JKAOH
Journal of Korean Academy of Oral Health 2018 June 42(2):52-58
https://doi.org/10.11149/jkaoh.2018.42.2.52
Original Article

기능 치아의 수가 잠재적으로 인지 기능에 영향을 줄 수 있을까?

조민정[1], 김지영[2], 정윤숙[1], 신해은[1], 윤하영[1], 박태준[1], 최연희[1], 송근배[1]

[1]경북대학교 치의학전문대학원 예방치과학교실, [2]울산과학대학교 치위생과

Can the number of functional teeth potentially affect cognitive function?

Min-Jeong Cho[1], Ji-Young Kim[2], Yun-Sook Jung[1], Hae-Eun Shin[1], Ha-Young Youn[1], Tae Jun Park[1], Youn-Hee Choi[1], Keun-Bae Song[1]

[1]Department of Preventive Dentistry, School of Dentistry, Kyungpook National University, Daegu, [2]Department of Dental Hygiene, Ulsan College, Ulsan, Korea

Received: May 29, 2018
Revised: June 13, 2018
Accepted: June 20, 2018

Corresponding Author: Keun-Bae Song
Department of Preventive Dentistry, School of Dentistry, Kyungpook National University, 2177 Dalgubeol-daero, Jung-gu, Daegu 41940, Korea
Tel: +82-53-660-6875
Fax: +82-53-423-2947
E-mail: kbsong@knu.ac.kr
*This work was supported by the National Research Foundation of Korea (NRF) Grant funded by the Korean Government (MSIT) (No. 2017R1A2B4009648).

Objectives: With the growing elderly population, there is an increasing interest in the oral and general health of elderly individuals. Loss of teeth is representative of oral disease in elderly individuals and is associated with medical and dental problems. The purpose of this study was to investigate the relationship between the number of remaining functional teeth and cognitive function.
Methods: A total of 456 (111 public health centers, 261 senior centers, 84 sanatoriums) older adults (aged ≥65 years) residing in Korea were included. A mental health nurse examined the cognitive function using the Korean version of the Mini-Mental State Examination. A dentist examined the number of functional teeth and denture status through an oral examination, while a dental hygienist surveyed the subjective masticatory level using a questionnaire.
Results: The mean age of the participants was 79.5 years (range 65-97 years), and 76.1% of them were women. Participants with a small number of functional teeth had lower cognitive function. In these participants, the odds ratio with poor cognitive function was 2.30 times higher; it was 2.74 times higher after adjusting for age, sex, residence, education, and denture use, and was statistically significant.
Conclusions: Our study suggested that the number of functional teeth was associated with cognitive function in the Korean elderly population.

Key Words: Cognitive function, Elderly, Functional teeth, Subjective mastication

Introduction

Korea has a growing aging society, with one of the fastest rates of aging in the world[1)]. The economic incapacity and physical health problems of the elderly are becoming serious social problems. Therefore, many countries are devising new policies to solve this social issue[2)].

There is a growing interest in the oral health and general health of the elderly. However, compared to the general health, the importance of oral health is often underestimated. Elderly people are experiencing various problems related to oral diseases in daily life[3)].

Loss of teeth is a representative oral disease of the elderly population, and is associated with medical problems such as malnutrition, physical disability, and mental dysfunction[4)]. The remaining teeth typically correspond to all residual teeth

including healthy teeth, teeth that have already been treated, and teeth with cavities[5]. Functional teeth correspond to a state in which opposing teeth exist[6]. Thus, the number of functional teeth is associated with chewing ability[7]. A lower number of functional teeth leads to chewing difficulties and reduces the ability to perform activities of daily living[8]. Therefore, oral health requires constant attention in order to overcome related physical, social, and mental disabilities[9]. The deterioration of masticatory function due to tooth loss is related to memory and learning ability, affects the heartbeat rate and blood flow during chewing, and impacts cognitive disorders similarly to other physical activities[10,11]. In addition, jaw movement during chewing stimulates the activity of the cerebral cortex to increase cerebral blood flow and activate the brain[12]. If the chewing ability is deteriorated, the aptitude to perform daily life activities decreases, thus increasing risk factors such as the quality of life or depression[13].

