J. Gifu Dent. Soc.
Vol. 29, No. 3, 267～274
February 2003

3-year Follow-up Study of Risk Factors Analysis of the Signs and Symptoms of Temporomandibular Disorders in Japanese University Students

YANBIN XU[1], MASATOSHI IWAHORI[2], AKIHIKO NIGAURI[2], MUTSUO YAMAUCHI[3], TOORU NAGASAWA[2]

1 : Chengdu Implantological Hospital, Sichuan University (Prof. Wu Dayi)
2 : Department of Prosthodontics, Asahi University School of Dentistry (Prof. Tooru Nagasawa)
3 : Post-doctoral Institute of Clinical Dentistry, Asahi University (Prof. Mutsuo Yamauchi)

ABSTRACT *The purpose of this study was to observe the changes in temporomandibular disorders (TMD) in young adults and analyze the risk factors, through a 3-year follow-up study in Japanese dental students.*

Valid data of 71 subjects were collected through questionnaires and clinical examinations from 140 students of Asahi University. TMD evaluations were based on the Helkimo clinical dysfunction index (Di) and anamnestic dysfunction index (Ai), respectively. Di and Ai were recorded twice with 3-year interval. Binary logistic regression was used to analyze the risk factors for the changing of signs and symptoms of TMD.

There was no significant increase in the prevalence of TMD. Quite different changes were observed for different individual subjects. Neck and shoulder pain, assisted balancing-side contacts were significant risk factors for the individual Ai-increasing. Grinding in sleep was significant risk factor for individual Di-decreasing, and no significant factors were found for Ai-decreasing and Di-increasing.

Key words : Temporomandibular joint disorders (TMD), Signs and symptoms, Helkimo Index, University student, Risk factor

INTRODUCTION

Temporomandibular disorders (TMD) is defined as a collective term embracing a number of clinical problems that involve the masticatory musculature, the temporomandibular joint (TMJ) and associated structures, or both. A literature review about the prevalence of TMD signs and symptoms showed a wide range of variation in results. It is natural to have doubts on the reproducibility and credibility of the measurement criteria, design or methodology. A very important effort to solve these kinds of problems is to create a standard index.

The Helkimo index[1] and the craniomandibular index[2] (CMI) are the most commonly used indices for the epidemiological studies and clinical evaluations of TMD. A high correlation has been reported between the Helkimo pain and Dysfunction index and the CMI.[3] Recently, some criticisms doubted the use of the Helkimo Index for clinical studies because it does not separate joint problems from muscle problem and is not sensitive enough to measure small changes in severity. However the Helkimo index is simpler and still widely used in Europe in clinical studies.

According to the biopsychosocial model for TMD,[4,5] TMD are multicausal[6] and their etiology involves the interplay of biological, psychological and sociological factors. Although epidemiological validation of this theory is not easy because it would be virtually impossible to conduct a study controlled for all the multitude possible variables, the logistic regression[7] was suggested to be one of the good

1 : 75#, Xiaotianzhu Street, Chengdu Sichuan, 610041 China
2 : 1851 Hozumi-cho, Motosu-gun, Gifu 501-0296, Japan
3 : 5-15 Miyako-dori, Gifu 500-8309, Japan
(Accepted January 29, 2003)

choices to analyze the multiple risk factors.[8~10]

Epidemiological and longitudinal studies have shown an increased prevalence of signs and symptoms of TMD with age for children and adolescents[11~14] and a decreased prevalence with age for elderly patients.[15,16] In basic on several follow-up studies, a fluctuation of signs and symptoms of TMD was found not only in TMD patients but also in non-patient populations, especially for adolescents and young adults.[17,18] However few of them discussed the risk factors for the fluctuation in young adults. The main purpose of this study was to observe the changes of signs and symptoms of TMD using the Helkimo index and to analyze the risk factors with logistic regression and AR, through a 3-year follow-up in Japanese dental students.

