

Can malocclusion provide clinicians with information for differential diagnosis of temporomandibular joint diseases?

A review

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Abstract

The aim of this literature review was to summarize the clinical characteristics and symptoms of temporomandibular joint diseases, and to discuss the associations between temporomandibular joint diseases and categorization of malocclusion. Electronic literature searches were performed using the PubMed database. The authors established a differential diagnostic method for temporomandibular joint diseases related to malocclusion. A literature search using PubMed yielded 213 texts, of which based on exclusion criteria, 28 were included in this study. Malocclusions were categorized into 5 types. The authors suggested a diagnostic tree of temporomandibular joint diseases based on the types of malocclusion and 4 variables in clinical characteristics and symptoms. Clinicians treating malocclusions must attempt to clarify the cause of the occlusal condition. If caused by temporomandibular joint disease, it is important to make a proper differential diagnosis at first, and not to overlook the causative disease. Further clinical knowledge of associations between temporomandibular joint diseases and malocclusions should be accumulated, and the diagnostic tree should be improved based on new information.

Abbreviations: TMD = temporomandibular disorders, TMJ = temporomandibular joint.

Keywords: diagnostic tree, differential diagnosis, malocclusion, temporomandibular joint

1. Introduction

Malocclusion can be interpreted as an irregular dental arch and/or occlusion associated with congenital and acquired factors, including harmful oral habits such as digit sucking, tongue thrust, lip habit, habitual mouth breathing, and unilateral mastication habit.^[1,2] The term malocclusion indicates deep overbite, midline deviation, excessive overjet, crossbite, malalignment, space, and open bite.^[2] It is the third most prevalent oral disease after tooth decay and periodontal disease. Unilateral cases are more frequent than bilateral cases.^[3,4] It may affect esthetic appearance, occlusal function, psychosocial well-being, and health-related quality of life. Malocclusion is also defined by the World Health Organization as a handicapping dentofacial anomaly.^[1,2]

Temporomandibular joint (TMJ) diseases, including temporomandibular disorders (TMD), are closely related to malocclusion.^[3,5] Acute lateral and/or vertical malocclusion is caused

by effusions in the TMJ associated with trauma, infection, and arthritis.^[3,6,7] It has recently become possible to observe joint effusions noninvasively and accurately owing to advances in magnetic resonance imaging (MRI) technology. However, recent studies have suggested that there is no clear association between the pathophysiology of TMD and any specific type of dental occlusion. TMD is generally accepted as a multifactorial disease.^[8–11] However, a study based on MRI of patients with anterior open bite suggested that TMJ degeneration associated with displaced discs caused the development of acquired anterior open bite.^[12] Furthermore, the authors' previous study suggested that TMJ closed lock, as a condition of TMD, and related acquired anterior open bite might occur regardless of whether an occlusal splint had been used.^[13] The cause-and-effect relationship between TMD and dental occlusion is controversial topic even today. It needs to be discussed from the perspectives of both etiologies and results.^[5] Additionally, the authors report on cases of malocclusion associated with metastases to the

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TMJ. They suggest that general dentists and oral and maxillofacial surgeons should rule out the presence of malignant diseases at first by imaging examinations in cases of malocclusion that cannot easily be repositioned.^[14] The authors also report a rare case of malocclusion associated with trigeminal neuropathy caused by maxillofacial trauma.^[15] Malocclusions are caused by various TMJ diseases and conditions. These findings may be useful in the early differential diagnosis of TMJ diseases and conditions, and might provide important information about management and treatment methods for general dentists and oral and maxillofacial surgeons. There are no detailed reports on the association between TMJ diseases and types of malocclusion. Furthermore, there has been no literature review discussing their usefulness in the assessment of malocclusion in the differential diagnosis of TMJ diseases. The authors consider it important to summarize the clinical characteristics and symptoms of TMJ diseases, and to establish a differential diagnostic method for TMJ diseases, such as a diagnostic tree, for clinicians treating malocclusion.

The aim of this literature review was to summarize the clinical characteristics and symptoms of TMJ diseases, including malocclusion, and to discuss the associations between TMJ diseases and categorization of malocclusion. Based on these associations, the authors established a differential diagnostic method, namely a diagnostic tree, of TMJ diseases based on the types of malocclusion.

