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Pattern analysis of patients with temporomandibular disorders resulting from unilateral mastication due to chronic periodontitis

Hye-Mi Jeon [1], **Yong-Woo Ahn** [2], **Sung-Hee Jeong** [2], **Soo-Min Ok** [2], **Jeomil Choi** [3], **Ju-Youn Lee** [3], **Ji-Young Joo** [3], **Eun-Young Kwon** [1,4,*]

[1]Dental Clinic Center, Pusan National University Hospital, Busan, Korea
[2]Department of Oral Medicine, Pusan National University School of Dentistry, Yangsan, Korea
[3]Department of Periodontology, Pusan National University School of Dentistry, Yangsan, Korea
[4]Biomedical Research Institute, Pusan National University Hospital, Busan, Korea

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***Correspondence:**
Eun-Young Kwon
Dental Clinic Center and Biomedical Research Institute, Pusan National University Hospital, 179 Gudeok-ro, Seo-gu, Busan 49241, Korea.
E-mail: betteryoung@hanmail.net
Tel: +82-51-240-7429
Fax: +82-51-240-7706

ORCID iDs
Hye-Mi Jeon
https://orcid.org/0000-0003-0007-5662
Yong-Woo Ahn
https://orcid.org/0000-0002-2197-0394
Sung-Hee Jeong
https://orcid.org/0000-0002-6296-4775
Soo-Min Ok
https://orcid.org/0000-0003-1776-371X
Jeomil Choi
https://orcid.org/0000-0002-7491-6711
Ju-Youn Lee
https://orcid.org/0000-0002-0772-033X
Ji-Young Joo
https://orcid.org/0000-0002-4050-5797
Eun-Young Kwon
https://orcid.org/0000-0001-9555-0360

ABSTRACT

Purpose: The purpose of the present study was to perform a pattern analysis in patients with temporomandibular disorder (TMD) resulting from unilateral mastication due to chronic periodontitis.
Methods: Thirty participants with signs or symptoms of TMD who engaged in unilateral mastication due to periodontitis-related discomfort (test group) were selected. Another 30 subjects exhibiting signs or symptoms of TMD resulting from unilateral mastication not due to chronic periodontitis (control group) were also recruited. An interview-based questionnaire was administered, and an examination of the temporomandibular joint (TMJ) with determination of periodontal status was performed.
Results: The duration of unilateral mastication was significantly longer in the control group than in the test group. There was a significant negative correlation between the duration of unilateral mastication and the Community Periodontal Index score. Using the Research Diagnostic Criteria for TMD (RDC/TMD) axis I algorithms, all the subjects were assigned to 3 main groups. The test group exhibited significantly a higher diagnostic distribution of group III (arthralgia, osteoarthritis, or osteoarthrosis), and in both the test and control groups, the number of diagnoses was larger for the non-chewing side. The control group showed a significantly higher diagnostic distribution of group I (myofacial pain), and in both the test and control groups, the number of diagnoses was larger for the chewing side.
Conclusions: The results of the present study indicate that unilateral mastication due to chronic periodontitis could induce not only pain but also structural TMJ changes if adequate treatment is not administered and supported within a short time from the onset of the condition. Therefore, immediate treatment of chronic periodontitis is recommended to prevent not only the primary progress of periodontal disease, but also secondary TMJ-related problems. Furthermore, subjects who have suffered chronic long-term periodontitis without treatment should be urged to undergo a TMJ examination.

Keywords: Mastication; Periodontitis; Temporomandibular joint disorders

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Author Contributions

Conceptualization: Hye-Mi Jeon, Eun-Young Kwon; Data curation: Hye-Mi Jeon, Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok, Jeomil Choi, Ju-Youn Lee, Ji-Young Joo, Eun-Young Kwon; Formal analysis: Ji-Young Joo, Ju-Youn Lee, Jeomil Choi; Funding acquisition: Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok; Investigation: Eun-Young Kwon, Ji-Young Joo, Ju-Youn Lee; Methodology: Hye-Mi Jeon, Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok, Jeomil Choi, Ju-Youn Lee, Ji-Young Joo, Eun-Young Kwon; Project administration: Eun-Young Kwon, Jeomil Choi; Resources: Hye-Mi Jeon, Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok, Jeomil Choi, Ju-Youn Lee, Ji-Young Joo, Eun-Young Kwon; Software: Eun-Young Kwon, Ji-Young Joo, Ju-Youn Lee; Supervision: Yong-Woo Ahn, Jeomil Choi; Validation: Eun-Young Kwon, Jeomil Choi; Visualization: Hye-Mi Jeon, Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok, Jeomil Choi, Ju-Youn Lee, Ji-Young Joo, Eun-Young Kwon; Writing - original draft: Hye-Mi Jeon, Yong-Woo Ahn, Sung-Hee Jeong, Soo-Min Ok, Jeomil Choi, Ju-Youn Lee, Ji-Young Joo, Eun-Young Kwon; Writing - review & editing: Hye-Mi Jeon, Eun-Young Kwon.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