MATERIALS AND METHODS

A three-year follow-up study of TMD signs and symptoms started in 1996 in the first-grade dental students at Asahi University. Excluding the orthodontic experienced samples, valid data of 71 subjects were obtained after twice investigations, who were randomly selected from 140 students after fully informed of the study. They were 49 males, 22 females with averaged 22.5 years old at the end of the study.

The clinical examination was performed by the same examiner. The items based on the Helkimo index[1] included : measurements of maximal mouth opening, maximal lateral movement to the right and left, maximal protrusion, deviation during opening-closing, overjet and overbite ; registration of TMJ sounds combined with palpation and a stethoscope, locking or luxation ; registration of pain on movement, and on palpation of TMJ and masticatory muscles. The palpation routinely consisted of palpation of the lateral and posterior parts of temporomandibular joints, the profound and superficial masseter muscle, anterior and posterior parts of the temporal muscle, insertion of the temporal muscle in the coronoid process, and the lateral and medial pterygoid muscles. In the second examination, the Angle's molar relation, the agreement of muscular position (MP)[19] and intercuspal position (ICP), protrusive contacts, laterotrusive contacts (type of guidance), and assisted balancing-side contacts[20] were also observed and recorded as follows.

Protrusive contact: the subject was asked to protrude his or her mandible until the anterior teeth reach an edge-to-edge position. Laterotrusive contact: the subject was asked to move the mandible laterally until the edge-to-edge contact of the canines was passed. Assisted balancing-side contact: while the subject was asked to move in the mediotrusive direction, a firm force by hand was applied on the mandiblar angle in a superomedial direction. Two-color articulating papers were used in all the above examinations to identify those contacts.

The anamnestic part of this study consisted of 19 questions included : reported joint sounds before and at the end of the study, stiffness on awakening, pain in the region of the TMJ or of the masticatory muscles, pain or tenderness of the TMJ and the masticatory muscles on movement and function, limitation of movement and opening, luxation and locking of the mandible, general stress, unilateral chewing habits, clenching habits and tooth grinding in sleep.[1]

In the first investigation, the questionnaires were completed individually under guidance from Japanese staff before the clinical examination. In the second investigation, the questionnaires were filled in by all the students of that grade during a class.

SPSS 9.0 for Windows (SPSS Japan Inc, Japan) was used for statistics. Mann-Whitney U tests were used in Ai and Di analysis of gender difference, and comparisons between two examinations of the follow-up study. Spearman correlation coefficient was adopted to see the relation between Ai and Di.

Binary logistic regression was used to analyze the multiple risk factors. Modeling strategy for assessing interaction : the highest-order interaction terms to be considered were two-factor product terms of E *Vi (E, exposure variable, Vi, potential confounding variables) ; For the confounding assessment, the eligible subsets (which gave approximately the same odds ratio as controls for all the potential confounders) of V's were identified first, then controls of the subsets with the largest gain in precision were selected or the gold standard was used (if no subset gave better precision).

The potential confounders obtained from the questionnaire were : gender, unilateral chewing habits, grinding in sleep, neck and shoulder pain, general stress and clenching habits. The potential confounders obtained from the clinical examination included : laterotrusive molar guidance, protrusive interference, assisted balancing-side contacts, crown

repair, agreement of MIP and IP, deep bite, Angle II first molar relation and Angle III first molar relation[9~14,21].

As most epidemiologists suggested, the one-tailed P-value was used when testing for the significance of an exposure variable in logistic regression, which was obtained from taking the half of the two-tailed P-value.[20]

RESULTS

Prevalence changes of TMD signs and symptoms

The prevalence of signs Di (I+II+III) in males was 57% in two investigations. The prevalence in females changed from 77% to 82%, but it was not a significant increase. There were no significant gender differences in Di in both investigations (Fig. 1).

Although the prevalence of Ai symptoms (I+II) for males changed from 18% to 22% and changed from 50% to 59% for females, the Ai-increases were not significant differences in either males or females. More females complained of symptoms of TMD than males ($P<0.01$) in both investigations (Fig. 2).