The elderly population is growing worldwide; as a consequence, there is an increased interest in senile dementia and oral health[14]. Dementia gradually decreases cognitive functions resulting in language problems, loss of memory, loss of sense of time and space, inability to learn, and difficulties in daily life activities[15]. In addition, dementia appears in the form of two or more cognitive dysfunctions at first, and subsequently progresses to personality changes such as depression or anxiety and abnormal behaviors[16]. The deterioration of cognitive performance is an important predictor of dementia, which also affects oral health[10]. Thus, abnormal cognitive functions can exacerbate oral health conditions[17] However, the precise mechanism of the relationship between oral health and cognitive ability is unknown[18].

Although many studies have addressed the relationship between the number of residual teeth and cognitive function, little research has been conducted in Korea, except for our preliminary data. The purpose of this study was to investigate the relationship between the number of remaining functional teeth and cognitive function.

Materials and Methods

This study was approved by the institutional review board (IRB) of the Kyungpook National University Hospital (KNUH 2015-07-007-001).

1. Study participants

From May 2015 to August 2016, we conducted a survey on older adults from the public health center, 16 senior centers, and four sanatoriums in Daegu. All participants were over 65 years of age who voluntarily took part in the study. Prior to the study, we received written consent from all the participants. Out of a total of 497 volunteers, 41 were excluded because of having (1) hearing or visual impairments, (2) no occlusion bite, and/or (3) refused to undergo oral examination or complete the questionnaire. A total of 456 (public health center 111, senior centers 261, sanatoriums 84) older adults (age ≥65 years) residing in Korea were included. A mental health nurse examined the cognitive function, one dentist examined the number of remaining teeth and the use of dentures through oral examinations, and one dental hygienist surveyed the questionnaires needed for the study. All participants were interviewed face to face. Participants who had difficulties filling the questionnaire by themselves were assisted by caregivers.

2. Measurements

This study was to investigate the relationship between the number of remaining functional teeth through oral examination and cognitive function using the Korean version of the Mini-Mental State Examination. Age, sex, residence type, and education level were examined with general characteristics. Through the oral examination, we investigated the number of functional teeth that could chew, including both third molars and prosthesis. We excluded individuals who were unable to bite because they had no teeth. Based on the number of functional teeth, the participants were assigned to two groups: *<20* teeth and *≥20* teeth[19]. We also investigated tooth mobility and the use of denture. Tooth mobility was recorded as *0* if there was no movement, *1* if there was movement within 1 mm, *2* if there was movement of more than 1 mm, and *3* if there was vertical movement based on Miller classification[20]. The teeth that had tooth mobility were excluded from the total number of functional teeth considering the functional aspect of the mastication.

The subjective masticatory level was examined using the 5-point likert scale and was divided into two groups: 1-2 points correspond to "*cannot chew*" and 3-5 points correspond to "can chew." The Mini-Mental Status Examination (MMSE) is a widely used tool for dementia determination[21]. In Korea, MMSE-K, which is referred to hereafter by MMSE, was developed by Park and Kwon in 1989 and has already proved its reliability and validity[22]. The total score of MMSE corresponds to 30, a score of 0-23 indicates that the cognitive function is "not good," while a score of 24-30 indicates that the cognitive function is "good"[23]. Therefore, the higher the

score, the better the cognitive function.

3. Statistical analysis

General characteristics according to the number of functional teeth and cognitive function were compared using crossover analysis and the mean values were compared using t-test and analysis of variance (ANOVA). Logistic regression analysis was conducted to investigate the effect of subjective masticatory level and the number of functional teeth on dementia and was adjusted for age, sex, type of residence, education level, and use of denture. The data collected were analyzed using SPSS 23.0 version and a $P<0.05$ was considered statistically significant.

Results

1. Characteristics of participants according to the number of functional teeth

Table 1 summarizes the characteristics of the participants according to the number of functional teeth.

