Acquired Temporomandibular Disorders in Infants, Children, and Adolescents

Latest Revision

2019

How to Cite: American Academy of Pediatric Dentistry. Acquired temporomandibular disorders in infants, children, and adolescents. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry; 2020:410-7.

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that disorders of the temporomandibular joint (**TMJ**), masticatory muscles, and associated structures occasionally occur in infants, children, and adolescents. These recommendations are intended to assist the practitioner in the recognition and diagnosis of temporomandibular disorder (**TMD**) and to identify possible treatment options. It is beyond the scope of this document to recommend the use of specific treatment modalities.

Methods

Recommendations on acquired temporomandibular disorders in infants, children, and adolescents were developed by the Clinical Affairs Committee—Temporomandibular Joint Problems in Children Subcommittee and adopted in 1990.[1] This document by the Council of Clinical Affairs is a revision of the previous version, last revised in 2015.[2] The update included an electronic search using the terms: temporomandibular disorder, TMJ dysfunction, TMD AND adolescents, TMD AND gender differences, TMD AND occlusion, TMD AND treatment; fields: all fields; limits: within the last 15 years, humans, English, clinical trials. The reviewers agreed upon the inclusion of 104 references to support these recommendations. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Definition of TMD

TMD is a collective term for a group of musculoskeletal and neuromuscular conditions which includes several clinical signs and symptoms involving the muscles of mastication, the TMJ, and associated structures.[3] While TMD has been defined as "functional disturbances of the masticatory system",[4] some researchers and clinicians include masticatory muscle disorders,[5] degenerative and inflammatory TMJ disorders,[6] and TMJ disk displacements[5] under the umbrella of TMD.

KEYWORDS: Pediatric, Adolescents, Temporomandibular Joint, Temporomandibular Disorders, Temporomandibular Joint Dysfunction Syndrome.

Prevalence of TMD in children and adolescents

TMDs have been identified as a major cause of nonodontogenic pain in the orofacial region.[8] The reported prevalence of TMD in infants, children, and adolescents varies widely in the literature.[9-14] This variation may be due to differences in populations studied, diagnostic criteria, examination methods, and inter- and/or intra-rater variations of examining practitioners.[15,16] The Diagnostic Criteria (**DC**) TMD examination protocol is used in research settings to decrease variability in diagnosis; however, few pediatric studies use this methodology.[17,18] One study using the criteria from the DC/TMD demonstrated an 11.9 percent prevalence of TMD in adolescents.[18] Most data suggests the prevalence of signs and symptoms of TMD increases with age.[14,18,19] One investigation noted that TMD-related symptoms were rare in three- and five-year-olds whereas five to nine percent of 10- and 15-year-olds reported more severe symptoms.[19] Another study found 4.2 percent of adolescents aged 12-19 years reported TMD pain.[16] A study of children in the primary dentition found that 34 percent of patients have signs and/or symptoms of TMD.[20] This could be due, in part, to inclusion of muscular signs such as tenderness to palpation which can be difficult to assess in young children.[13,20] A systematic review and meta-analysis of intra-articular TMD in children and adolescents found a 16 percent prevalence of clinical signs and a 14 percent prevalence of TMJ sounds.[13] Although TMD pain in children increases with age in both boys and girls, recent surveys have indicated a significantly higher prevalence of symptoms and greater need for treatment in girls than boys.[14,21] The development of symptomatic TMD has been correlated with the onset of puberty in girls.[22] For ages 16-19 years, 32.5 percent of girls compared to 9.7 percent of boys reported school absences and analgesic consumption due to TMD-related pain.[21] Headaches appear to be independently and highly associated with TMD in adolescents, with most occurring before the onset of jaw pain.[23]

ABBREVIATIONS

AAPD: American Academy Pediatric Dentistry. **CBCT:** Cone-beam computed tomography. **DC:** Diagnostic criteria. **TMD:** Temporomandibular disorder. **TMJ:** Temporomandibular joint.