Individual changes in TMD signs and symptoms

The changes of TMD signs and symptoms during 3 years were different among individual subjects. The Ai index values increased in 11 subjects (16%), decreased in 7 subjects (10%) and did not change in 53 subjects (75%) (Fig. 3); the Di index value increased in 11 subjects (16%), decreased in 10 subjects' (14%) and did not change in 50 subjects (70%) (Fig. 4).

Risk factors for the signs and symptoms of TMD

Neck and shoulder pain and assisted balancing-side contacts showed a significant influence on the Ai increasing ($p<0.05$) (Table 1).

There were no significant risk factors for the Ai -decreasing. No significant risk factors were found for the Di increasing. The Di-decreasing was positively affected by the grinding in sleep, the AR of which is not higher than that of unilateral chewing (Table 2).

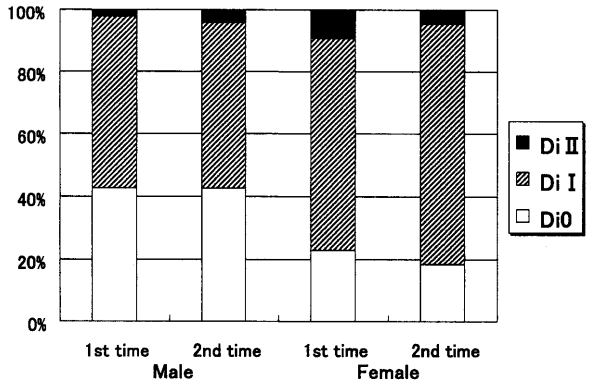

Fig. 1. Three-year follow-up of signs (Di) of TMD in Japanese dental students

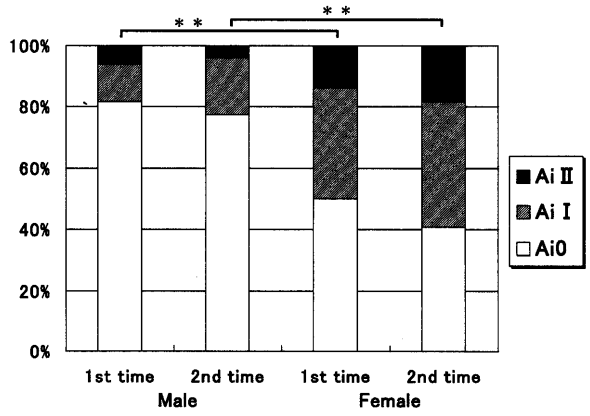

Fig. 2. Three-year follow-up of symptoms (Ai) of TMD in Japanese dental students (**p< 0.01).

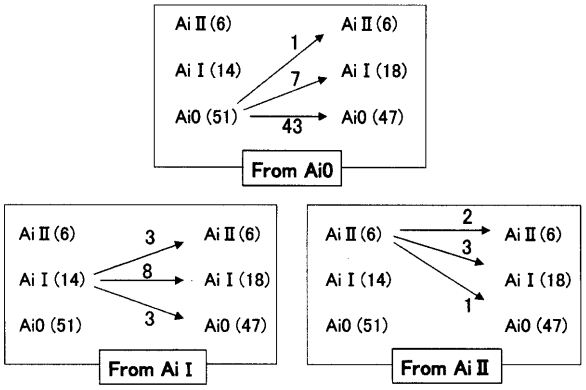

Fig. 3. Changes in symptoms (Ai) in the 3-year follow-up study

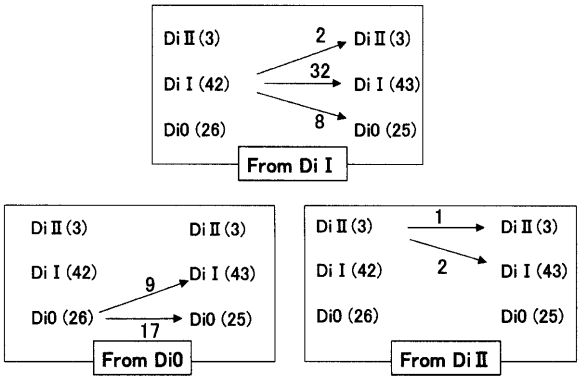

Fig. 4. Changes in signs (Di) in the 3-year follow-up study

The relation between Ai and Di

As shown in Table 3, there were significant correlations between the Ai and Di in both investigations ($P<0.01$).