The number of functional teeth based on the two groups (<20, ≥20) was significant according to age, sex, education level, subjective masticatory level, use of denture, and cognitive function ($P<0.05$). The number of functional teeth was 19.13±10.24 in the age-group 65-60 years, 16.61±10.37 in 70-74 years, 17.48±10.09 in 75-79 years, 14.84±10.39 in 80-84 years, and 11.94±10.24 in group ≥ 85 years; there was a significant age effect ($P<0.05$). Moreover, there was a significant difference in the number of functional teeth according to sex ($P<0.05$). Furthermore, the number of functional teeth in participants below elementary school graduation was 14.93 ±10.50, while it was 18.31±9.79 in middle school graduates and above ($P<0.05$). The number of functional teeth of participants whose subjective mastication level was "not good" corresponded to 13.74±9.72, while it was 16.78± 10.72 in participants with "good" subjective mastication level; there was a significant difference ($P<0.05$). The number of functional teeth of participants whose cognitive function was

Table 1. Characteristics of subjects according to the number of functional teeth

Variables	Number of functional teeth				
	<20 (N=254)	≥20 (N=202)	*P*-value*	Mean±SD	*P*-value†
Number of functional teeth	7.49±6.54	25.5±3.08	**<0.001**	15.47±10.40	
Age					
65-69	8 (3.1)	15 (7.4)		19.13±10.24[b]	
70-74	39 (15.4)	36 (17.8)		16.61±10.37[a,b]	
75-79	64 (25.2)	73 (36.1)	**0.001***	17.48±10.09[a,b]	**0.001†**
80-84	75 (29.5)	56 (27.7)		14.84±10.39[a,b]	
≥85	68 (26.8)	22 (10.9)		11.94±10.24[a]	
Sex					
Men	51 (20.1)	58 (28.7)	**0.032***	17.12±10.87	**0.032†**
Women	203 (79.9)	144 (71.3)		15.08±10.27	
Residence types					
Spouse	57 (22.4)	64 (31.7)		17.34±10.53	
Others	72 (28.3)	54 (26.7)	0.076	15.37±10.67	0.079
Alone	125 (49.2)	84 (41.6)		14.67±10.18	
Education					
Elementary school	217 (85.4)	153 (75.7)	**0.009***	14.93±10.50	**0.009†**
≥Middle school	37 (14.6)	49 (24.3)		18.31±9.79	
Subjective masticatory level					
Not good	126 (49.6)	63 (31.2)	**<0.001***	13.74±9.72	**0.001†**
Good	128 (50.4)	139 (68.8)		16.87±10.76	
Denture usage					
No	27 (10.6)	153 (75.7)	**<0.001***	24.34±6.59	**<0.001†**
Yes	227 (89.4)	49 (24.3)		9.85±8.31	
Cognitive ability					
Impaired cognitive	119 (46.9)	56 (27.7)	**<0.001***	12.93±10.25	**<0.001†**
Normal cognitive	135 (53.1)	146 (72.3)		17.22±10.24	

*$P<0.05$ by chi-square test.
†$P<0.05$ by t-test & ANOVA.
[a,b]Denoted by Scheffe's post-hoc analysis.
SD: Standard Deviation.

"impaired" was 12.93±10.25, while it was 17.22±10.24 in participants with "normal" cognitive function ($P<0.05$).

2. Characteristics according to the cognitive ability

The cognitive function was divided into two groups according to the MMSE scores. There were significant differences according to age, sex, type of residence, education level, subjective mood, and functional tooth number ($P<0.05$). Based on the type of residence, the MMSE score was 25.51±3.25 in participants living with their spouses, 22.06±5.24 in participants living with other family members, and 23.83±4.55 in participants living alone. There was a statistically significant difference ($P<0.05$). The MMSE score of participants with under the elementary school was 23.22±4.56, while it was 26.21±4.15 in participants with who graduated middle school; there was a significant difference in cognitive function according to the education level ($P<0.001$). The MMSE score of participants whose subjective mastication level was "not good" was 23.19±4.79, compared to 24.21±4.48 in participants with a "good" subjective mastication level ($P<0.05$). Furthermore, the MMSE score was 22.90±4.99 in the participants with less than 20 functional teeth, while the MMSE score was 24.90±3.86 when the number of functional teeth exceeded 20; this difference was statistically significant ($P<0.05$) (Table 2).

