Correlation between Chewing Preference and Condylar Asymmetry in Patients with Temporomandibular Disorders

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Abstract. This study was performed to analyze the relationship between the chewing preference and condylar asymmetry in patients with temporomandibular disorder (TMD). A cross-sectional study was performed at Prosthodontic Clinic, Faculty of Dentistry, Universitas Indonesia using secondary data obtained from the medical records of 40 patients with TMD. Panoramic radiography tracing was performed for all patients included in the study to evaluate condylar asymmetry using the Habets Asymmetry Index and the Kjellberg Symmetry Index. Measurements of condylar asymmetry were then correlated to the chewing preference, Helkimo’s Index, and DC/TMD. The data showed no correlation between the chewing preference and condylar asymmetry in patients with TMD.

1. Introduction

Chewing is the process by which food is crushed and ground to a smaller size by teeth before being swallowed [1,2,3]. This process involves functional units of the neuromuscular system and the components of mastication such as teeth, periodontal tissues, masticating muscles, temporomandibular joint, palate, tongue, salivary glands, nervous system, and blood vessels [1,2]. Using both sides of the jaw when chewing is an ideal mastication process because it enables alternate active and rest periods of muscle and joint use, which balances the function of mastication and muscle use. Consistent chewing or one-sided dominant chewing is known as a chewing side preference [4,5]. Unilateral chewing preference is common in global populations, with a prevalence of 45–97% [6]. Unilateral chewing habits may lead to an imbalanced dentofacial growth stimulation and the structural instability of the stomatognathic system [1,4].

The temporomandibular joint (TMJ) connects the articular fossa of the temporal bones to the mandibular condyle, with the articular disc located in between. Temporomandibular disorders (TMD) are conditions that cause dysfunction in the joints and muscles of mastication. Symptoms of TMD include pain, a clicking sound, and an irregularity or limited function of the jaw [7,8]. In diagnosing TMD, standardized indices are used to classify the disease severity based on the signs and symptoms of TMD [9]. Diagnosis of TMD at Prosthodontic Clinic, Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia was performed with the Temporomandibular Disorders Diagnostic Index (ID-TMD), Helkimo Index, and Diagnostic Criteria for Temporomandibular Disorders (DC/TMD).
The primary factors contributing to the etiology of TMD include: anatomy of the teeth and joints, neuromuscular factors, and psychological factors [10]. Important anatomical factors include a difference in height or vertical asymmetry between the left and right condyles. Condylar asymmetry is a common condition and does not necessarily describe the presence of a disease, but is one of the risk factors that may cause TMD [11,12]. The prevalence of condylar asymmetry among patients with signs and symptoms of TMD ranges from 54.2–70.8% [12]. The incidence of TMD is fairly high, with 5–50% of individuals experiencing TMD pain (Dworkin dan Massoth, 1994). The incidence of TMD is higher in women than in men [10].

Patients with TMD generally have a greater condylar asymmetry than patients without signs and symptoms of TMD [13]. Bezuur et al. reported that patients with TMD caused by myogenic factors generally have a greater condylar asymmetry than patients with TMD caused by arthrogenic factors [11]. Condylar asymmetry may be evaluated by comparing the left and right condyle vertical height, as determined with panoramic radiography. The radiographic features resulting from the panoramic projection include the maxilla and mandible on both sides of the jaw arch in a film, thus allowing the panoramic radiograph to be used as an initial examination to detect the presence or absence of bony structural changes around the condyle in patients with TMD complaints [14].

Condylar asymmetry is one of the structural alterations that may be a risk factor for TMD. Previous studies have reported that individuals with unilateral chewing preference have more signs and symptoms of TMD than individuals with bilateral chewing preference. Unilateral chewing preference and condylar asymmetry are commonly found in patients with TMD seen at Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia. We focused on this patient population in an effort to identify any correlation between the chewing preference and condylar asymmetry in patients with TMD.

2. Methods
The design of this study was cross-sectional. Data were obtained from the medical records and panoramic radiographs of patients with TMD seen at Prosthodontic Clinic, Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia, from January 2012 to April 2015. Inclusion criteria were the absence of a history of mandible fracture, complete medical records, and interpretable panoramic radiography. The minimum sample size required for this study, as determined based on unpaired categorical analysis, was 16 subjects. Secondary data included medical records related to TMD and traces on panoramic radiography. The degree of asymmetry was assessed with Habet and Kjellberg indices. Data were processed and analyzed using Microsoft Excel and SPSS Statistics V21.