INTRODUCTION

Chronic periodontitis is a bacterial infection resulting in the loss of alveolar bone and the occurrence of periodontal pockets [1]. Its etiology is related to bacteria with calculus, overhang restorations, smoking, systemic diseases, and genetic factors [2]. Without adequate treatment, it eventually can lead to discomfort during chewing or the loss of teeth, and often causes unilateral mastication.

Mastication, a dynamic process of the stomatognathic system, can occur bilaterally at the same time. Unilateral mastication, often a function of habit or preference and performed consistently or predominantly on one side, has been regarded as one of the properties of human mastication [3]. It is common even in humans who usually are asymptomatic and who engage in normal mastication [4]. There are various factors influencing unilateral mastication. Central nervous system determination, correlations with other lateralities such as handedness [5], and peripheral factors such as dental- or oral-related problems have been suggested as decisive influences [6]. Dental factors include asymmetric tooth discomfort or side differences in occlusal contact area and bite force. Oral factors include temporomandibular joint (TMJ) problems such as unilateral joint clicking, unilateral facial muscle pain, and structural alterations [7].

Temporomandibular disorders (TMD) are defined as "a collective term embracing a number of clinical problems involving the TMJ, masticatory muscles, or both" in the criteria of the American Academy of Orofacial Pain (AAOP) [8]. The exact cause of TMD is still unknown, though TMJ overloading is considered to be a chief etiologic factor (often inducing histological joint changes) [9]. Some studies have reported that unilateral mastication, with remodeling of the chewing apparatus, can be a contributing factor to TMD syndromes [7], whereas others have not found any correlation between unilateral mastication and TMD [3].

To date, no conclusive findings on the exact causal factors of unilateral mastication and its association with TMD have been established. Although unilateral mastication is not the sole, sufficient factor for TMD, it has been suggested to be an influencing factor. While there are many studies on the relationship between TMD and unilateral mastication by habit or preference, there is little known about the effect of chronic periodontitis-related unilateral mastication on the TMD [10]. The purpose of the present study was to perform a pattern analysis in patients with TMD resulting from unilateral mastication due to chronic periodontitis by comparing them with TMD patients who engaged in unilateral mastication without chronic periodontitis.

MATERIALS AND METHODS

This was a prospective study that employed a cross-sectional design. The inclusion criteria for the test and control groups were women and men older than 20 years presenting cardinal signs or symptoms of TMD resulting from unilateral mastication. We excluded patients with any skeletal deformity, condyle fracture, or TMJ tumor; those who had undergone any TMJ surgery within the past 6 months; and those suffering systemic diseases such as rheumatoid arthritis. Additionally, patients were excluded if they had undergone periodontal treatment within the previous 3 months, had severe malocclusion or parafunctional habits such as bruxism or clenching, and who had undergone any orthodontic treatment potentially affecting the TMD.

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Before the study began, the intraexaminer reliability of the investigator was tested by measuring the Community Periodontal Index (CPI) score repeatedly within a 2-week interval in 20 subjects; this yielded an intraclass correlation coefficient of 0.97.

The study protocol was approved by the Ethics Committee of Pusan National University Hospital (PNUH; approval no. H-1704-010-054) and adhered to the Declaration of Helsinki.

Subject population

Test group

Patients who had visited the PNUH dental clinic due to chronic periodontitis with discomfort during chewing were recruited from January 2016 through March 2017. Among them, only those who had answered 'yes' in the interview-based questionnaire regarding the presence of unilateral mastication due to discomfort caused by periodontal problems were included. Moreover, among those patients, only those who showed signs or symptoms of TMD according to the criteria of the AAOP, in addition to unilateral mastication, were included in the study. As a result, a total of 30 adults presenting with TMD resulting from unilateral mastication due to chronic periodontitis comprised the test group.