3. Association between masticatory level, number of functional teeth, and cognitive ability

When the subjective mastication level was "not good", the risk ratio of poor cognitive function was 1.49 times higher compared with a "good" mastication level, which was significantly different ($P<0.05$). However, after adjusting for age, sex, type of residence, education level, and denture use, the odds ratio was 1.46, but there was no significant difference ($P>0.05$). When the number of functional teeth was small (<20), the risk ratio of poor cognitive function was 2.30 times

Table 2. Characteristics of the study participants according to the cognitive ability

Variables	MMSE score				
	0-23 Impaired cognition	24-30 Normal cognition	*P*-value*	Mean±SD	*P*-value†
Age					
65-69	5 (2.9)	18 (6.4)		25.91±3.10[c]	
70-74	16 (9.1)	59 (21.0)		25.52±3.41[a,b,c]	
75-79	47 (26.9)	90 (32.0)	**<0.001***	24.31±4.50[a,b,c]	**<0.001†**
80-84	58 (33.1)	73 (26.0)		23.05±5.06[a,b]	
≥85	49 (28.0)	41 (14.6)		22.07±4.62[a]	
Sex					
Men	25 (14.3)	84 (29.9)	**<0.001***	25.16±4.23	**<0.001†**
Women	150 (85.7)	197 (70.1)		23.35±4.66	
Residence types					
Spouse	22 (12.6)	99 (35.2)		25.51±3.25[a]	
Others	71 (40.6)	55 (19.6)	**<0.001***	22.06±5.24[b]	**<0.001†**
Alone	82 (46.9)	127 (45.2)		23.83±4.55[c]	
Education					
Elementary school	162 (92.6)	208 (74.0)	**<0.001***	23.22±4.56	**<0.001†**
≥Middle school	13 (7.4)	73 (26.0)		26.21±4.15	
Denture usage					
No	61 (34.9)	119 (42.3)	0.111	24.28±4.44	0.063
Yes	114 (65.1)	162 (57.7)		23.46±4.73	
Subjective masticatory level					
Not good	83 (47.4)	106 (37.7)	**0.041***	23.19±4.79	**0.020†**
Good	92 (52.6)	175 (62.3)		24.21±4.48	
Functional teeth					
<20	119 (68.0)	135 (48.0)	**<0.001***	22.90±4.99	**<0.001†**
≥20	56 (32.0)	146 (52.0)		24.90±3.86	

*$P<0.05$ by chi-square test.
†$P<0.05$ by t-test & ANOVA.
[a,b]Denoted by Scheffe's post-hoc analysis.
MMSE: Mini-Mental Status Examination; SD: Standard Deviation.

Table 3. Logistic regression analysis for association between masticatory level, number of functional teeth, and cognitive ability

Variables	I		II		III	
	OR	95% CI	OR	95% CI	OR	95% CI
Subjective masticatory level						
Good	ref.		ref.		ref.	
Not good	1.49	1.02-2.18*	1.39	0.93-2.07	1.46	0.96-2.22
Functional teeth						
≥20	ref.		ref.		ref.	
<20	2.30	1.55-3.41*	1.96	1.29-2.96*	2.74	1.50-4.98*

*P<0.05, CI: Confidence interval; OR: Odds ratio.
I: Unadjusted model.
II: Age, sex adjusted model.
III: Age, sex, residence, education & denture usage adjusted model.

higher, while the odds ratio was 2.74 after adjusting for age, sex, type of residence, education level, and denture use; the difference was statistically significant (P<0.05) (Table 3).

Discussion

The number of remaining functional teeth is one of the objective indicators that can evaluate oral health status and predict the quality of life related to oral health. A smaller number of functional teeth indicates poor oral health, which leads to difficulty in mastication, thus affecting the diet, and pain in the soft tissue during chewing[24]. Adam and Preston[25] showed significant differences in the number of remaining functional teeth according to age and sex (P<0.05), but not according to education level (P>0.05). Mummolo et al.[19] also reported no significant difference between the number of remaining teeth and the level of education. In addition, the cognitive function was significantly different from the education level.

In the present study, as the age increased, the number of remaining teeth decreased; there was also a significant difference according to sex (P<0.05). Furthermore, lower was the level of education, the smaller was the number of functional teeth. The cognitive function was also significantly different from the education level (P<0.05).

