Analysis of Temporomandibular Joint Disorders in Children and Adolescents: Diagnosis and Treatment Pattern by Age

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Abstract
Temporomandibular joint disorders (TMDs) can occur at any age, including childhood and adolescence, and pain-related TMDs can affect growth and quality of life. In the present study, recent trends in the diagnosis and treatment of TMDs in children and adolescents were analyzed over a 10-year period. Using 10 years of data from the Health Insurance Review and Assessment Service (HIRA) and Jeonbuk National University (JBNU) Dental Hospital, patients between 0 and 19 years of age diagnosed with K07.6 (temporomandibular joint disorders) were analyzed by 5-year bins. Both datasets indicated a higher prevalence in females (1.2-fold in HIRA, 1.5-fold in JBNU) and in ages 15 to 19 years (72.1% in HIRA, 74.7% in JBNU). HIRA reported a 42.3% increase in prevalence per 100,000 people, from 651.4 in 2011 to 927.0 in 2020. JBNU reported K07.66 (masticatory muscle disorders) as the most common diagnosis in subjects under 10 years of age and K07.60 (internal derangement of temporomandibular joint) in those over 10 years of age. In addition, both were treated mainly by a combination of physical therapy and medication, and the treatment rate increased in accordance with age. Because TMDs can affect various structures in the orofacial region and cause pain that tends to differ with age, an early and specific diagnosis appropriate for age is important for treatment. Therefore, pediatric dentists need to promptly recognize TMDs in children and adolescents and consult with specialists as the prevalence increases. [J Korean Acad Pediatr Dent 2024;51(2):185-196]

Keywords
Temporomandibular joint disorders, Children and Adolescents, Diagnosis, Treatment, Health Insurance Review and Assessment Service (HIRA), Jeonbuk National University Dental Hospital (JGNU)

Introduction
Temporomandibular joint disorders (TMDs) are a group of neuromuscular and
musculoskeletal disorders that includes a variety of clinical manifestations involving the temporomandibular joints (TMJs), masticatory muscles, and associated tissues or structures[1]. Associated symptoms include joint pain, opening restriction, and displacement in mandibular movement, often accompanied by toothaches, headaches, and sounds such as clicking[2]. TMD can occur at any age, either congenitally or acquired, and symptoms and signs can worsen with age[3].

Young age is associated with a higher risk of TMD, especially due to anatomical and physiological differences in TMJs[4]. In addition, the adaptive capacity of the mandibular condyle to mechanical stimulation is relatively low in children compared with adults[5]. TMDs can lead to psychological distress as well as chronic fatigue syndrome, difficulties in forming social relationships, and recurring sick days or school absences[6]. In addition, it can affect oral and maxillofacial growth and development, as well as quality of life[7]. Causes of TMD in children and adolescents include trauma, occlusal relationships such as open bite and anterior crossbite, oral habits such as grinding and clenching, and a number of systemic diseases including arthritis[8]. Therefore, TMD in children and adolescents is a multifactorial disease, complicating the establishment of an exact etiology[9].

The diagnostic criteria for TMDs have been evolving, starting with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) published in 1992 and continuing with the new Diagnostic Criteria for TMD (DC/TMD) published in 2014[3]. However, similar to the RDC/TMD, the DC/TMD was established for adults; unlike adults, it has not been validated fully in children and adolescents[10]. In addition, indirect interference from caregivers of young children can bias the clinical assessment, resulting in low reliability[11]. Furthermore, the prevalence of TMDs in children and adolescents is based largely on symptoms and signs, associated risk factors, or self-reported pain rather than an exact diagnosis[12]. Consequently, the reported prevalence of TMDs in children and adolescents, as usually assessed at a specific period, varies widely in studies, ranging from 7% to 77.7%[6,13-15].

Therefore, we aimed to analyze the trends in diagnosis and treatment of TMDs in children and adolescents by age over the past 10 years based on data from two institutions using a different approach from previous studies. Knowledge and experience in diagnosing and treating TMD-related pain in children and adolescents are still lacking, and their importance remains underestimated[16]. Through this study, we try to increase interest in the diagnosis and treatment of TMDs in children and adolescents and provide a basis for future studies.