3. Results
Forty sets of medical records and panoramic radiographs were ultimately included in the study. Condylar asymmetry was determined based on measurements of panoramic radiographs. Condylar asymmetry was assessed with the Kjellberg Symmetry Index. Data were collected and processed using SPSS Statistics V21 software (SPSS Inc., Tokyo, Japan).

Condylar asymmetry was assessed with the Habets Asymmetry Index and the Kjellberg Symmetry Index. The results of the calculation with Habets Asymmetry Index showed 30% of the subjects classified as symmetric and 70% as asymmetric. Kjellberg Symmetry Index 1 showed 50% of the subjects classified as symmetric and 50% as asymmetric. Use of Kjellberg Symmetry Index 2 classified 45% as symmetric and 55% as asymmetric.
Table 1. Data distribution of study subjects

| Variable                              | N  | %  |
|---------------------------------------|----|----|
| Gender                                |    |    |
| • Men                                 | 5  | 12,5 |
| • Women                               | 35 | 87,5 |
| Chewing Preference                    |    |    |
| • One side                            | 27 | 67,5 |
| • Two side                            | 13 | 32,5 |
| Habets Asymmetry Index                |    |    |
| • Symmetry                            | 12 | 30  |
| • Asymmetry                           | 28 | 70  |
| Kjellberg Symmetry Index 1            |    |    |
| • Symmetry                            | 20 | 50  |
| • Asymmetry                           | 20 | 50  |
| Kjellberg Symmetry Index 2            |    |    |
| • Symmetry                            | 18 | 45  |
| • Asymmetry                           | 22 | 55  |
| ID-TMD                                |    |    |
| • Non-TMD                             | 0  | 0   |
| • TMD                                 | 40 | 100 |
| Helkimo Index                         |    |    |
| • Mild TMD                            | 13 | 32,5 |
| • Moderate TMD                        | 17 | 42,5 |
| • Severe TMD                          | 10 | 25  |
| DC/TMD Axis I                         |    |    |
| • Pain disorders                      | 3  | 7,5 |
| • Joints disorder                     | 15 | 37,5 |
| • Pain and joints disorders           | 22 | 55  |

For bivariate analysis, the correlation between chewing preference and Habets Asymmetry Index was analyzed using Fisher's test (Table 2). The correlation between chewing preference and Habets Asymmetry Index was not statistically significant (p = 0.609, p > 0.05).

Table 2. Correlation between chewing preference and Habets Asymmetry Index

| Habets Asymmetry Index | p-value |
|------------------------|---------|
|                        |        |
| Symmetry               | Asymmetry |
| N  | %  | N  | %  |    |
| Chewing Preference     |    |    |    |    |
| One side                | 8  | 29,6 | 19 | 70,4 | 0.609 |
| Two side                | 4  | 30,8 | 9  | 69,2 |
| Total                   | 12 | 30  | 28 | 70  |

Fisher’s test; Significant (p < 0.05)

Correlation between chewing preference and Kjellberg Symmetry Index 1 was not statistically significant (p = 0.500, p > 0.05).
To check for a correlation between the chewing preference and Kjellberg Symmetry Index 2, chi-square test with Continuity Correction was performed (Table 4). The correlation between the chewing preference and classification according to Kjellberg Symmetry Index 2 was not statistically significant ($p = 0.263$, $p > 0.05$).

The correlation between the chewing preference and severity of TMD (according to the Helkimo Index) was analyzed using the chi-square test with likelihood ratio (Table 5). The correlation between the chewing preference and severity of TMD (according to Helkimo Index) was not statistically significant ($p = 0.573$, $p > 0.05$).

The correlation between the chewing preference and TMD (according to DC/TMD Axis I) was analyzed using chi-square test with likelihood ratio (Table 6). Based on the data analysis, it was found that the correlation between the chewing preference and group of TMD disorders according to DC/TMD Axis I was not statistically significant ($p = 0.417$, $p > 0.05$).
Table 6. Correlation between chewing preference and group of TMD disorders according DC/TMD Axis I

| Chewing Preference | Group of TMD Disorders According DC/TMD Axis I | p-value |
|--------------------|---------------------------------------------|---------|
|                    | Pain Disorders | Joints Disorder | Pain and Joints Disorders |
|                    | N  | %  | N  | %  | N  | %  |
| One side           | 1  | 3,7 | 10 | 37  | 16 | 59,3 | 0,417 |
| Two side           | 2  | 15,4 | 5  | 38,5 | 6  | 46,2 |
| Total              | 3  | 7,5 | 15 | 37,5 | 22 | 55   |

Chi-square test with likelihood ratio; Significant (p < 0.05)

The correlation between condylar asymmetry (assessed using Habets Asymmetry Index) and severity of TMD (according to the Helkimo Index) was analyzed using chi-square test with likelihood ratio (Table 7). Based on the data analysis, it was found that the correlation between Habets Asymmetry Index and severity of TMD (according to the Helkimo Index) was not statistically significant (p = 0,625, p > 0.05).