Table 1. Significant risk factors for the Ai increasing (n=71)

Factors	Logistic regression		
	1-tailed P	Odd ratio	95% CI
Neck & shoulder pain	0.0085	60.796	2.082-1775.507
Assisted Balancing-side contacts	0.0128	66.368	1.666-2644.173
Protrusive interference	0.0518	11.912	0.603- 235.469
Angle II molar relation	0.0583	0.051	0.001- 2.094
Angle III molar relation	0.1074	0.114	0.004- 3.527
Sex	0.1162	0.241	0.023- 2.492
General stress	0.1551	0.309	0.032- 2.982
Laterotrusive molar guidance	0.1892	0.198	0.005- 7.266
Grinding in sleep	0.1941	0.356	0.034- 3.716
MP and ICP	0.2809	1.961	0.202- 19.050
Crown repairing	0.3387	0.553	0.034- 9.021
Deep bite	0.4331	1.308	0.058- 29.728

Table 2. Significant risk factors for the Di decreasing (n=71)

Factors	Logistic regression		
	1-tailed P	Odd ratio	95% CI
Grinding in sleep	0.0362	9.9832	0.810-123.006
Unilateral Chewing	0.0683	4.2607	0.632- 28.721
Assi. balancing-side contacts	0.0903	0.1800	0.014- 2.217
Deep bite	0.1134	4.6266	0.385- 55.516
Clenching habits	0.1644	3.0747	0.322- 29.303
Protrusive interference	0.2810	0.5329	0.063- 4.475
Crown repairing	0.3939	0.0000	0.000-2.38E+28

Table 3. The relation between Ai and Di

First investigation	Second investigation
$p<0.01$	$p<0.01$
rs*=0.6182	rs=0.5691

*rs: Spearman correlation coefficient

DISCUSSION

It has been clear that most signs and symptoms of TMD will not progress to more serious or long-term debilitating conditions.[23] In the present 3-year follow-up study of university students, the prevalence of TMD was not significantly changed although individual fluctuation was observed.

Unassisted balancing-side contact has been regarded as having adverse affect on masticatory function and therefore represents a potential etiologic factor as a functional disturbance.[24,25] However, there is an assumption that assisted-balancing contacts that are only present with significant assisted force to overcome the neuromuscular protection may actually protect the ipsilateral joint during heavy loading (such as during bruxism).[26] In Okeson's study,[27] unassisted balancing contacts were only found in 30% of the TMD patients, while the balancing-side contacts increased to 90% when assisted with force. Minagi et al.[28] reported that there was a highly significant positive correlation between the absence of assisted balancing-side contacts and an increasing prevalence of joint sounds with age (r=0.975). However no significant correlation between mediotrusive contacts (balancing-side contacts) and increasing sound was found in Christensen's study.[29] In the present study, the assisted balancing-side contacts showed a significant risk factor for Ai increasing. Further research needs to be considered.

Parafunctional behaviors, especially clenching and grinding, are assumed to be important initiating and perpetuating factors in TMD,[30] which was supported by one cross-sectional study (self-reported data by Paulo Cesar et al.[31] and some experimental studies.[32~34] The mean prevalence of bruxism is about 20% and decreases with age in young and adult populations.[35] For the subjects in the present study, self-reported grinding in sleep was 22%. However, why the grinding in sleep was a significant risk factor for the Di decreasing in 71 subjects requires further research: it is unclear whether it was a false result because of the small sample sizes or because the grinding in sleep may be an adaptation to the TMD. No correlation was found between TMJ problems and unilateral chewing habits,[36] as in the present study.