Elsig et al.[26] reported that there was no relationship between the number of teeth remaining and dementia. However, based on our preliminary data and findings from a previous study[27], we suggest a relationship between the number of residual teeth and dementia. In the present study, when the number of remaining teeth was less than 19, the risk ratio of cognitive function was 2.30 times higher, and it was 2.74 times higher after adjusting, with a statistically significant difference (P<0.05). Yamamoto et al.[28] reported that the risk ratio for dementia was 1.97 times higher when only some teeth remained without denture, and, after adjusting for various variables, the odds ratio was 1.85 times higher. This present study further investigated the relevance between subjective mastication level of oral health related index and cognitive function. When the subjective mastication level was not good, the risk ratio of poor cognitive function was 1.49 times higher, but the difference was no statistically significant (P>0.05). Grover et al.[29] investigated the relationship between the masticatory level and dementia. The participants with good masticatory level scored higher on the MMSE. Furthermore, the cognitive function was good and so was the ability to perform everyday life activities. The deterioration of the masticatory function makes it difficult to eat, thus it affects the general health[30]. Therefore, it is necessary to recover the missing teeth of the elderly; this could result in psychological and mental satisfaction. In order for this to occur, it is necessary to help elderly people to become more interested about oral health care.

There are several limitations in this study. First, this cross-sectional study cannot explain the causal relationship between functional teeth and cognitive function. Second, the reliability of the questionnaire was not considered and it is difficult to extrapolate the general population from our findings by investigating the elderly over 65 years of age who living in some communities. Third, the number of subjects was small and the confidence interval was wide and most of the participants we visited in the senior centers were women; thus, it was not possible to compare according to sex. Furthermore, the education level of the majority of the elderly participants was low, which made it also difficult to perform comparisons according to the level of education. In addition, given that elderly individuals residing in nursing facilities relied in their statements on their caregivers, it was difficult to confirm their subjective statements.

Nevertheless, despite these limitations, this present study is meaningful in that it investigated the relationship between the number of functional teeth and cognitive function in the elderly population of a total of 22 care facilities, by involving a single team consisting of one dentist, one dental hygienist, and one nurse.

To our knowledge, this study is the first to investigate the relationship between the number of functional teeth and cognitive function in Korea, and that is concerned with the oral health of the elderly. Given that oral health performed by the elderly themselves can be a sufficiently preventive measure, it is necessary to promote continuously oral health care education. This study is on the basis data to studying further the relationship between oral health and cognitive function, and suggests that the quality of life in elderly people will improve by maintaining a healthy oral health condition, thus it is expected that the risk of dementia can be lowered.

Our findings suggest that the number of functional teeth decreased with age, female sex, and lower education level. Furthermore, age, sex, residence type, and education level were found to be related to cognitive function. This study confirmed that the number of functional teeth and cognitive function were related.

