical location should be considered.

Key words: Temporomandibular disorder, Bruxism, Occlusal tooth wear, Takei's age estimation method

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Ⅰ. INTRODUCTION

Age estimation plays a great role within forensic science not only in identification of bodies, but also in that of living individuals. Especially, dental indicators have low interpersonal variability, so the developmental and physiological changes of teeth have been used generally in age estimation of individuals.[1)] These dental indicators reflecting aging include some parameters such as tooth calcification stage, tooth eruption stage, the size of pulp cavity, dental attrition, microhistologic change

of tooth and relative density of tooth.[2] An early age estimation technique in adults was published by Gustafson in 1950,[3] it is based on the measurement of regressive changes in teeth according to scoring system of six criteria: attrition, secondary dentin formation, periodontal attachment loss, cementum apposition, root resorption and apical translucency. This technique had been improved by Dalitz and then by Johanson. The improvements by Johanson has been actually the most widely accepted among forensic odontologists.[1] Because tooth extraction and preparation of microscopic sections of tooth is essential to apply this method, it is not used in age estimation of a living person. To overcome these limitations, there have been several studies on non-invasive and brief methods of age estimation. Among them, age estimation method using occlusal tooth wear is one of non-invasive methods which can be easily applied in dental clinics environment. Several researchers reported the age estimation method focused on only one parameter using the occlusal tooth wear.[1,4-10] Among them, Takei's method can be more easily applied in a clinical environment than any others because it considers various tooth conditions such as unsound, restored and missing. But, there are few studies to evaluate the validity and the reliability of the Takei's method in Korean.

Besides chronological aging process, occlusal tooth wear is affected by various factors such as chewing habits, the hardness of dental tissue, bite force, gender, geographical location, environmental conditions and parafunctional habits like bruxism.[10]

Bruxism is a common parafunctional activity that includes grinding or clenching of the teeth. Although, there is considerable controversy about the correlation between bruxism and occlusal tooth wear,[11] occlusal tooth wear is the most frequently mentioned sign of bruxism.[12]

According to the American Academy of Orofacial Pain(AAOP), bruxism is defined as diurnal or nocturnal parafunctional activity including clenching, bracing, gnashing, and grinding of teeth.[13] American Sleep Disorders Association(ASDA) mentioned the bruxism as a periodic, stereotyped movement disorder of masticatory system that involves tooth grinding or clenching during sleep.[14] Although the relationship between bruxism and TMD is complex and is not yet clearly understood, many studies suggested that bruxism is generally accepted as a contributing or causative factor of TMD. Bruxism in TMD patients, therefore, may directly affect the occlusal tooth wear, it also affects the age estimation method by occlusal tooth wear.

Until now there are few methods to consider the effects of bruxism in TMD patients on occlusal tooth wear. Therefore, the purpose of this study is (1) to estimate the relationship between occlusal tooth wear and bruxism severity in TMD patients, (2) to verify the effectiveness of age estimation method by occlusal tooth wear in TMD patients, and (3) to evaluate the validity of the application of Takei's method in Korean.

Ⅱ. MATERIALS AND METHODS

1. Subject

This study was based on the data from 163 subjects(72 males and 91 females) whose age range from 20 years to 50 years. Subjects who had severe malocclusion and a large number of missing tooth were excluded. They were categorized into two groups(107 TMD patients, 56 normal subjects). Age distribution for subjects is presented in Table 1. TMD patients who visited Department of Oral

Table 1. Age distribution of subjects.

Age \ Subject	Control	TMD patients	Total
20s	22	36	58
30s	18	33	51
40s	7	22	29
50s	9	16	25
Total	56	107	163

Table 2. Ranking standards of attrition degree.

	Ranking Standards			
	Upper Jaw		Lower Jaw	
Incisor	A	Attrition parts are still separated	A	Attrition parts are still separated
	B	Dentin appears linearly	B	Dentin appears linearly
	C	Exposed dentin assumes breadth	C	Exposed dentin assumes breadth
Cuspid	A	Attrition on tip only	A	Attrition on tip only
	B	Spreads to mesial side	B	Spreads to labial side
	C	Dentin becomes exposed	C	Spreads to mesio-distal sides and dentin becomes exposed
Premolar	A	Attrition on tip of cusp only	A	Attrition on buccal side cusp only
	B	Spreads wide but separated buccal and lingual	B	Spreads along ridge
	C	Links up buccal and lingual, and dentin exposed	C	Dentin is exposed
Molar	A	Attrition parts are still separated	A	Attrition parts are still separated
	B	Attrition parts are united	B	Attrition parts are united
	C	Dentin is exposed	C	Dentin is exposed

Medicine, Kangnung National University Dental Hospital were evaluated through clinical examination and Research Diagnostic Criteria for Temporomadibular Disorders (RDC/TMD) Axis I assessment.[15] Each evaluation was performed by one well-trained examiner.