Materials and Methods

1. Study subjects

TMDs are defined as K07.6 in the Korean Standard Classification of Diseases (KCD) and divided into the subgroup K07.60 - K07.69 starting in the 6th revision of the KCD in 2011 (Table 1)[17]. Accordingly, the present study included patients 0 - 19 years of age who were diagnosed with K07.6 - K07.69 as principal and secondary diagnoses between January 2011 and December 2020.

2. Methods

1) Health Insurance Review and Assessment Service (HIRA)

Using data from the Healthcare Bigdata Hub of the Health Insurance Review and Assessment Service (HIRA) in the Republic of Korea, the diagnosis rate per 100,000 people was calculated and analyzed for annual changes, with the age of 20 as the reference point. After comparing across each age group, we additionally analyzed differences in diagnosis rate between age groups of 0 - 4 years, 5 - 9 years, 10 - 14 years, and 15 - 19 years in only those under 20 years of age.

2) Jeonbuk National University Dental Hospital (JBNU)

Using electronic medical records from the Jeonbuk National University Dental Hospital (JBNU), gender, age, diagnosis, and medical billing details were collected. Next, the diagnosis rate for K07.6 subgroups was calculated,
and differences between age groups were analyzed. Similar to the HIRA data, age was divided into 5-year bins.

In addition, the names and codes of medications prescribed to patients diagnosed with TMDs were investigated to analyze treatment methods. Several reversible treatments, such as physical therapy, medications, and occlusal appliances, were included in the present study. If two or more treatments were used together, it was classified as a combination treatment. Based on the prescription system from JBNU, temporomandibular joint simple stimulation therapy (J12381), temporomandibular joint complex stimulation therapy (J12383), and temporomandibular joint electrostimulation therapy (J12384) were classified as physical therapy. The occlusal stabilization device (JDOM221) and anterior repositioning appliance (JDOM222) were classified as occlusal appliance treatments, and all other drugs were classified as medication treatments.

The aim of this study was to analyze changes in the diagnosis and treatment of TMDs in children and adolescents over the past decade. This study was approved by the Institutional Review Board (IRB) of Jeonbuk National University Hospital (IRB File No. CUH 2023-05-050).

3. Statistical analysis

The Cochrane-Armitage trend test was performed to analyze the annual change in TMD diagnosis rate and differences between age groups using the HIRA data. The analysis was performed using SAS enterprise guide 9.4.2 (SAS Institute, Cary, NC, USA). In addition, the Statistical Package for Social Sciences (version 26.0, IBM, Chicago, IL, USA) was used to analyze the JBNU data collected in Excel 2019 (Microsoft, Redmond, WA, USA). While demographic characteristics such as gender and age were analyzed in both HIRA and JBNU data, frequency analysis for comparing diagnosis and treatment patterns by age group was only performed on JBNU data.

Results

1. Health Insurance Review and Assessment Service (HIRA)

1) Demographic characteristics

From 2011 to 2020, 21,981 patients under 20 years of age were diagnosed with TMDs (K07.6). Among the patients, 9,833 (44.7%) were male and 12,148 (55.3%) were female, indicating 1.2 times more females than males. When dividing patients into 5-year age groups, 142 (0.6%) were in the 0 - 4 age group, 680 (3.1%) in the 5 - 9 age group, 5,310 (24.2%) in the 10 - 14 age group, and 15,849 (72.1%) in the 15 - 19 age group (Fig. 1).
2) Diagnosis rate

The diagnostic rate was 0.8% among subjects under 20 years of age over the 10-year period, and the diagnosis rate per 100,000 people increased by 42.3% from 651.4 in 2011 to 927.0 in 2020. Similarly, among subjects over 20 years of age, the diagnostic rate was 0.9% and the diagnosis rate per 100,000 people increased by 61.4%, from 709.4 in 2011 to 1145.3 in 2020 (Fig. 2, Table 2).

2. Jeonbuk National University Dental Hospital (JBNU)

1) Demographic characteristics

From 2011 to 2020, 2,166 patients were diagnosed with TMDs (K07.6). Among the patients, 860 (39.7%) were male and 1,306 (60.3%) were female, indicating 1.5 times more females than males. When dividing patients into 5-year age groups, 9 (0.4%) were in the 0 - 4 age group, 43 (2.0%) were in the 5 - 9 age group, 495 (22.9%) were in the 10 - 14 age group, and 1,619 (74.7%) were in the 15 - 19 age group (Fig. 3).