References

1. Nam SH, Moon SY, Yoo JY. Long-term prospects of population structure and analysis of economic impact of aging. Korea Institute for Health and Social Affairs 2013:1-2.
2. Ko DS. Differences in daily living and exercise capability of the elderly in welfare centers, hall and asylum. Journal of the Global Senior Health Promotion Institute 2012; 2(2):5-17.
3. Atchison KA, Dolan TA. Development of the geriatric oral health assessment index. J Dent Educ 1990;54(11):680-687.
4. Kim SW, Cho KH, Han KD, Roh YK, Song IS, Kim YH. Tooth loss and metabolic syndrome in South Korea: The 2012 Korean National Health and Nutrition Examination Survey. Medicine 2016;95(16):1-8.
5. Tada A, Watanabe T, Yokoe H, Hanada N, Tanzawa H. Relationship between the number of remaining teeth and physical activity in community-dwelling elderly. Arch Gerontol Geriatr 2003;37(2):109-117.
6. Hatch JP, Shinkai RSA, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. Arch Oral Biol 2001;46(7):641-648.
7. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japaneses adults. J Oral Rehabil 2008;35(5):337-344.
8. Shinkai RSA, Hatch JP, Sakai S, Mobley CC, Saunders MJ, Rugh JD. Oral functional and diet quality in a community-based sample. J Dent Res 2001;80(7):1625-1630.
9. Banu RF, Veeravalli PT, Kumar VA. Comparative evaluation of changes on brain activity and cognitive function of edentulous patients, with dentures and two-implant supported mandibular overdenture-pilot study. Clin Implant Dent Res 2016:18(3):580-587.
10. Listl S. Oral health conditions and cognitive functioning in middle and later adulthood. BMC Oral health 2014;14(1)70-76.
11. Kaiser MJ, Bauer JM, Uter W, Donini LM, Stange I, Volkert D, et al. Prospective validation of the modified mini nutritional assessment short-forms in the community, nursing home, and rehabilitation setting. J Am Geriatr Soc 2011;59(11) :2124-2128.
12. Okamoto N, Morikawa M, Okamoto K, Habu N, Hazaki K, Harano A et al. Tooth loss is association with mild memory impairment in the elderly: the Fujiwara-kyo study. Brain Res 2010;1349:68-75.
13. Kimura Y, Ogawa H, Yoshihara A, Yamaga T, Tkiguchi T, Wada T, et al. Evaluation of chewing ability and its relationship with activities of daily living, depression, cognitive status and food intake in the community-dwelling elderly. Geriatr Gerontol Int 2013;13(3):718-725.
14. Shon SH, Choi TK, Oh BH, Oh HC, Kim SM, An SK, et al. Differences in cognitive function and activities of daily living between Alzheimer patients with depression and those without depression. J Korean Neuropsychiatric Asso 1999;38(1):278-288.
15. Ghezzi EM, Ship JA. Dementia and oral health. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89(1):2-5.
16. Lim YM. Nursing intervention for grooming performance of elders with dognitive impairment. Geriatr Nurs 2003;24(1):11-15.
17. Chalmers JM, Carter KD, Spencer AJ. Caries in incidence and increments in community-living older adults with and without dementia. Gerodontology 2002;19(2):80-94.
18. Naorungroj S, Schoenbach VJ, Wruck L, Mosley TH, Gottesman RF, Alonso A, et al. Tooth loss, periodontal disease, and cognitive decline in the atherosclerosis risk in communities (ARIC) study. Community Dent Oral Epidemiol 2015;43(1):47-57.
19. Mummolo S, Ortu E, Necozione S, Manac A, Marzo G. Relationship between mastication and cognitive function in elderly in L'Aquila. Int Clin Med 2014;7(4):1040-1046.
20. Textbook of periodontology. 6th ed. Koonja 2015;294.
21. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12(3):189-198.
22. Park JH, Kwon YC. Standardization of Korean version of mini-mental state examination (MMSE-K) for use in the elderly. Part II. Diagnostic validity. J Korean Neuropsychiatr Assoc 1989;28(3): 508-513.
23. Park JH, Kwon YC. Modification of the mini-mental state examination for use in the elderly in a non-western society: Part I. Development of Korean version of mini-mental state examination. Int J Geriatr Psychiatry 1990;5(6):381-387.
24. Gerritsen AE, Allen PE, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: A systemic review and meta-analysis. Health Qual Life Outcomes 2010;8:552-562.
25. Adam H, Preston J. The oral health of individuals with dementia in nursing homes. Gerodontology 2006;23(2):99-105.
26. Elsig F, Shimmel M, Duvernay E, Giannelli SV, Graf CF, Carlier S, et al. Tooth loss, chewing efficiency and cognitive impairment in geriatric patients. Gerodontology 2015;32(2):149-156.
27. Cho MJ, Jung EK, Lee SS, Choi YH, Song KB. The relationship between the number of remaining teeth and senile dementia: A pilot study. J Korean Acad Oral Health 2015;39(3):161-167.
28. Yamamoto T, Kondo K, Hirai H, Nakade M, Aida J, Hirata Y. Association between self-reported dental health status and onset of dementia: A 4-year prospective cohort study of older Japanese adults from the aichi gerontological evaluation study (AGES) project. Psychosom Med 2012;74(3):241-248.
29. Grover M, Vaidyanathan AK, Veeravalli PT. OHRQoL, masticatory

performance and crestal bone loss with single implant, magnet-retained mandibular overdentures with conventional and shortened dental arch. Clin Oral Implants Res 2014;25(5):580-586.

30. Hutton B, Feine J, Morais J. Is there an association between edentulism and nutritional state? J Can Dent Assoc 2002;68(3):182-187.