2. Assessment of bruxism

Bruxism was assessed in a self-reporting standardized questionnaire.[16,17] The questionnaire included the following:

1. Awareness of nocturnal teeth grinding
2. History of nocturnal teeth grinding, as reported by a spouse, a friend and/or a relative
3. Feeling of diurnal teeth grinding
4. Awareness of nocturnal teeth clenching
5. History nocturnal teeth clenching, as reported by a spouse, a friend and/or a relative
6. Feeling of diurnal teeth clenching
7. Feeling of pain and fatigue upon awakening on the jaws
8. Anamnestic report of awakening frequently at night grinding or clenching
9. Feeling of tension and stiffness during the day on masticatory muscle
10. Feeling of tension and stiffness on masticatory muscle on awakening

In the standardized questionnaire, patients were asked to indicate how frequently they have experience about that above question. Frequency of experience is divided into five-point scale.(0=not at all, 1=a little bit, 2=moderately 3=quite a bit, 4=extremely) According to total point, patients were classified into non-bruxer(0), mild(1-5), moderate(6-10), and severe bruxer(≧11).

3. Age estimation

Age estimation was performed using Takei's method based on theory of quantification type I.[6] For all subjects, the degree of occlusal tooth wear was evaluated from diagnostic full arch casts and by the ranking standards of attrition degree(Table

Table 3. The calculating table for age estimation.

		Upper Right							Upper Left						
Attrition degree	No.	17	16	15	14	13	12	11	21	22	23	24	25	26	27
A	1	-1.24	-1.12	-0.52	-0.44	-0.54	0.53	-1.66	1.01	-0.55	-0.95	-0.58	-1.05	-0.42	-2.47
B	2	-0.76	0.23	-0.49	-0.91	-0.46	-0.69	-0.58	-0.06	0.56	-0.71	0.04	0.13	0.14	-0.54
C	3	1.17	2.10	1.88	1.89	-0.34	2.40	-0.43	2.69	-0.34	-0.64	1.19	-0.07	1.02	2.70
Caries, Filling, Crown	4	1.24	-0.33	0.59	0.55	1.51	-1.18	1.20	-0.93	0.36	1.41	-0.66	0.83	-1.23	-0.30
Stump of tooth, Pontic, Missing	5	1.38	0.74	0.25	0.40	1.30	0.44	2.71	-1.84	-0.05	3.11	0.76	0.67	1.08	3.31
		Lower Right							Lower Left						
Attrition degree	No.	47	46	45	44	43	42	41	31	32	33	34	35	36	37
A	1	-0.11	-0.97	-1.48	0.34	0.25	0.03	0.61	-2.33	-1.03	-1.48	-1.54	-0.45	-0.08	-0.74
B	2	0.24	2.50	-0.65	-1.14	-0.45	-0.36	0.22	-0.34	0.18	-0.34	-0.42	0.39	0.66	-1.05
C	3	1.49	1.72	-0.94	1.33	0.29	1.27	0.27	0.11	0.28	0.16	1.08	2.88	-1.36	1.95
Caries, Filling, Crown	4	-1.50	-1.21	1.38	0.57	-1.62	0.50	1.48	2.94	-1.76	2.27	1.42	-0.89	0.02	0.73
Stump of tooth, Pontic, Missing	5	0.94	0.04	1.54	-0.77	1.10	-1.05	-3.45	5.51	2.54	2.30	2.58	0.64	-0.01	0.38

Mean : 38.78

2), and then category classification on each tooth was performed by one well-trained examiner after the confirmation of concordance for inter- and intra- examiner reliability. From the calculating table(Table 3), each of the 28 teeth is assigned to a numerical value matching with their conditions. Total sum of twenty-eight numerical values is converted into estimated age.