**Fig. 1.** Demographic characteristics of subjects diagnosed with temporomandibular joint disorders (TMDs; K07.6) under 20 from 2011 to 2020 by Health Insurance Review and Assessment Service data. (A) Sex, (B) Age (years).

**Fig. 2.** Annual change in the diagnosis rate of temporomandibular joint disorders (TMDs; K07.6) per 100,000 from 2011 to 2020 by Health Insurance Review and Assessment Service data.
Table 2. Changes in patients diagnosed with temporomandibular joint disorders (TMDs; K07.6) in the Republic of Korea between 2011 and 2020 by Health Insurance Review and Assessment Service data

<table>
<thead>
<tr>
<th>Year</th>
<th>Live birth ≥ 20 years of age</th>
<th>TMDs</th>
<th>Live birth &lt; 20 years of age</th>
<th>TMDs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Rate /100,000 people</td>
<td>Number</td>
<td>Rate /100,000 people</td>
</tr>
<tr>
<td>Total</td>
<td>10,708,093</td>
<td>920.3</td>
<td>2,836,446</td>
<td>774.9</td>
</tr>
<tr>
<td>2011</td>
<td>1,075,083</td>
<td>709.4</td>
<td>332,953</td>
<td>651.4</td>
</tr>
<tr>
<td>2012</td>
<td>1,093,757</td>
<td>759.3</td>
<td>327,950</td>
<td>674.8</td>
</tr>
<tr>
<td>2013</td>
<td>1,110,735</td>
<td>815.5</td>
<td>320,058</td>
<td>737.3</td>
</tr>
<tr>
<td>2014</td>
<td>1,132,172</td>
<td>885.4</td>
<td>314,460</td>
<td>778.1</td>
</tr>
<tr>
<td>2015</td>
<td>1,146,082</td>
<td>922.3</td>
<td>307,404</td>
<td>795.7</td>
</tr>
<tr>
<td>2016</td>
<td>1,166,504</td>
<td>973.2</td>
<td>301,529</td>
<td>813.5</td>
</tr>
<tr>
<td>2017</td>
<td>1,180,190</td>
<td>986.4</td>
<td>292,893</td>
<td>794.8</td>
</tr>
<tr>
<td>2018</td>
<td>1,197,093</td>
<td>1008.6</td>
<td>284,828</td>
<td>825.0</td>
</tr>
<tr>
<td>2019</td>
<td>807,358</td>
<td>1082.4</td>
<td>183,831</td>
<td>888.8</td>
</tr>
<tr>
<td>2020</td>
<td>799,119</td>
<td>1145.3</td>
<td>170,540</td>
<td>927.0</td>
</tr>
</tbody>
</table>

*p for trend* - - < 0.0001 - - < 0.0001

* p-value based on Cochran-Armitage trend test.

Fig. 3. Demographic characteristics of subjects diagnosed with temporomandibular joint disorders (TMDs; K07.6) under 20 from 2011 to 2020, according to Jeonbuk National University Dental Hospital data. (A) Sex, (B) Age (years).
2) Diagnosis rate

All cases diagnosed with more than one of the K07.6 subgroups were examined, allowing duplicates. Among the 3,379 cases, internal derangement of temporomandibular joint (K07.60) was the most common with 1,381 cases (40.6%), followed by masticatory muscle disorders (K07.66) with 1,126 cases (33.1%) and pain in temporomandibular joint, not elsewhere classified (K07.63) with 416 cases (12.3%; Fig. 4).

When divided into 5-year age groups, masticatory muscle disorders (K07.66) accounted for the largest percentage, with 33.3% in the 0 - 4 age group and 42.9% in the 5 - 9 age group. Conversely, internal derangement of temporomandibular joint (K07.60) accounted for the largest percentage, with 41.7% in the 10 - 14 age group and 40.8% in the 15 - 19 age group (Fig. 5).

3) Treatment pattern

Combination treatment was used in 61.1% of cases, and single treatment was used in 38.9% of cases. Physical therapy (87.7%) was the most common single treatment, followed by medication (12.0%) and occlusal appliances (0.3%). In combined treatment, physical therapy with medication (89.5%) was the most common (Fig. 6). When divided into 5-year age groups, there was no treatment in the 0 - 4 age group, while 0.7% in the 5 - 9 age group, 24.8% in the 10 - 14 age group, and 74.5% in the 15 - 19 age group. In patients over 5 years old, physical therapy was the most common, followed by medication and occlusal appliance regardless of age (Fig. 7).