Control group

In order to evaluate the effect on unilateral mastication caused by chronic periodontitis, subjects exhibiting signs or symptoms of TMD due to unilateral mastication without chronic periodontitis also were recruited. The specific inclusion criterion for this group was the presentation of TMD signs or symptoms due only to habitual unilateral mastication, without chronic periodontitis. Its purpose was to reduce possible additional confounding factors and to select a homogeneous group of individuals. This group likewise comprised 30 adults.

Study protocol

Questionnaire and TMJ examination

The Research Diagnostic Criteria for TMD (RDC/TMD) have 2 axes. Axis I runs an algorithm for clinical diagnosis, and axis II evaluates mandibular function, psychological status, and the level of TMD-related psychosocial disability. The Korean version of the RDC/TMD history questionnaire for the axis I portion [11] was prepared for each patient. It included age, gender, onset, as well as site and duration of TMD pain over the preceding month. To evaluate unilateral mastication, the following additional questions were asked: "Do you chew only on one side, and if so, which?" and "Why and how long have you chewed only on one side?". Only those subjects whose onset of unilateral mastication was prior to the onset of signs or symptoms of TMD were included, in order to exclude subjects who performed unilateral mastication due to TMJ problems.

Following the questionnaire, all the participating patients underwent clinical TMJ examinations by an experienced orofacial pain specialist for signs or symptoms of TMD. Both subjective symptoms and objective clinical findings were investigated. Pain intensity was assessed on a numeric rating scale (NRS) from 0 to 10, where 0 was 'no pain' and 10 was 'the worst pain.' Mandibular movement was evaluated by measurement of the maximum comfortable opening (MCO) of the mouth for each patient. A maximum opening under 40 mm was considered to indicate limited mouth opening (LMO).

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Based on the RDC/TMD algorithms, all subjects were assigned to 3 main groups (group I, myofascial pain; group II, disc displacement; and group III, arthralgia, osteoarthritis, or osteoarthrosis). Multiple diagnoses per subject were possible.

Periodontal examination

In order to assess periodontal status, the CPI was determined in both groups by a single certified examiner using a World Health Organization (WHO) probe at 6 sites (mesiobuccal, mid-buccal, distobuccal, distolingual, mid-lingual, and mesiolingual) per tooth. The CPI score was calculated according to the WHO protocol [12], by which the dentition is divided into 6 sextants defined by tooth numbers: 18–14, 13–23, 24–28, 33–43, and 44–48. It was coded as follows:

Code 0: healthy periodontium
Code 1: bleeding on gentle probing
Code 2: calculus deposition
Code 3: probing depth of 4 to 5 mm
Code 4: probing depth of 6 mm or deeper

The index teeth in each sextant that had to be assessed were 17, 16, 11, 26, 27, 37, 36, 31, 46, and 47. If the index tooth was absent, all the remaining teeth in that sextant were evaluated, and the highest score was recorded as the score for the sextant. The highest CPI code among all 6 sextants was recorded as the patient's final CPI score to represent his or her periodontal condition. According to the WHO definition of periodontitis, if the subject had only one site with a probing depth ≥4 mm (CPI score of 3 or 4), he or she was diagnosed with periodontal disease. The number of missing teeth also was calculated for each patient.

Statistical analysis

The data were analyzed using SPSS version 22 for Windows (IBM Corp., Armonk, NY, USA). A normality test for the parameters was performed using the Kolmogorov-Smirnov test. For parameters that followed a normal distribution, parametric methods were used, and for parameters that did not follow a normal distribution, nonparametric methods were adapted to analyze the data. For comparison of the differences between the test and control groups, data were analyzed by the independent *t*-test or the Mann-Whitney test for continuous variables and by the χ^2 test or Fisher exact test for categorical variables. The Spearman correlation test was used to identify relationships among the studied parameters. For all tests, *P* values <0.05 were considered to indicate statistical significance.