Table 7. Correlation between Habets Asymmetry Index and severity of TMD (according to the Helkimo Index)

| Degree of TMD Severity According to Helkimo Index | p-value |
|--------------------------------------------------|---------|
| Mild | Moderate | Severe |
| N  | %  | N  | %  | N  | %  |
| Habets Asymmetry Index Symmetry | 5  | 41,7 | 5  | 41,7 | 2  | 16,7 | 0,625 |
| Asymmetry | 8  | 28,6 | 12 | 42,9 | 8  | 28,6 |
| Total | 13 | 32,5 | 17 | 42,5 | 10 | 25  |

Chi-square test with likelihood ratio; Significant (p < 0.05)

Correlation between the condylar asymmetry (assessed using Kjellberg Symmetry Index 1 and 2) and severity of TMD (according to the Helkimo Index) was analyzed using chi-square test (Table 8 and 9). Based on the data analysis, it was found that the correlation between Kjellberg Symmetry Index 1 and severity of TMD (according to the Helkimo Index) (p = 0,543, p > 0.05) and Kjellberg Symmetry Index 2 and severity of TMD (according to the Helkimo Index) (p = 0,684, p > 0.05) were not statistically significant.

Table 8. Correlation between Kjellberg Symmetry Index 1 and severity of TMD (according to the Helkimo Index)

| Degree of TMD Severity According to Helkimo Index | p-value |
|--------------------------------------------------|---------|
| Mild | Moderate | Severe |
| N  | %  | N  | %  | N  | %  |
| Kjellberg Symmetry Index Symmetry | 5  | 25 | 10 | 50 | 5  | 25 | 0,543 |
| Asymmetry | 8  | 40 | 7  | 35 | 5  | 25 |
| Total | 13 | 32,5 | 17 | 42,5 | 10 | 25 |

Chi-square test; Significant (p < 0.05)
Table 9. Correlation between Kjellberg Symmetry Index 2 and severity of TMD (according to the Helkimo Index)

| Degree of TMD Severity According to Helkimo Index | N | % | N | % | N | % |
|---------------------------------------------------|---|---|---|---|---|---|
| Mild                                              |   |   |   |   |   |   |
| Kjellberg Symmetry                                | 5 | 27,8 | 9 | 50 | 4 | 22,2 |
| Symmetry Index 2 Asymmetry                        | 8 | 36,4 | 8 | 36,4 | 6 | 27,3 |
| Total                                             | 13 | 32,5 | 17 | 42,5 | 10 | 25 |

Chi-square test; Significant (p < 0.05)

The correlation between the condylar asymmetry (assessed using Habets Asymmetry Index) and TMD disorder classification (according to DC/TMD Axis I) was analyzed using the chi-square test with likelihood ratio (Table 10). Based on the data analysis, it was found that the correlation between the Habets Asymmetry Index and group of TMD disorders according to DC/TMD Axis I was statistically significant (p = 0.004, p < 0.05). Therefore, according to Habets Asymmetry Index, the asymmetry group tends to have pain and joints disorders compared to the symmetry group.

Table 10. Correlation between Habets Asymmetry Index and group of TMD disorders according to DC/TMD Axis I

| Group of TMD Disorders According DC/TMD Axis I | p-value | N | % | N | % | N | % |
|-----------------------------------------------|---------|---|---|---|---|---|---|
| Pain Disorders                                 |         |   |   |   |   |   |   |
| Joints Disorder                                |         |   |   |   |   |   |   |
| Pain and Joints Disorders                      |         |   |   |   |   |   |   |
| Habets Symmetry                                | 3       | 25 | 6 | 50 | 3 | 25 | 0,004 |
| Asymmetry Index                                | 0       | 0  | 9 | 32,1 | 19 | 67,9 |
| Total                                         | 3       | 7,5 | 15 | 37,5 | 22 | 55 |

Chi-square test with likelihood ratio; Significant (p < 0.05)

Correlation between the condylar asymmetry (assessed using Kjellberg Symmetry Index 1 and 2) and group of TMD disorders according to DC/TMD Axis I was analyzed using chi-square test with likelihood ratio (Table 11 and 12). Based on the data analysis, it was found that correlation between Kjellberg Symmetry Index 1 and group of TMD disorders according to DC/TMD Axis I (p = 0.110, p > 0.05) and Kjellberg Symmetry Index 2 and group of TMD disorders according to DC/TMD Axis I (p = 0.692, p > 0.05) were not statistically significant.