Knowledge about the relation between the occlusal state and function disorders is unclear and controversial, although, there is a higher risk of children with severe malocclusions for developing TMD.[37] However, some studies suggested there was no scientific evidence for a positive relation between occlusion factors and TMD in young adults.[38] In the present study, the first molar Angle II and Angle III relations were not to be found significant risk factors of TMD.

Although there is still disagreement on the association between neck pain and TMD,[39~44] a recent study showed that neck pain was experienced within the last year in 39% of the total series, and the prevalence of complaints was higher in females than in males (42% vs 34%), and a significant association between neck pain and the TMD was found.[45] In the present study, a mean of 42% of the subjects complained of neck pain, and significantly more females than males had neck pain (69% vs 30 %, $P<0.05$). According to logistic regression, neck pain was a significant risk factor for the Ai increasing.

Stress is a significant factor affecting TMD.[10,46] In the present study, reported stress was not found to be a significant risk factor for TMD changing. However, it was a simple "Yes" or "No" question, and a scientific index should be considered for use in future research.

A somewhat higher prevalence of TMD in girls compared with boys or women than men has often been reported. For the 71 subjects in the follow-up study, more women complained of symptoms of TMD than men, but no significant different was found in the signs of TMD.

CONCLUSION

After 3 years, although there was no significant increase in the prevalence of signs and symptoms of TMD, quite different changes were observed for different subjects. Both neck and shoulder pain, and assisted balancing-side contacts were significant risk factors for the individual Ai-increasing. Grinding in sleep was significant risk factor for individual Di-decreasing, and no significant factors were found for Ai-decreasing and Di-increasing.

The authors sincerely thank Dr. Masaya Funakoshi, an emeritus professor of Asahi University, for his valuable advice and help to ensure the completion of research.

REFERENCES

1) Helkimo M. : Studies on function and dysfunction of the masticatory system. II. Index for anamnestic