RESULTS

A total of 60 subjects were enrolled for the analysis. The age and gender distributions are shown in Table 1. The mean age of the test group was higher than that of the control group. The ratio of females to males was higher in both groups and was over 80%. The durations of unilateral mastication in the test and control groups ranged from 0.04 to 10 years and from 1 to 30 years, respectively. It was significantly longer in the control group (mean, 9.50±7.63 years) than in the test group (mean, 4.21±3.91 years). Concerning the mean CPI score and number of missing teeth, the test group patients (with chronic periodontitis) showed significant differences from the control group. The mean CPI scores in the test and control groups were 3.60±0.56 and 0.93±1.01, respectively, with significantly higher scores

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Table 1. Characteristics of the subjects enrolled in the 2 groups

Characteristics	Test group (n=30)	Control group (n=30)	*P* value
Mean age (yr)	59.97±13.09	43.87±14.71[a]	0.001[a]
Gender			1.000[b]
Female/male (female %)	26/4 (86.67)	25/5 (83.33)	
Mean duration of unilateral mastication (yr)	4.21±3.91	9.50±7.63[a]	0.001[c]
Mean CPI score	3.60±0.56	0.93±1.01[a]	0.000[c]
Mean No. of missing teeth	1.53±1.33	0.73±1.34[a]	0.006[c]
Mean pain NRS	4.63±2.08	4.27±1.78	0.781[c]
Mean MCO (mm)	35.17±7.49	37.37±6.99	0.116[c]
LMO			0.184[d]
No. of subjects with LMO	21	16	
No. of subjects without LMO	9	14	

CPI: Community Periodontal Index, NRS: numeric rating scale, MCO: maximum comfortable opening, LMO: limited mouth opening.
[a]The differences between the test and control groups were tested with the independent *t*-test; [b]The differences between the test and control groups were tested with Fisher exact test; [c]The differences between the test and control groups were tested with Mann-Whitney test; [d]The differences between the test and control groups were tested with the χ^2 test.

observed in the test group. The average number of teeth lost in the test group was 1.53±1.33, which was also significantly higher than in the control group (0.73±1.34; $P<0.05$). Although insignificant, the mean score of the pain NRS and the number of subjects exhibiting LMO were higher in the test group than in the control group. The number of mean millimeters of MCO was smaller in the test group, though without statistical significance (Table 1).

There was a negative correlation between CPI score and duration of unilateral mastication ($r=-0.403$, $P<0.05$): as the CPI scores increased, the duration of unilateral mastication decreased.

According to the RDC/TMD algorithms, myofacial pain was classified as group I, and the number of diagnoses was higher for the chewing side in both the test and control groups. The control group had a significantly larger number of subjects in group I than did the test group. Disc displacement was classified as group II, and the number of diagnoses was higher for the non-chewing side in both groups. The test group had a larger number of subjects in group II than did the control group, though the difference was insignificant. Arthralgia, osteoarthritis and osteoarthrosis were classified as group III, and the number of diagnoses was higher for the non-chewing side in both groups. The test group had a significantly larger number of subjects in group III than did the control group (Table 2).

DISCUSSION

Various studies have reported an association between loss of occlusal support due to chronic periodontitis and TMJ dysfunction, especially with the loss of premolars and molars [13-15]. This syndrome can lead to modification of the neuromuscular pattern of jaw activity, resulting in structural TMJ changes due to the altered distribution of loads in response to the mechanical stress on the TMJ system [9,16]. The results of the present study showed an association between structural TMJ changes and more frequent pain, such as arthralgia with osteoarthritis or osteoarthrosis in the subjects who engaged in unilateral mastication due to chronic periodontitis. A plausible cause could be the imbalance of functional and parafunctional loads on the TMJ system as a consequence of chewing on one side exclusively due to masticatory discomfort from chronic periodontitis-related occlusal abnormalities.

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Table 2. Diagnostic distributions of cases according to the RDC/TMD axis I algorithms

Diagnostic distributions	Test group (n=30)	Control group (n=30)	*P* value
Group I (MP)			
Chewing side			0.002[a]
Subjects with MP	3	14	
Subjects without MP	27	16	
Non-chewing side			0.237[b]
Subjects with MP	0	3	
Subjects without MP	30	27	
Group II (DD)			
Chewing side			0.112[b]
Subjects with DD	0	4	
Subjects without DD	30	26	
Non-chewing side			0.292[a]
Subjects with DD	14	10	
Subjects without DD	16	20	
Group III (AOO)			
Chewing side			0.237[b]
Subjects with AOO	0	3	
Subjects without AOO	30	27	
Non-chewing side			0.012[a]
Subjects with AOO	25	16	
Subjects without AOO	5	14	

The values are presented as the number of subjects.
RDC/TMD: Research Diagnostic Criteria for temporomandibular disorder, MP: myofacial pain, DD: disc displacement, AOO: arthralgia, osteoarthritis, or osteoarthrosis.
[a]The differences between the test and control groups were tested with the χ^2 test. [b]The differences between the test and control groups were tested with the Fisher exact test.