Table 11. Correlation between Kjellberg Symmetry Index 1 and group of TMD disorders according to DC/TMD Axis I

| Group of TMD Disorders According DC/TMD Axis I | p-value | N | % | N | % | N | % |
|-----------------------------------------------|---------|---|---|---|---|---|---|
| Pain Disorders                                 |         |   |   |   |   |   |   |
| Joints Disorder                                |         |   |   |   |   |   |   |
| Pain and Joints Disorders                      |         |   |   |   |   |   |   |
| Kjellberg Symmetry                            | 3       | 15 | 7 | 35 | 10 | 50 | 0,110 |
| Asymmetry Index 1                              | 0       | 0  | 8 | 40 | 12 | 60 |
| Total                                         | 3       | 7,5 | 15 | 37,5 | 22 | 55 |

Chi-square test with likelihood ratio; Significant (p < 0.05)
Table 12. Correlation between Kjellberg Symmetry Index 2 and group of TMD disorders according to DC/TMD Axis I.

| Group of TMD Disorders According to DC/TMD Axis I | Pain Disorders | Joints Disorder | Pain and Joints Disorders |
|-------------------------------------------------|----------------|----------------|--------------------------|
| Kjellberg Symmetry | 2, N = 11,1 | 7, N = 38,9 | 9, N = 50, P = 0.692 |
| Symmetry Index 2 Asymmetry | 1, N = 4,5 | 8, N = 36,4 | 13, N = 59,1 |
| Total | 3, N = 7,5 | 15, N = 37,5 | 22, N = 55 |

Chi-square test with likelihood ratio; Significant (p < 0.05)

4. Discussion

Data used for this study were obtained from medical records and panoramic radiography of patients with TMD presented at the Prosthodontic Clinic, Teaching Hospital, Faculty of Dentistry, Universitas Indonesia. A total of 40 panoramic radiographs and medical records in which there were data on chewing preference, TMD diagnoses using ID-TMD, Helkimo Index, and DC/TMD were used. Panoramic radiographs were traced to assess condylar asymmetry by measuring bilateral heights of the condyle, mandibular ramus, and mandible body. The measurement results were then processed using Habets Asymmetry Index, Kjellberg Symmetry Index 1, and Kjellberg Symmetry Index 2. Consistent measurements using the Habets and Kjellberg Asymmetry Index were performed by double tracing and measurement on 10 panoramic radiographs. The first and second measurements of the ten radiographs showed the same result, so that the procedure of tracing and measurement of condyle, mandibular ramus, and mandibular body height on both sides of the jaw were consistent.

This study found that 67.5% of subjects chewed on one side of the jaw (32.5% chewed using both sides of the jaw). The results obtained in this study resemble the results of the study by Alkhiary et al. (2013) on lateral mastication for the parameters required in evaluating TMD. The study found 63% of subjects chewed on one side of the jaw and 37% on both sides.

The results of the assessment using Habets Asymmetry Index showed 30% of the subjects classified as symmetric and 70% as asymmetric. However, the Kjellberg Symmetry Index 1 showed 50% of the subjects classified as symmetric and 50% as asymmetric. The assessment using Kjellberg Symmetry Index 2 showed 45% of the subjects classified as symmetric and 55% as asymmetric.

Percentages of asymmetry determined with either Habets or Kjellberg technique are similar to those reported by Iturriaga et al. on the prevalence of condylar asymmetry in patients with the signs and symptoms of TMD [12]. In that study, there were differences in the number of asymmetric patients using Habets (70.8%) and Kjellberg (54.2%) indices. The percentage difference of asymmetry between the Habets and Kjellberg indices suggested that the two assessments were incomparable, due to differences in the measuring point and the method of calculation on both indices [12]. This difference may be due to the difficulty in determining the reference point of measurement on the Habets method and the small distance between the highest and most lateral point of the condyle. In addition, the mathematical calculation relation on Habets method is a linear relation, whereas Kjellberg method uses the ratio between the height of condyles with the mandible or mandibular ramus.