and clinical dysfunction and occlusal state. *Swed. Dent. J.,* **67** : 101～121, 1974.
2) Fricton J. R. and Schiffman E. L. : The craniomandibular index: Validity. *J. Prosthet. Dent.,* **58** : 222～228, 1987.
3) Fricton J. R. and Schiffman E. L. : Reliability of a craniomandibular index. *J. Dent. Res.,* **65** : 1359～1364, 1986.
4) Dworkin S. F. and Massoth D. L. : New understanding of the behavioral and psychosocial aspect of chronic orofacial pain. Dentistry Today, *Nov./Dec.* : 38～45, 1993.
5) McCreary C. P. and Clark G. T., Merril R. L., Flack V. and Oakley M. E. : Psychological distress and diagnostic subgroups of temporomandibular patients. *Pain,* **44** : 29～34, 1991.
6) McNeil C. : American Academy of Orofacial Pain (Temporomandibular disorders: guidelines for classifications, assessment, and management), Quintessence (Chicago), 27～38, 1993.
7) Kleinbaum D. G. : Logistic regression -a self learning text. Springer-verlay New York, Inc. 1994.
8) Ciancaglini R., Testa M. and Radaelli G. : Association of neck pain with symptoms of temporomandibular dysfunction in the general adult population. *Scand J. Rehabil Med.,* **31** : 17～22, 1999.
9) Henrikson T., Ekberg E. C. and Nilner M. : Symptoms and signs of temporomandibular disorders in girls with normal occlusion and class II malocclusion. *Acta Odontol. Scand,* **55** : 229～235, 1997.
10) Liu W. and Shi Z. : Risk factors of temporomandibular disorders-a clinical contrast research. *J. West China Stomatology,* **15** : 36～39, 1997.
11) Magnusson T. and Egermark-Eriksson I. and Carlsson G. E. : Four-year longitudinal study of mandibular dysfunction in children. *Community Dent. Oral Epidemiol.,* **13** : 117～120, 1985.
12) Magnusson T. : Five-year longitudinal study of signs and symptoms of mandibular dysfunction in adolescents. *Cranio,* **4** : 338～344, 1986.
13) deBoever J.A. and van den Berghe L.: Longitudinal study of functional conditions in the masticatory system in Flemish children. *Community Dent. Oral Epidemiol.,* **15** : 100～103, 1987.
14) Egermark-Eriksson I., Carlsson G. E., Magnusson T. and Thilander B. : A longitudinal study on malocclusion in relation to signs and symptoms of craniomandibular disorders in children and adolescents. *Eur. J. Orthod.,* **12** : 399～407, 1990.
15) Heft M. W. : Prevalence of TMJ signs and symptoms in the elderly. *Gerodontology* **3** : 125～130, 1984.
16) Jensen R., Rasmussen B. K. Pedersen B., Louis I. and Olesen J. : Prevalence of temporomandibular dysfunction in a general population. *J. Orofac. Pain,* **7** : 175～182, 1993.
17) Morinushi T., Ohno H., Ohno K., Oku T. and Ogura J. : Two year longitudinal study of the fluctuation of clinical signs of TMJ dysfunction in Japanese adolescents. *J. Clini. Pediatr. Dent.,* **15** : 232～240, 1990.
18) Onizawa K. and Yoshida H. : Longitudinal changes of symptoms of temporomandibular disorders in Japanese young adults. *J. Orofac. Pain,* **10** : 151～156, 1996.
19) Brill N. and Posselt U.: Mandibular positions and mandibular movements. *Brit. Dent. J.,* **106** : 391～400, 1959.
20) Okeson J. P. Dickson J. L. and Kemper J. T. : The influence of assisted mandibular movement on the incidence of non-working contacts. *J. Prosthet. Dent.,* **48** : 174～177, 1982.
21) Richard A.P. and Dennis R. B. : Clinical management of tempolomandibular disorders and orofacial pain. 1 st ed., Quintessence (Illinois), 61～71, 1995.
22) Kleinbaum D. G. : Logistic regression -a self learning text. Springer-verlay(New York), Inc. 1994.
23) de Leeww R., Boering G., Stegenga B. and de Bont L. G. M. : Clinical sings of TMJ osteoarthrosis and internal derangement 30-years after non-surgical treatment. *J. Orofac. Pain,* **8** : 18～24, 1994.
24) Ramfjord S. : Bruxism, a clinical and electromyographic study. *J. Am. Dent. Assoc.,* **52** : 21, 1961.
25) Williamson E. H. and Lundquist D. O. : Anterior guidance, its effect on electromyographic activity of the temporal and masseter muscles. *J. Prosthet. Dent.,* **49** : 816～823, 1983.
26) Okeson J. P. : Management of temporomandibular disorders and occlusion. Mosby Year Book : pp. 271, 1989.
27) Minagi S., Watanabe H., Sato T. and Tsuru H. : Relationship between balancing -side occlusal contact patterns and temporomandibular joint sounds in humans : Proposition of the concept of balancing-side protection. *J. Craniomandib. Disord,* **4** : 251～256, 1990.
28) Christensen L. V., Donegan S. J. and McKay D. C. : Mediotrusive tooth guidance and temporomandibular joint sounds in non-patients and patients. *J. Oral Rehabil.,* **23** : 686～698, 1996.
29) Glaros A. G. and Glass E. G. : Temporomandibular disorders (Psycho-physiological Disorders : Research and clinical Applications) (Gatchel R. J., Blanchard E. B.), American Psychological Association (Washington, DC), 299～356, 1993.
30) Conti P. C., Ferreira P. M., Pegoraro L. F., Conti J. V and Salvador M. C. G. : A cross-sectional study of prevalence and etiology of signs and symptoms of temporomandibular disorders in high school and university students. *J. Orofac. Pain,* **10** : 254～262, 1996.
31) Glaros A. G., Tabacchi K. N. and Glass E. G. : Effect of parafunctional clenching on TMD pain. *J. Orofac. Pain,* **12** : 145～152, 1998.
32) Clark G. T., Adler R. C. and Lee J. J. : Jaw pain and

tenderness levels during and after repeated sustained maximum voluntary protrusion. *Pain,* **45** : 17 ~22, 1991.