2. Methods

2.1. Literature search strategy

Electronic searches of PubMed (National Center for Biotechnology Information, NCBI) were performed on April 20, 2020. Literature search strategy was as follows: (((((((malocclusion[Title/Abstract]) OR occlusal abnormality[Title/Abstract]) OR abnormal occlusion[Title/Abstract]) AND temporomandibular joint[MeSH Terms]) AND English[Language]) NOT orthodontic[MeSH Terms]) NOT orthognathic[MeSH Terms]) NOT postoperative[MeSH Terms] AND (“1970”[Date - Publication]: “2019”[Date - Publication]).

2.2. Selection of studies and data extraction

The authors' literature search initially included case reports, case series, and narrative reviews where the full text was available. The literature was evaluated by 2 reviewers (SM and SM) and relevant texts were extracted.

The exclusion criteria were as follows: cases of only subjective occlusal symptoms without obvious identifiable occlusal disharmony, controlled clinical trials, cross-sectional studies, systematic reviews, and letters to editors; experimental or animal trials; reports of malocclusion after orthodontic treatment and/or dental treatment, including occlusal splints and reports of postoperative malocclusion; and literature for which the full text was unavailable.

Clinical characteristics and symptoms of TMJ diseases, including the types of malocclusions, were extracted. The authors summarized the following points: type of malocclusion involving side, acute or chronic occlusal change, pain, inflammation, swelling, and limitation of mouth opening. Methods for malocclusion diagnosis, treatment, and management were not extracted.

3. Results

By performing an electronic literature search using PubMed, 213 texts were extracted. These texts were assessed for eligibility, and 28 eligible texts were included in this study. The diseases and conditions include TMD, septic arthritis, condylar

hyperplasia, dislocation, idiopathic condylar resorption, juvenile idiopathic arthritis, rheumatoid arthritis, condylar fracture, articular disc fracture, ankylosis, chromosomal and genetic abnormalities, or congenital anomalies.

The authors categorized malocclusion associated with TMJ diseases into 5 types: posterior open bite on the affected side and/or mandibular shift toward the unaffected side, posterior open bite on the unaffected side and/or mandibular shift toward the affected side; bilateral posterior open bite; anterior open bite and/or clockwise rotation of the mandible; and others (Figs. 1 and 2. Table 1). Duplicate categorization of TMJ diseases into 5 types of malocclusion was allowed in this study. TMD, septic arthritis, condylar hyperplasia, and dislocation were grouped as “Posterior open bite on the affected side and/or mandibular shift toward the unaffected side.” TMD, idiopathic condylar resorption, juvenile idiopathic arthritis, rheumatoid arthritis, condylar fracture, articular disc fracture, ankylosis, and dislocation were grouped as “Posterior open bite on the unaffected side and/or mandibular shift toward the affected side.” Condylar hyperplasia was identified as “bilateral posterior open bite.” TMD, idiopathic condylar resorption, juvenile idiopathic arthritis, rheumatoid arthritis, condylar fracture, articular disc fracture, ankylosis, and dislocation were grouped as “anterior open bite and/or clockwise rotation of the mandible.” Chromosomal and genetic abnormalities or congenital anomalies were grouped as “Others.” Furthermore, the authors created a diagnostic tree of TMJ diseases based on types of malocclusion and 4 variables in clinical characteristics and symptoms as follows: type of malocclusion, acute or chronic occlusal change, presence or absence of pain, and presence or absence of limitation of mouth opening (Fig. 3). The details of the 5 malocclusion types are described below.

3.1. Posterior open bite on the affected side and/or mandibular shift toward the unaffected side

3.1.1. TMD (unilateral case). Increasing disc space-related thickness of the posterior band is associated with disc displacement with reduction and an inflammatory response of the TMJ component caused by malocclusion (Fig. 2A).^[3]

3.1.2. Septic arthritis (unilateral case). Septic arthritis is usually associated with head and neck infections, and occasionally with hematogenous dissemination.^[16] It causes malocclusion, trismus, pain, swelling, fever, regional lymphadenopathy, fibrosis or ankylosis, and abnormal growth.^[16] *Staphylococcus aureus* is the most common pathogen in this condition.^[16]

3.1.3. Condylar hyperplasia (unilateral case). Condylar hyperplasia is a progressive and pathologic overgrowth of the

Normal occlusal position

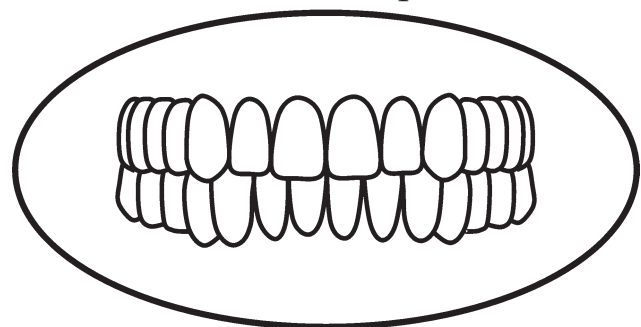


Figure 1. The normal occlusal condition without any diseases.