Discussion

TMDs are representative musculoskeletal disorders affecting the oral and maxillofacial regions and one of the most common causes of nonodontogenic pain[18]. The association between gender and the prevalence of TMDs varies in several studies[19-21]. However, in the present study, there were 1.2-fold and 1.5-fold more females than males in the HIRA and JBNU data, respectively. The di-

![Fig. 4. Classification of K07.6 subgroups for patients under 20 from 2011 to 2020 by Jeonbuk National University Dental Hospital data. K07.6: Temporomandibular joint disorders.](image-url)
Fig. 5. Proportion rate of K07.6 subgroups for patients under 20 from 2011 to 2020 in 5-year age groups by Jeonbuk National University Dental Hospital data. K07.6: Temporomandibular joint disorders.

- K07.6 = Temporomandibular joint disorders
- K07.60 = Internal derangement of temporomandibular joint
- K07.61 = Snapping jaw
- K07.62 = Recurrent dislocation and subluxation of temporomandibular joint
- K07.63 = Pain in temporomandibular joint, not elsewhere classified
- K07.64 = Stiffness of temporomandibular joint, not elsewhere classified
- K07.65 = Degenerative joint disease of temporomandibular joint
- K07.66 = Masticatory muscle disorders
- K07.77 = Other specified temporomandibular joint disorder, not elsewhere classified
- K07.69 = Temporomandibular joint disorder, unspecified

Fig. 6. Treatment pattern of patients diagnosed with temporomandibular joint disorders under 20 from 2011 to 2020 at Jeonbuk National University Dental Hospital. P: physical therapy, M: medication, O: occlusal appliance.
agnosis rate tended to increase with age, with the largest increase in the 15 - 19 year group. This result is similar to a study by Rongo et al.[12] in which the prevalence of TMDs increased with age from childhood to adolescence, especially in females. Late adolescents may experience higher pressure from friendships and academic responsibilities than younger patients. Transitioning away from the family and to the smaller community of school also can place them in stressful environments. Such psychosocial factors contribute to the onset of TMDs and the persistence of TMD-related pain[22,23]. Furthermore, in general, females have higher sensitivity to stimuli and lower thresholds[24]. In addition, females experience more intense, numerous, and frequent physical symptoms than males, and psychological factors such as depression are more prevalent during puberty[25]. Hormones in pubescent females may play a role in the pathology of TMDs[26]. Based on these results, pediatric dentists should notice that population demographics and socio-environmental factors can influence the occurrence of TMDs.

In the HIRA data, the diagnosis rate of TMDs has increased consistently every year since 2011, both for subjects under and over 20 years of age. Yang and Kim[27] also showed an increasing trend in the diagnosis rate of TMDs when analyzed using data from HIRA between 2003 and 2005. Firstly, advancements in medical technology may have enhanced the ability to detect and diagnose TMDs. In addition, psychological factors are considered one cause of TMDs, and the recent increase in anxiety and depression may have influenced the incidence of TMDs[13,28].

However, over the 10-year period, only 0.8% of the total population under 20 years of age was diagnosed and treated with TMDs yet. This is significantly lower than the prevalence of TMDs found in a systemic review by Velesan et al.[29], who reported a diagnosis rate of 11% in children and adolescents. Kim et al.[30] also reported a prevalence of TMD-related symptoms such as pain, clicking sound, and limited mouth opening as greater than 3%. In addition, Macfarlane et al.[31] reported that approximately 60 - 70% of the population has at least
one TMD symptom, although only 5% received treatment. Treatment is based on the clinician’s judgment or patient perception of the need for treatment; however, a lack of public awareness and understanding of TMDs remains[32,33]. According to Bakke et al.[34], less than 1% of younger children are aware of the need for treatment. From this perspective, children are less likely than adults to seek treatment because treatment decisions are typically made by their caregivers rather than themselves because they are not fully cognitively developed. It is important to increase the recognition of symptoms of TMD among children, their families, and caregivers through even more active public education and encourage them to seek dental care for diagnosis.