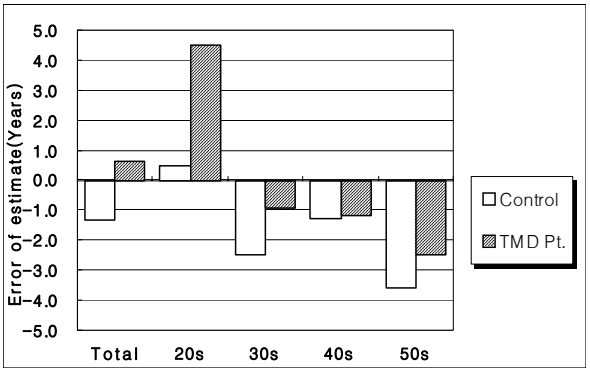
4. Statistical Analysis

Student *t*-test was used to evaluate the difference (error of estimate) between estimated age and actual age in controls and TMD patients according to age group and sex. Pearson's correlation coefficient and linear regression analysis were performed to evaluate the relation between bruxism severity and error of estimate. One-way ANOVA was performed to evaluate the differences(error of estimate) between estimated age and actual age according to RDC/TMD criteria and bruxism severity. A Chi-square test was performed to evaluate the differences in accuracy of estimation between control and TMD patients. SPSS 14.0 for windows was used for all statistical analyses.

Ⅲ. RESULTS

The results of the difference(Mean error of estimate) between estimated age and actual age in control and TMD patients are shown in Table 4 and Fig. 1. Mean estimated age by Takei's method is lower than actual age in control. In all age groups, the difference between estimated age and actual age of TMD patients was higher than that of control. However, only in 20's, a statistically significant difference was found($p<0.01$).

Mean error of estimate according to sex is



t-test; *: p<0.05, **: p<0.01

Fig. 1. Mean error of estimate according to age group.

showed in Table 5. Mean error of estimate was higher in TMD patients than asymptomatic controls in male and female, but there was a statistically significant difference only in male(p<0.05). Mean error of estimate was higher in male than those in female in control and TMD patients, but there was no statistically significant difference.

Mean error of estimate according to bruxism severity is showed in Table 6. Mean error of estimate was higher in all bruxer groups than asymptomatic controls. In TMD patients, except for severe group, error of estimate tends to increases as bruxism severity increases. However, there was no statistically significant difference(p=0.067).

A positive and statistically significant correlation between bruxism severity and error of estimate was found(correlation coefficient=0.207, P=0.016). Regression equation, Y= −0.923+0.243X(r^2=0.043, P<0.05), was obtained(Fig. 2).

Mean error of estimate according to RDC/TMD subgroups are showed in Table 7. RDC/TMD subgroups including myofascial pain had more severe bruxism compared to any other subgroups. There was no significant difference between bruxism severity and occlusal tooth wear among the RDC/TMD subgroups. Except for TMD patients only with myofascial pain, mean error ofestimate was higher in all RDC/TMD subgroups than asymptomatic controls. However, there was no statistically significant difference(p=0.122).

Table 4. Mean error of estimate according to age group.

Age	Control (Years)	TMD Patients (Years)	p-value
20s	0.47	4.48	0.004**
30s	−2.48	−0.91	0.379
40s	−1.30	−1.16	0.962
50s	−3.61	−2.47	0.699
Total	−1.35	0.62	0.061

t-test; *: p<0.05, **: p<0.01

Table 5. Mean error of estimate according to sex.(unit : years)

	Control	TMD Patients	p-value
Male	−0.47 (n=38)	2.43 (n=34)	0.046*
Female	−3.21 (n=18)	−0.23 (n=73)	0.08
p-value	0.104	0.051	

t-test; * : p<0.05

Table 6. Mean error of estimate according to bruxism severity.

	Score of bruxism questionnaire (Mean)	Mean error of estimate (Years)
Control (n=56)	-	−1.35
TMD patients (n=107)	6.35	0.62
Non-Bruxer (n=10)	0	−1.95
Mild (n=51)	2.98	−0.13
Moderate (n=25)	8.20	2.74
Severe (n=21)	15.33	1.14

ANOVA : F=2.243, p=0.067

The accuracy of estimation is showed in table 8.In this study, accuracy of estimation in control and TMD patients was higher than those of Takei's study,[6] accuracy of estimation in TMD patients was lower than those in control. The accuracy of estimation tended to decrease as bruxism severity increased, except for severe group. However, there were no statistically significant differences(within ±3 years: p=0.66, within ±5 years: p=0.846).

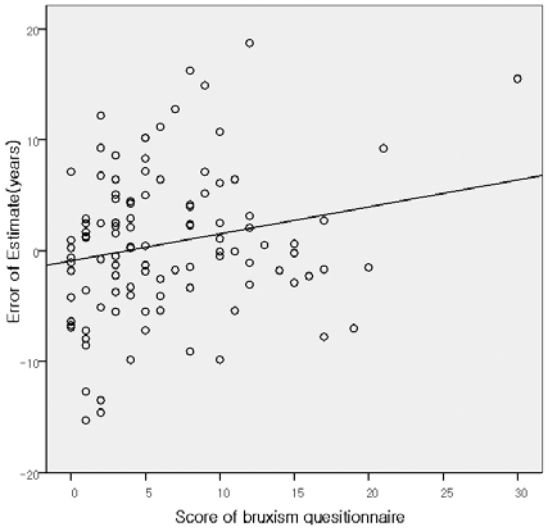


Fig. 2. Linear regression analysis between bruxism severity and error of estimate in TMD patients.