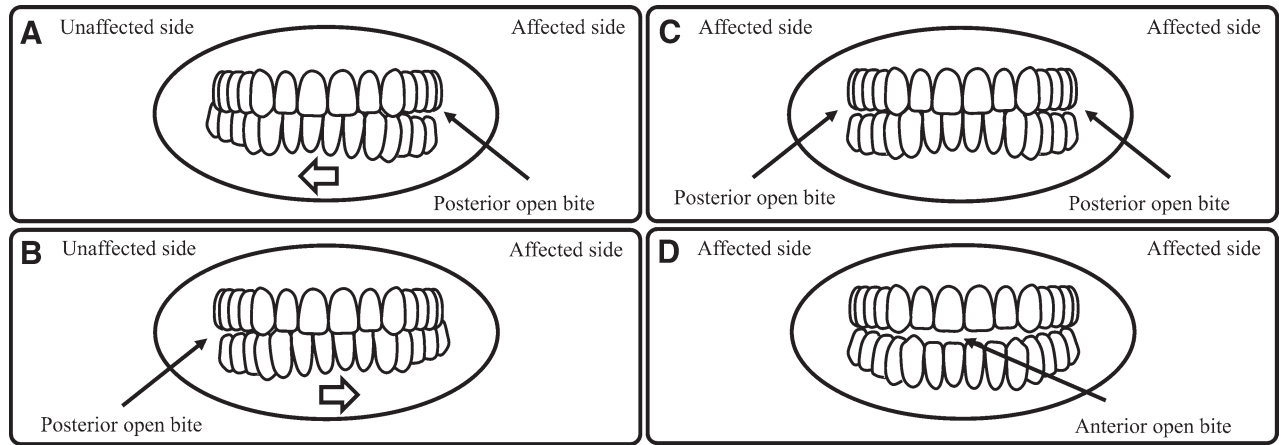


Figure 2. The 5 types of malocclusion. (A) The posterior open bite on the affected side and/or mandibular shift toward the unaffected side. (B) The posterior open bite on the unaffected side and/or mandibular shift towards the affected side. (C) The bilateral posterior open bite. (D) The anterior open bite and/or clockwise-rotation of the mandible.

mandibular condyle that can cause malocclusion and dentofacial deformity.^[17,18] It is associated with neoplasia, trauma, infection, abnormal condylar loading, hormonal influence, heredity, and aberrant growth factors.^[18] In 2014, Wolford et al suggested classification into 4 types based on clinical characteristics, imaging examination findings, and histology: Type 1 is an accelerated and prolonged aberration of normal condylar growth; Type 2 is included in condylar pathologic entities such as osteochondroma, Type 3 is included in other types of benign tumors, and Type 4 is included in malignant tumors arising from the mandibular condyle.^[17,18] Thus, Type 1 is a self-limiting condition, whereas the others do not.^[17,18]

3.1.4. Dislocation (unilateral case). Anterior dislocation commonly presents with characteristic clinical symptoms such as pain, tenderness, mouth-closing disability, speech disability, salivation, and facial deformity.^[19]

3.2. Posterior open bite on the unaffected side and/or mandibular shift toward the affected side

3.2.1. TMD (unilateral case). The TMJ condition of disc displacement without reduction causes reduced disc space and leads to heavy contact on the affected side and an open bite on the unaffected side (Fig. 2B).^[3]

3.2.2. Idiopathic condylar resorption (unilateral case). Idiopathic condylar resorption is a progressive degenerative disease of the TMJ, without specific local or systemic etiologies.^[20-22] It can cause malocclusion, dentofacial deformity, and TMJ symptoms. However, 25% of the patients had no TMJ symptoms.^[20-22]

3.2.3. Juvenile idiopathic arthritis (unilateral case). Juvenile idiopathic arthritis is the most common type of arthritis in