There were more female subjects in the current study than male subjects in both groups, which is consistent with previous findings of greater TMD frequency among females [17]. The mean age of the test group was higher than that of the control group, most likely due to the association of chronic periodontitis with older age. The test group also showed a significantly higher CPI score and larger number of missing teeth than did the control group, also due to chronic periodontitis. There was a significant negative correlation between the CPI score and the duration of unilateral mastication. It can be assumed that individuals who perform unilateral mastication due only to habit would not readily recognize their problem, as it is usually asymptomatic for a long time; those who perform unilateral mastication due to masticatory discomfort from chronic periodontitis, however, would easily recognize their state as caused by periodontal problems and avoid chewing on a specific side due to pain or decreased masticatory efficiency. For this reason, they are likely to visit a dental clinic earlier than those without chronic periodontitis. In the current study, the test group showed a higher pain NRS and LMO percentage, and a lower MCO score, than the control group, although the differences were not significant.

It has been reported that unilateral mastication can induce 2 distinct features: increased masseter muscle activity and reduced TMJ motion on the chewing side. During unilateral mastication, the masseter muscle and teeth on the chewing side are stimulated. Kumai [18] proved this by demonstrating higher electromyography levels in the chewing side muscle. However, the TMJ on the non-chewing side performs more extensive motion, because the masticatory force during unilateral mastication is imparted not to the TMJ, but to the food bolus on the chewing side. This phenomenon can lead to a leverage effect, with decreased internal TMJ pressure on the chewing side and an increase in the internal TMJ pressure on the non-chewing side. As a result, the TMJ on the non-chewing side is lubricated, and can exchange metabolites better than that on the chewing side. Eventually, TMJ overloading

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on the non-chewing side could lead to pain, along with structural changes to the condylar cartilage [19]. These findings are consistent with our present observations of a tendency for chewing side muscle pain and non-chewing side joint pain and/or structural changes. Both the test and control groups exhibited a high frequency of myofacial pain on the chewing side and arthralgia with osteoarthritis or osteoarthrosis on the non-chewing side. Chewing side myofacial pain was found more frequently in the control group, and non-chewing side arthralgia with osteoarthritis or osteoarthrosis in the test group. In the test group, 2 subjects who had performed unilateral mastication for a short time (under 1 month) presented only myofacial pain, while most of the others showed joint pain with structural changes. It can be speculated that without adequate chronic periodontitis treatment within a short time from the onset of the condition, simple myofacial pain might gradually deteriorate into complex joint problems.

For unilateral mastication assessment, visual spot checking, observation while chewing, electromyography recordings, electrognathography, and questionnaires can be utilized [7]. A commonly used method is a questionnaire or interview. Several studies have reported significant associations between the stated chewing side and observed chewing side. Christensen and Radue [5] found 83% agreement between the chewing side as stated by subjects and the side observed by the examiner. However, Hidaka et al. [20] pointed out that unilateral mastication is a general habit, and that most individuals have a tendency to chew on a preferred side. Also, as laterality is controlled by the central nervous system, chewing consistently on the same side can be induced; and in fact, one study showed that more adults prefer right-side chewing than prefer left-side chewing [10]. Therefore, an interview, as an attempt to obtain information on unconscious function, can often be unsuccessful in this context, and an objective assessment is often required. As this study identified subjects performing unilateral mastication through a questionnaire with an interview, further studies, including various supportive measures, are recommended.

In conclusion, the present study found, within the confines of its inherent limitations, that unilateral mastication due to chronic periodontitis induced not only pain, but also structural TMJ changes if adequate periodontal treatment was not provided within a short time from the onset of the condition. Therefore, immediate treatment of chronic periodontitis is recommended in order to prevent not only the primary progress of periodontal disease, but also secondary TMJ-related problems. Furthermore, subjects who have suffered long-term chronic periodontitis without appropriate treatment should be urged to undergo a TMJ examination.

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