Table 7. Mean error of estimate according to RDC/TMD subgroups.

	Bruxism severity (Mean)	Mean error of estimate (Years)
Control (n=56)	-	-1.35
Group Ⅰ (n=10)	8.70	-3.41
Group Ⅱ (n=9)	5.00	4.01
Group Ⅲ (n=22)	4.59	1.14
Group Ⅰ+Ⅱ (n=13)	7.08	2.09
Group Ⅰ+Ⅲ (n=30)	7.20	0.61
Group Ⅱ+Ⅲ (n=11)	7.00	-0.32
Group Ⅰ+Ⅱ+Ⅲ (n=12)	5.08	-0.26
Total (n=107)	6.35	0.62

Group Ⅰ= Myofascial pain, Group Ⅱ= Disc displacement, GroupⅢ= Other joint conditions.
ANOVA : F=1.665, p=0.122

Ⅳ. DISCUSSION

The aim of this study was to investigate the effectiveness of age estimation method by occlusal tooth wear in TMD patients. Bruxism is considered the most detrimental among the parafunctionalactivities of the stomatognathic system, being responsible for tooth wear, periodontal tissue lesions, and articular and/or muscular damage.[16] Bruxism in TMD patients, therefore, may directly affect the occlusal tooth wear. Efforts to develop the precise methods to evaluate bruxism behavior have been made in many studies; polysomnography, electromyography, self-report questionnaire, severity of occlusal tooth wear, and many other strategies.[17] But, there is no gold standard in methods to measure it.[18] Polysomnographic and electromyographic observations are relatively objective method that is used to evaluate bruxism.[19] However, these methods have many problems such as change of the natural sleeping environment, short-term evaluation for bruxism that has its own limitations of night-to-night variability, time-consuming, and expensive costs. In this study, self-reporting standardized questionnaire was used to evaluate bruxism. Although self-reporting of any behavior run the risk of bias toward either under-reporting or over-reporting, self-reporting questionnaire can be easily applied in a clinical environment. To make up for these weak points, we considered various situation of unconscious bruxism in subjects and included some questions related to the signs and symptoms of masticatory muscle responsible for potentiality of bruxism.

Table 8. Accuracy of estimation according to bruxism severity.(unit: %)

	Within ±3 years	Within ±5 years
Control	44.6	62.5
TMD patients	43.9	57.9
Non-Bruxer	50.0	60.0
Mild	41.2	56.9
Moderate	36.0	52.0
Severe	57.1	66.7
p-value*	0.66	0.846
Takei's study	32.3	52.3

* : Chi-square test

In control, their mean estimated age by Takei's method is lower than their actual age. It is speculated that these results may be caused by some factors, such as the type of diet eaten, geographical location, socioecological status, economical and environmental conditions.

Although the difference(Error of estimate) between estimated age and actual age was higher in TMD patients than asymptomatic controls, it was not statistically significant($p=0.061$). However, there was a significant difference between TMD patients with bruxism and control($p<0.05$). In addition, mean error of estimate was higher in all bruxer groups than in asymptomatic controls. Mean error of estimate tended to increases as bruxism severity increases, which is not exactly coincide with the our expectation. However, there was no statistically significant difference($p=0.067$). It may be so, but bruxism in TMD patients would be distinctive effect on occlusal tooth wear according bruxism severity. In the future study, definite classification criteria and question item should be devised for exact evaluation of bruxism severity.
In all age groups, the difference between estimated age and actual age of TMD patients was higher than that of control. However, only in 20's, a statistically significant difference was found. Although some studies indicate that there is no association between bruxism and age,[18,20] our results were in accordance with the previous studies that the prevalence of bruxism is higher in childhood.[21,22]

Although there was no statistically significant difference, mean error of estimate was higher in male than those in female in both control and TMD patients. In addition, mean error of estimate between control and TMD patients has a statistically significant difference only in male. Therefore, the degree of occlusal tooth wear was more severe in male than in female, which was in agreement with previous studies.[9,20,23] It may be explained that male could exert stronger masticatory force than female.[20,23]

In this study, although we found no significant difference in bruxism severity and occlusal tooth wear among the RDC/TMD subgroups, patients in RDC/TMD subgroups including myofascial pain showed a higher bruxism severity than disc displacement or other joint condition patients. However, it is difficult to interpret the results and compare many previous studies, because different classification systems for TMD have been applied and etiology of TMD is multifactorial.[24] In addition, occlusal tooth wear may be not a sign of current bruxism, but a cumulative record of tooth wear from both functional and parafunctional activity.[18] The daily fluctuations of both bruxism behavior and symptoms of TMD make it difficult to reveal a definite temporal relationship.