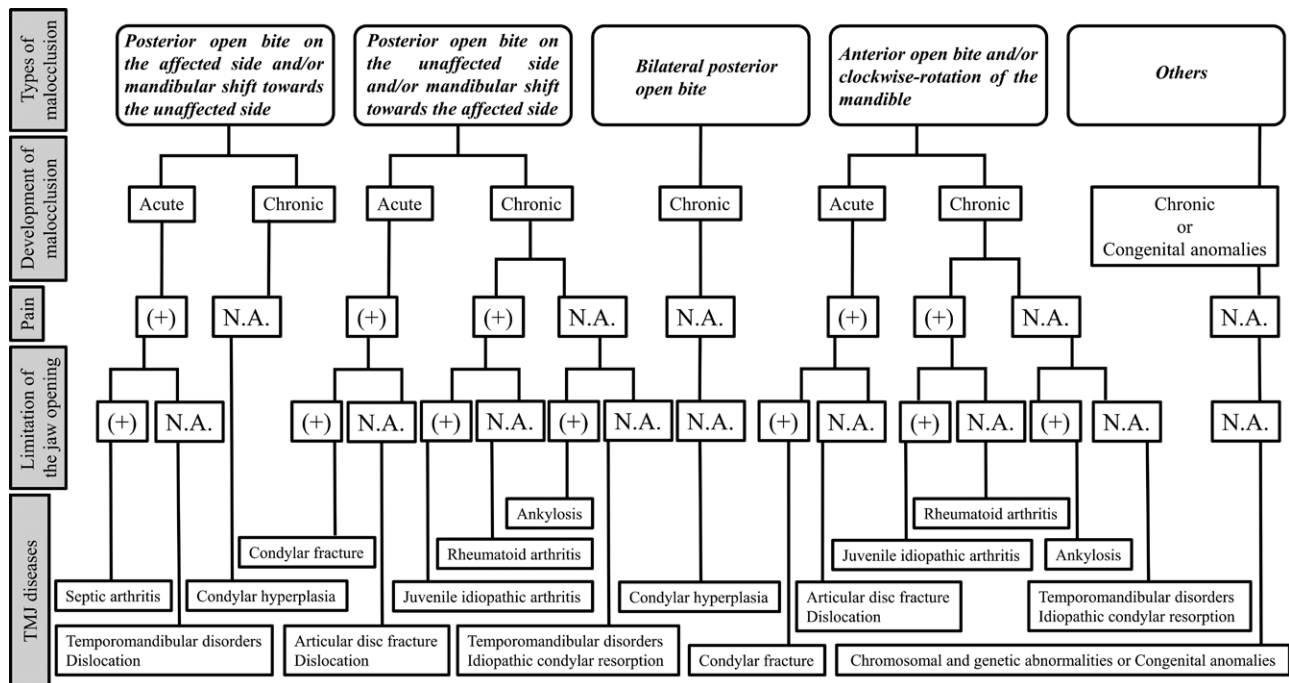


Figure 3. Diagnostic tree of TMJ diseases based on types of malocclusion, and 4 other variables of clinical characteristics and symptoms, TMJ=temporomandibular joint.

Table 1
Clinical symptoms of various temporomandibular diseases categorized with types of malocclusion.