The results collected showed no correlation between the chewing preference and classification according to Habets Asymmetry Index (p = 0.609, p > 0.05), Kjellberg Symmetry Index 1 (p = 0.500, p > 0.05), or Kjellberg Symmetry Index 2 (p = 0.263, p > 0.05). Bianchini et al., (1998) and Lucena et al. suggest that a unilateral chewing preference may cause the structural instability of stomatognathic system as it causes muscles in the working side, especially the masseter, temporalis, and buccinator work harder, while the muscles on the balancing side are elongated and have a lower muscle tone,
which may cause a visual asymmetry of the muscle [1]. From this statement it may be assumed that the habit of chewing on one side is more influential on the asymmetry of the muscles mastication compared to the condyle structure.

In this study, there was no correlation between the chewing preference and severity of TMD (according to the Helkimo Index) (p = 0.573, p > 0.05) and the group of TMD disorders according to DC/TMD Axis I (p = 0.417, p < 0.05). The lack of reference with regard to the chewing preference with severity of TMD and group of TMD disorders is an obstacle to discussing the results obtained in this study. Reinhardt et al. suggest that individuals with a unilateral chewing preference have more signs and symptoms of TMD than individuals with a bilateral chewing preference [15]. However, the study has a different way of measuring the severity of TMD, based only on the number of TMD signs and symptoms on the subject. In addition, the study also did not classify the type of TMD disorders in the study subjects.

In this study, there was no correlation between Habets Asymmetry Index (p = 0.625, p > 0.05), Kjellberg Symmetry Index 1 (p = 0.543, p > 0.05) and Kjellberg Symmetry Index 2 (p = 0.684, p > 0.05) with the severity of TMD (according to the Helkimo Index). This resembles the results of Itturiaga et al. which indicated that the prevalence of condylar asymmetry is high and may act as a risk factor for TMD; but the condylar does not affect the increased degree of TMD signs and symptoms severity [12]. Comparisons obtained from this study are not fully attributable to the study by Itturiaga et al. (2012). This is due to the differences in how the severity of TMD is measured, based on the degree of TMD signs and symptoms severity without using the Helkimo Index.

Based on the data analysis, there was a correlation between Habets Asymmetry Index and group of TMD disorders according to DC/TMD Axis I (p = 0.004, p < 0.05). In addition, the group with condylar asymmetry according to Habets Asymmetry Index tends to have a combination of pain and joint disorders compared to the symmetry group. However, there was no correlation between Kjellberg Symmetry Index 1 (p = 0.110, p > 0.05) and Kjellberg Symmetry Index 2 (p = 0.692, p > 0.05) with the group of TMD disorders according to DC/TMD Axis I.

The results of the analysis using Habets Asymmetry Index were contradictory to the results of the analysis using the Kjellberg Symmetry Index and the Ji et al. study, on the correlation between mandibular asymmetry and TMD. In that study, TMD subjects were divided into groups based on the diagnosis of RDC/TMD Axis I, and it was found that there was no correlation between the group with muscular or disc displacement disorders with asymmetric incidence. In the study, Ji et al. found that the incidence of asymmetry was greater in subjects in the arthrosis/arthritis group (p < 0.01) [16].

The results differ from those reported by previous studies, suggesting that patients with myogenic-induced TMD generally have a greater condylar asymmetry than patients with TMD due to arthrogenic factors [11,17-19]. However, previous research did not examine condylar asymmetry in patients with TMD caused by a combination of myogenic and arthrogenic factors.

This study has some limitations. Only 40 subjects were included in the study. All of the subjects in this study had TMD; there was no control group of patients without TMD for comparison. Medical information on the subjects included in the study was obtained as secondary data from some operators; these data may have been incomplete and the variability of the examiner was unknown. The quality of contrast used in panoramic radiography varied, which sometimes complicated the tracing process.

5. Conclusion
The results collected showed no correlation between the chewing preference with condylar asymmetry in patients with TMD. Specifically, there was no correlation between the chewing preference and severity of TMD (according to Helkimo Index and DC/TMD), nor was there any correlation between condylar asymmetry and Helkimo Index. There was a correlation between condylar asymmetry (according to Habets Asymmetry Index) and DC/TMD, but there was no relationship between condylar asymmetry (according to Kjellberg Symmetry Index) and DC/TMD.
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