33) Christensen L. V. : Progressive jaw muscle fatigue of experimental tooth clenching in man. *J. Oral Rehabil.,* **8** : 413~420, 1981.

34) De Meyer M. D. and De Boever J. A. : The role of bruxism in the appearance of temporomandibular joint disorders. *Rev. Belge. Med. Dent.,* **52** : 124~138, 1997.

35) Kayser A. F. : Shortened dental arches and oral function. *J. Oral Rehabil.,* **8** : 457~462, 1981.

36) Sonnesen L., Bakke M. and Solow B. : Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. *Eur. J. Orthod.,* **5** : 543~559, 1998.

37) Rugh J. D. : Panel Discussion : Etiology of TMD's in current controversies in temporomandibular disorders (McNeil C.), Quintessence Publishing Company Inc. (Illinois), 17~30, 1992.

38) Braun B. L. : Postural differences between asymptomatic men and women and craniofacial patients. *Arch. Phys. Med. Rehabil.,* **72** : 653~656, 1991.

39) Clark G. T. Green E. M. and Dornan M. R. and Flack V. F. : Craniocervical dysfunction levels in a patient sample from a temporomandibular joint clinic. *J. Am. Dent. Assoc.,* **115** : 251~256, 1987.

40) Janda V. : Some aspects of extracranial causes of facial pain. *J. Prosthet. Dent.,* **56** : 484~487, 1986.

41) Kirveskari P., Alanen P., Kaitaniemi P., Holtari M., Virtanen T. and Laine M. : Association of functional state of stomatognathic system with mobility of cervical spine and neck muscle tenderness. *Acta Odontol. Scand,* **46** : 281~286, 1988.

42) Kraus, S. : In evaluation, treatment and prevention of musculoskeletal disorders (H. Saunders), Anderberg-Lund (Minneapolis), 191~192. 1985.

43) Passero P. L., Wyman, B. S., Bell J. W., Hirschey S. A. and Schlosser W. S. : Temporomandibular joint dysfunction syndrome. A clinical report. *Phys. Ther.,* **65** : 1203~1207, 1985.

44) Ciancaglini R., Testa M. and Radaelli G. : Association of neck pain with symptoms of temporomandibular dysfunction in the general adult population. *Scand. J. Rehabil. Med.,* **31** : 17~22, 1999.

45) Rugh J. D. and Solberg W. K. : Psychological implication in temporomandibular pain and dysfunction. *Oral Sciences Reviews,* **7** : 3 ~30, 1976.

岐　歯　学　誌
29巻3号 267～274
2003年2月

青年における顎関節症の症状と徴候の変化のリスクファクターに関する3年間の追跡調査による検討

徐　彦彬[1]　岩堀正俊[2]　苦瓜明彦[2]
山内六男[3]　長澤　亨[2]

[1]四川大学成都市歯科インプラント病院
[2]朝日大学歯学部歯科補綴学講座
[3]朝日大学歯科臨床研究所附属歯科診療所

キーワード：顎関節症，症状と徴候，Helkimo index，大学生，リスクファクター

抄録　この研究の目的は，日本人歯学部学生の3年間の追跡調査を通して，青年の顎関節症の症状と徴候の変化を観察することにより顎関節症のリスクファクターを分析することである．

朝日大学歯学部学生140名から71人の有効なデータが，アンケートおよび臨床診査から収集された．顎関節症の評価は，Helkimo clinical dysfunction index(Di)およびanamnestic dysfunction index(Ai)にそれぞれ基づいた．DiおよびAiは3年間隔で2回測定された．バイナリロジスティック回帰が，顎関節症の症状と徴候の変化に関するリスクファクターを分析するために用いられた．

顎関節症の発症頻度の増加はなかったが，個人毎にまったく異なった変化が観察された．首と肩の痛み，平衡側接触は個人のAiを増加させる有意なリスクファクターであった．また，夜間の歯ぎしりはDiを減少させる有意な因子であった．しかし，Aiを増加させる因子やDiを増加させる因子はなかった．