Malocclusion		Development of malocclusion							
Temporomandibular diseases	Involving side	Pain	Inflammation	Swelling	Limitation of the mouth opening	Age	Gender	Prevalence	Other remarks
Anterior open bite on the unaffected side and/or mandibular shift towards the unaffected side									
Temporomandibular disorders ^[9]	Unilateral	(+)	(+)	Not described	Not described	Not described	Not described	Not described	There are bilateral cases.
Septic arthritis ^[16]	Unilateral	(+)	(+)	(+)	(+)	Not described	Not described	Not described	<i>S aureus</i> is the most common pathogen.
Condylar hyperplasia ^[17,18]	Unilateral	(+)/(−)	Not described	(−)	(+)/(−)	TYPE 1: Early to middle 20s TYPE 2: Second decade	TYPE 2: Female predominant (3:1)	Not described	There are bilateral cases. Wolford's classification (4 types)
Dislocation ^[19]	Unilateral	(+)	Not described	(+)	Not described	Not described	Not described	Not described	Anterior dislocation. There are bilateral cases.
Posterior open bite on the unaffected side and/or mandibular shift towards the affected side									
Temporomandibular disorders ^[9]	Unilateral	Not described	Not described	Not described	Not described	Not described	Not described	Not described	There are bilateral cases.
Idiopathic condylar resorption ^[20–22]	Unilateral	(−)	Not described	(−)	(−)	10–40 years old with a strong predominance for teenagers	Female predominant (9:1)	Not described	There are bilateral cases.
Juvenile idiopathic arthritis ^[23–27]	Unilateral	(+)	(+) Inflammation occur in one or more joint	Not described	(+)	Under 16 years old	Girls predominant (3:2)	11–80 per 100,000 children	There are bilateral cases. Malocclusion observed in 21–69%
Rheumatoid arthritis ^[26]	Unilateral	(+)	(+) Inflammation occur in one or more joint	Not described	Not described	Not described	Not described	Not described	There are bilateral cases.
Condylar fracture ^[28–33]	Unilateral	(+)	Not described	Not described	(+)	Mean age: approximately 30 years old	Male predominant	9–49% of all mandibular fractures	There are bilateral cases.
Articular disc fracture ^[34]	Unilateral	(+)	Not described	Not described	(−)	Not described	Not described	Not described	There are bilateral cases.
Ankylosis ^[35–37]	Unilateral	(+)/(−)	Not described	Not described	(+)	Not described	Not described	Not described	There are bilateral cases.
Dislocation ^[38]	Unilateral	(+)	Not described	Not described	Not described	Pediatric predominant.	Female predominant.	Not described	Upward dislocation.
Bilateral posterior open bite									
Condylar hyperplasia ^[17,18]	Bilateral	(−)	Not described	Not described	Not described	TYPE 1: Early to middle 20s	Not described	Not described	There are unilateral cases. Only TYPE 1 occur bilaterally.
Anterior open bite and/or clockwise-rotation of the mandible									
Temporomandibular disorders ^[9]	Bilateral	Not described	Not described	Not described	Not described	Not described	Not described	Not described	There are unilateral cases.
Idiopathic condylar resorption ^[20–22]	Bilateral	(−)	Not described	(−)	(−)	10–40 years old with a strong predominance for teenagers	Female predominant (9:1)	Not described	There are unilateral cases.

(Continued)

Table 1 (Continued)										
Malocclusion										
Temporomandibular diseases	Involving side	Development of malocclusion	Pain	Inflammation	Swelling	Limitation of the mouth opening	Age	Gender	Prevalence	Other remarks
Juvenile idiopathic arthritis ^[23-27]	Bilateral	Chronic	(+)	(+) Inflammation occur in one or more joint	Not described	(+)	Under 16 years old	Girls predominant (3:2)	11–80/100,000 children Occlusal abnormality observed in 21–69%	There are unilateral cases.
Rheumatoid arthritis ^[28]	Bilateral	Chronic	(+)	(+) Inflammation occur in one or more joint	Not described	Not described	Not described	Not described	Not described	There are unilateral cases.
Condylar fracture ^[29-33]	Bilateral	Acute	(+)	Not described	Not described	(+)	Mean age: approximately 30 years old	Male predominant	9–49% of all mandibular fractures	There are unilateral cases.
Articular disc fracture ^[34]	Bilateral	Acute	(+)	Not described	Not described	(-)	Not described	Not described	Not described	There are unilateral cases.
Ankylosis ^[37-39]	Bilateral	Chronic	(+)/(+)	Not described	Not described	(+)	Not described	Not described	Not described	There are unilateral cases.
Dislocation ^[19]	Bilateral	Acute	(+)	Not described	(+)	Not described	Not described	Not described	Not described	Anterior dislocation. There are unilateral cases.
Others										
Chromosomal and genetic abnormalities or congenital anomalies ^[40-42]	Not applicable	Chronic (or congenital anomalies)	Not described	Not described	Not described	Not described	Not described	Not described	Not described	A number of other clinical features

children under 16 years of age.^[23,24] It was formerly known as juvenile rheumatoid arthritis, juvenile chronic arthritis, Still disease, or juvenile chronic polyarthritis.^[25] Inflammation occurs in ≥1 joints, and almost half of the patients have at least one sign or symptom attributable to TMJ.^[26,27] Imaging examination of the TMJ reveals condylar bony changes, which lead to disturbances in dentofacial growth and mandibular function.^[23-25] It causes anterior and/or lateral open bite, trismus, decreased chewing ability, jaw and facial pain, headache, craniofacial abnormality, and jaw opening limitation.^[27]