In Takei's study, estimated ages were within ±3 years of the actual age in 32.3% of the subjects, and accuracy of estimation within ±5 years was 52.3%.[6] In this study, although accuracy of estimation in TMD patients was lower than those in control, accuracy of estimation within ±3 and ±5 years in control and TMD patients was higher than those in Takei's study. Therefore, application of Takei's method would be still useful for age estimation in Korean. The accuracy of estimation tended to decreases, except for severe group, as bruxism severity increases in TMD patients. However, there was no statistically significant difference(within ±3 years: $p=0.66$, within ±5 years: $p=0.846$). It is speculated that standard of classifying the bruxism severity may be incorrect, and standard of classifying the attrition degree in Takei's method may be not reflected the exact quantity of loss of tooth substances. Also, it may be due to fact that occlusal tooth wear was indirectly evaluated through the age estimation method.

Collectively, in case of age estimation of living individuals using occlusal tooth wear, evaluation of the bruxism severity and appropriate correction according to age, sex, difference of geographical location should be considered. Also, in case of TMD patients, especially bruxism should be considered among above-mentioned factors. For more accurate age estimation for TMD patients, the evaluation of bruxism in control must be included in further

large-scale studies, as well as TMD patients.

V. CONCLUSIONS

The purpose of this study was to estimate occlusal tooth wear and bruxism severity in TMD patients, and evaluate the effectiveness of the present age estimation method by occlusal tooth wear in TMD patients. Takei's age estimation method was applied to 163 subjects(56 controls, 107 TMD patients). The author analyzed the degree of occlusal tooth wear from the difference between estimated age and actual age.

The obtained results were as follows:

1. In all age group, occlusal tooth wear in TMD patients is higher than those in asymptomatic controls. In 20's age group, a statistically significant difference was found.
2. In both gender, occlusal tooth wear in TMD patients is higher than those in asymptomatic control. In male, a significant difference was found.
3. Occlusal tooth wear in TMD patients with bruxism is significantly higher than that in control.
4. We found no significant difference in bruxism severity and occlusal tooth wear among the RDC/TMD subgroups.
5. Application of Takei's method would be still useful for age estimation in Korean.

In case of age estimation of TMD patients using occlusal tooth wear, evaluation of the bruxism severity and appropriate correction according to age, sex and difference of geographical location should be considered.

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국문요약

측두하악장애 환자에서 치아 교모도에 의한 연령감정의 유효성

강릉대학교 치과대학 구강내과진단학 교실

정재용 · 김영준 · 김철 · 박문수

본 연구는 측두하악장애 환자에서 이갈이의 유무 및 심도에 따른 추정연령과 실제 연령과의 차이(추정오차)를 평가하여 그 관계를 살펴보고, 측두하악장애 환자의 이갈이가 치아 교모도를 통한 연령감정에 미치는 영향에 대해 알아보고자 하였다. 교모도를 이용한 Takei의 연령감정법을 163명(대조군: 56명, 환자군: 107명)의 대상자에게 적용하였다. 저자는 추정연령과 실제연령의 차이를 통해 대상자의 교모도를 분석하여 다음과 같은 결론을 얻었다.

1. 연령에 따라서는 측두하악장애 환자군이 대조군에 비해 모든 연령군에서 교모도가 더 큰 경향을 나타냈으며, 특히 20대에서 유의성 있는 차이가 나타났다.
2. 성별에 따라서는 측두하악장애 환자군이 대조군에 비해 교모도가 더 큰 경향을 나타냈으며, 특히 남성에서 유의성 있는 차이가 나타났다.
3. 이갈이가 있는 측두하악장애 환자군은 대조군에 비해 교모도가 더 큰 경향을 나타냈으며 유의성 있는 차이를 나타냈다.
4. 측두하악장애 환자군간에는 이갈이 심도와 교모도에 대한 유의성 있는 상관관계를 발견하지 못하였다.
5. Takei에 의한 방법은 한국에서 여전히 유용한 연령감정법으로 평가된다.

따라서 측두하악장애 환자에서 교모도를 이용한 연령감정의 경우, 이갈이 심도에 대한 평가와 연령, 성별, 지역에 따른 차이에 대해서도 고려해야 할 것으로 생각된다.

주요어: 측두하악장애, 이갈이, 치아교모도, Takei의 연령감정법