Specifically, according to the JBNU data, only 0.2% of patients were diagnosed in the department of pediatric dentistry when analyzed based on diagnostic departments within the same population as the present study. This indicates that children and adolescents are rarely seen for diagnosis and treatment despite having symptoms of TMDs, especially in pediatric dentistry. Also, it implies insufficient detection of symptoms associated with TMDs at an early stage by pediatric dentists. Therefore, for early and accurate detection, we should include simple examinations related to TMDs such as palpation of the TMJ and masseter muscles and the range and path of mouth opening during daily check-ups[35]. In addition to examinations, it is also essential to assess parafunction and pain or discomfort around the TMJ and associated muscles thorough routine, brief questionnaires. Then, we should consult TMD-related specialists at an appropriate time if necessary. To naturally carry out this series of processes, the importance of education on TMD in pediatric dentistry specialization courses should be emphasized more than ever before.

The K07.6 subgroups were investigated further using JBNU data. Overall, both K07.60 and K07.66 were most prevalent in all ages. However, K07.66 was more prevalent in subjects under 10 years of age, and K07.60 was more prevalent in individuals over 10 years of age. Secondary mandibular growth spurts occur between 10 and 15 years of age, and cortical bone begins to form around the condyle between 12 and 14 years of age[36,37]. The timing of these events is considered responsible for the increase in pain in subjects over 10 years of age, with more frequent pain being associated with the temporomandibular joint itself rather than the muscles. In addition, differences in awareness based on age and limitations in clinical and radiologic examination may have contributed to differences in diagnosis. Therefore, it is important to establish an age-appropriate diagnostic protocol for TMDs prior to treatment. In patients over 10 years of age, a more proactive approach to panoramic radiography, cone-beam computed tomography, and arthrography of TMJ is recommended for a clear diagnosis of TMDs.

Combination treatments are generally accepted as more effective than single treatments and were 1.6-fold more prevalent in the present study. In addition, the treatment rate of occlusal appliances was gradually increased by age. Although occlusal appliance therapy is a simple, effective, and non-invasive method, it may interfere with the eruption of primary and permanent teeth[38]. The therapy also requires caution when used for growing children because the tooth changes during this period require frequent refabrication of the appliance[14]. Therefore, occlusal appliance therapy is considered one of the most commonly used treatments in the late mixed dentition and early permanent dentition when tooth eruption is almost complete[39]. Also, its long-term efficacy in late adolescents has already been proven[40]. However, unlike occlusal appliance therapy, both physical therapy and medication were actively used over 5 years old, and their effectiveness has been demonstrated in several studies[41,42]. In addition to prescription items, various home care methods are recommended, which are considered crucial for treatment[43]. For patients under 10 years old, treatment such as physical therapy, muscle training, and hot packs is recommended over appliance usage. In conclusion, we should consider the tendency for diagnosis criteria and treatment methods to vary according to age. Then, appropriate treatment should follow accordingly based on the diagnosis by using various radiographic results and

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clinical examinations.

Diagnostic criteria for TMDs are still evolving, and differences may exist in diagnosis between examiners and time periods. The diagnosis rate using the KCD is limited from previous studies because it involves multiple examiners and may include provisional diagnoses for prescription. Also, irreversible treatments were excluded in this study because reversible treatments are preferred for TMDs in children and adolescents[1]. However, the HIRA data cover a long period of 10 years and the entire country rather than a limited region. In addition, the JBNU data allowed treatment trends to be examined with a diagnosis rate, which may be a new approach to TMD research in pediatric dentistry. Notably, non-insurance items such as orthodontic treatment were examined in the present study using JBNU data, unlike in the study by Yang et al.[27] which used only HIRA data. In future studies, the overall trend of reversible and irreversible treatments as well as the detailed analysis of each treatment should be analyzed. In addition, more research with evidence-based data should be conducted on the prevalence and treatment of children with primary or mixed dentition with TMD-related pain.

Conclusion

In the present study, the trends of TMDs in children and adolescents over the last 10 years were analyzed using data from HIRA and JBNU. The diagnosis rate and treatment of TMDs in children and adolescents have been increasing but remain relatively low compared with the clinical symptoms and signs due to the characteristics associated with young age. Consequently, pediatric dentists should recognize clinical symptoms of TMDs and diagnose and treat them promptly to prevent progression to pain. In addition, additional specific procedures for diagnosing TMDs should be performed during daily routine examinations. Therefore, pediatric dentists should have a clear understanding of the symptoms associated with TMDs for early detection in children and adolescents and an appropriate time for consulting with specialists. Furthermore, continued research and efforts to establish definitions, diagnoses, and treatment standards for TMDs in children and adolescents are necessary.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

References

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