3.2.4. Rheumatoid arthritis (unilateral case). Rheumatoid arthritis involvement in the TMJ causes malocclusion and pain, and inflammation occurs in ≥1 joints.^[26] Imaging examinations reveal condylar bony changes, which occasionally progress to ankylosis.^[26]

3.2.5. Condylar fracture (unilateral case). Condylar fracture usually relates to various accidents.^[28-30] It accounts for 9% to 49% of all mandibular fractures and causes trismus, pain, and malocclusion.^[28-33] It is associated with fibrous or bony ankylosis.^[31]

3.2.6. Articular disc fracture (unilateral case). This term indicates complete separation of the TMJ disc.^[34] It can cause mild, dull TMJ pain, and acute malocclusion, including vertical and/or lateral occlusal changes followed by mastication difficulty.^[34]

3.2.7. Ankylosis (unilateral case). Ankylosis is divided into 3 conditions: intra-articular or extra-articular, bony/fibrous, or fibro-osseous, complete, or incomplete.^[35-37] It causes malocclusion, trismus, and craniofacial abnormalities.^[35-37] It is associated with trauma, local or systemic infection, and systemic diseases such as ankylosing spondylitis, rheumatoid arthritis, and psoriasis.^[35-37]

3.2.8. Dislocation (unilateral case). There are rare cases of fracturing of the glenoid fossa with mandibular condyle dislocation into the middle cranial fossa without mandibular condyle fractures, namely upward dislocation.^[38] This can cause malocclusion, pain, trismus, facial asymmetry, cerebrospinal fluid leak, laceration of the external auditory canal, and various neurological findings.^[38]

3.3. Bilateral posterior open bite

3.3.1. Condylar hyperplasia (bilateral case). It is possible that type 1 condylar hyperplasia occurs bilaterally (Fig. 2C).^[17,18]

3.4. Anterior open bite and/or clockwise rotation of the mandible

3.4.1. TMD (bilateral case). TMD is associated with reduced mandibular ramus height, causing a clockwise rotation of the mandibular plane (Fig. 2D).^[39]

3.4.2. Idiopathic condylar resorption (bilateral case). Bilateral idiopathic condylar resorption causes malocclusion with or without an anterior open bite.^[20-22]

3.4.3. Juvenile idiopathic arthritis (bilateral case). Juvenile idiopathic arthritis usually occurs bilaterally.^[23-27]

3.4.4. Rheumatoid arthritis (bilateral case). Bony changes related to rheumatoid arthritis generally occur bilaterally.^[26]

3.4.5. Condylar fracture (bilateral case). Bilateral condylar fractures cause an anterior open bite with clockwise rotation of the mandibular plane.^[28-33]

3.4.6. Articular disc fracture (bilateral case). Bilateral cases cause an anterior open bite with clockwise rotation of the mandible.^[34]

3.4.7. Ankylosis (bilateral case). Bilateral ankylosis causes anterior open bite with clockwise rotation of the mandibular plane, limitation of jaw opening, and TMJ pain.^[35–37]

3.4.8. Dislocation (bilateral case). Bilateral dislocation causes an anterior open bite with clockwise rotation of the mandibular plane, with pain and mouth closing disturbance.^[19]

3.5. Others

3.5.1. Chromosomal and genetic abnormalities or congenital anomalies. Hemifacial microsomia is characterized by facial asymmetry associated with bone deficiency, hypoplasia, or the absence of soft tissue.^[40] Malocclusion was observed with these features.^[40]

Auriculocondylar syndrome is characterized by prominent malformed ear, condylar aplasia or hypoplasia, and a number of other features associated with auricular and oral abnormalities.^[41] Malocclusion was observed with such features.^[41]

Hallermann-Streiff syndrome is characterized by dyscephaly, short stature, bilateral microphthalmia, cataracts, hypotrichosis, and skin atrophy.^[42] Dental abnormalities, such as malocclusion, severe caries, enamel hypoplasia, supernumerary and neonatal teeth, hypodontia, and premature eruption of primary teeth, are present in 80% of patients with this syndrome.^[42]

4. Discussions

In the Diagnostic Criteria for Temporomandibular Disorders, imaging examinations were not required for the initial diagnosis of TMD. Clinical diagnoses were derived from information such as clinical characteristics and symptoms.^[43] However, medical and dental clinicians who treat malocclusion must have clinical knowledge about the relationship between TMJ diseases and characteristics, including malocclusion. However, there are no reported reviews summarizing and discussing them.

This literature review was conducted to summarize clinical knowledge, including malocclusion, described in the published literature on TMJ diseases, including TMD. The authors also set out to create a diagnostic tree of TMJ diseases based on the types of malocclusion and the clinical characteristics and symptoms of the 4 variables. This study covers malocclusion cases that were not only conscious occlusal problems, but also identifiable and obvious ones. Thus, cases of subjective occlusal symptoms without obvious identifiable occlusal disharmony, such as “phantom bite syndrome” and “occlusal discomfort syndrome,” were excluded.^[44,45] To the best of the authors’ knowledge, this is the first literature review, and the current study suggests that it is important to diagnose TMJ diseases based on clinical characteristics and symptoms, including malocclusion. The authors thought that summarizing clinical knowledge of TMJ diseases and the diagnostic tree suggested in this study might play an important role in the differential diagnosis of TMJ diseases related to malocclusion in clinical practice. Furthermore, the authors believe that these can help medical and dental clinicians treat malocclusion to avoid overlooking causative diseases. This is thought to be a breakthrough in this specialized area.

The authors suggest that malocclusion can be categorized into 5 types: posterior open bite on the affected side and/or mandibular shift toward the unaffected side; posterior open bite on the unaffected side and/or mandibular shift toward the affected side, bilateral posterior open bite, anterior open bite and/or clockwise rotation of the mandible, and others. In addition, the authors proposed a differential diagnostic method for TMJ

diseases based on 4 clinical characteristics and symptoms: type of malocclusion, acute or chronic occlusal change, presence or absence of pain, and presence or absence of limitation of mouth opening. The authors believe that the 5 types of malocclusion and the 4 clinical characteristics and symptoms provide useful information for the differential diagnosis of TMJ diseases.

Some diseases and conditions related to malocclusion, such as septic arthritis, type 4 condylar hyperplasia, and condylar dislocation into the middle cranial fossa, may lead to serious conditions, including death.^[14,17,18,38,46–49] Thus, it is important to diagnose temporomandibular joint diseases as soon as possible, and to prevent delay of treatment. TMD is widely accepted as a self-limiting condition. TMD signs and symptoms usually show a natural tendency to improve.^[50] Thus, conservative therapy is the most common treatment for TMD. Malocclusions resulting from inflammatory reactions, including those associated with joint effusion, may improve naturally. However, the authors reported that malocclusions associated with disc dislocation are occasionally observed, and these may not improve naturally.^[13] To make matters worse, they tend to appear in the chronic phase, in which mouth opening limitation improves.^[13] Therefore, the authors suggest that it is important to make proper differential diagnosis at first so as not to overlook the causative disease related to malocclusion, and recommend that clinicians set an appropriate follow-up endpoint considering the possibility of occlusal changes after improvement in TMJ diseases.

Malocclusion cases may include congenital, progressive, or serious diseases and conditions. Additionally, tooth decay, periapical lesions, and periodontal disease of deciduous and permanent teeth can occur during malocclusion. Therefore, specialists, including medical doctors, general dentists, orthodontists, oral and maxillofacial surgeons, and speech-language-hearing therapists must be involved in managing these conditions and in maintaining, restoring, and/or improving quality of life.

Regarding the limitations of this study, few studies have discussed the association between TMJ diseases and malocclusion. The authors only included 28 relevant published works in this study. Additionally, because there is little literature on malocclusion associated with TMJ diseases in humans, this review was conducted based on case reports, case series, and narrative reviews. The authors believe that further reports describing detailed information and analysis of associations between TMJ disease and malocclusion are required to avoid duplicate categorization of TMJ diseases into 5 types of malocclusion in this study. Therefore, the diagnostic tree has room for improvement. In the future, further clinical knowledge of the associations between malocclusion and causative TMJ diseases should be accumulated, and the diagnostic tree should be updated based on new information.

5. Conclusions

Clinicians treating malocclusion need to try differential diagnosis at first, and it is important that they do not overlook causative diseases. This study reviewed the relationship between malocclusion and causative TMJ diseases. The summarized information and preliminary diagnostic tree suggested in this study will be helpful for the differential diagnosis of causative TMJ disease in the future.

Author contributions

Conceptualization: Shinpei Matsuda

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Writing – review & editing: Akihito Gotouda, Hitoshi Yoshimura, Saki Mikami, Shinpei Matsuda, Taihiko Yamaguchi

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