Etiology of TMD

Temporomandibular disorders have multiple etiological factors.[24] There is insufficient evidence to reliably predict which patients will or will not develop TMD.[25] Predisposing (risk) factors, precipitating (initiating) factors, and perpetuating (or sustaining) factors contribute to the development of TMDs.[25] The available evidence base suggests a poor correlation between any single etiological factor and resulting signs (i.e., findings identified by the dentist during the examination) and symptoms (i.e., findings reported by the child or parent).[26] Alterations in any one or a combination of teeth, periodontal ligament, the TMJ, or the muscles of mastication may lead to TMD.[26] Furthermore, systemic and psychosocial factors may reduce the adaptive capacity of the masticatory system and contribute to TMD.[27]

Etiologic factors suggested as contributing to the development of TMD are:

1. Macrotrauma: A common occurrence in childhood because of falling, chin trauma is reported to be a factor in the development of TMD in pediatric patients.[28-31] Additional macrotraumatic injuries occur due to motor vehicle accidents, sports, physical abuse, forceful intubation, and third molar extraction.[31,32] Unilateral and bilateral intracapsular or subcondylar fractures are the most common mandibular fractures in children.[33] Closed reduction and prolonged immobilization can result in ankylosis.[34,35] Improperly treated fractures may result in facial asymmetry.[34,35] Traumatic brain injury may accompany mandibular fracture and other types of jaw injuries.[31] Indirect trauma such as flexion-extension (whiplash) injuries may alter pain processing and lead to TMD symptoms; however, a direct relationship between TMD and indirect trauma has yet to be established.[27]
2. Microtrauma from parafunctional habits: Bruxism, clenching, hyperextension, and other repetitive habitual behaviors are thought to contribute to the development of TMD by joint overloading that leads to cartilage breakdown, synovial fluid alterations, and other changes within the joint.[36] Bruxism may occur while the patient is asleep or awake; sleep bruxism is a different entity from daytime bruxism. Sleep bruxism has been classified as a sleep-related movement disorder.[37] A study of 854 patients younger than 17 years old found the prevalence of bruxism to be 38 percent,[38] but studies generally do not distinguish between sleep or daytime bruxism. The literature on the association between parafunction and TMD in pediatric patients is contradictory.[39-41] However, childhood parafunction was found to be a predictor of the same parafunction 20 years later.[42] Other studies found a significant association between reported bruxism and TMD.[34,44] Children who grind their teeth were found to complain more often of pain and muscle tenderness when eating.[45] Other examples of microtrauma include repetitive strain such as playing a wind instrument, fingernail biting,[25] or another activity in which the mouth is held open outside of rest position.
3. Anatomical factors (skeletal and occlusal) and orthodontic treatment: The association of skeletal and occlusal factors and the development of TMD is relatively weak.[27,46-48] Furthermore, the available data does not support that the development of TMD is caused or improved by orthodontic treatment,[49-53] regardless of whether premolars were extracted.[32] Changes in freeway dimension of the rest position (normally two to four millimeters) may be impinged by occlusal changes, disease, muscle spasms, nervous tension, and/or restorative prosthetics.[4] While most children and adolescents may be able to compensate without problem, in others, failure of the masticatory system to adapt may lead to greater risk of dysfunction. Although there is little evidence to implicate skeletal or occlusal factors with TMD, the following have some association across studies:
    a. skeletal anterior open bite.[54,55]
    b. steep articular eminence of the temporal bone.[27]
    c. overjet greater than six to seven millimeters.[54-57]
    d. skeletal class II profile[58]
    e. class III malocclusion.[16]
    f. unilateral posterior crossbite.[46-55]
    g. posterior crossbite.[46]

    Craniocervical posture has been suggested to be associated with occlusion and with dysfunction of the TMJ, including abnormalities of the mandibular fossa, condyle, ramus, and disc.[59] Cervical pain and dysfunction can be a result of poor posture.[60] Cervical pain is frequently referred to orofacial structures and can be misinterpreted as TMD.[61]
4. Psychosocial factors: Psychosocial factors may play a part in the etiology of TMD.[61,62] Behavioral factors such as somatization, anxiety, obsessive-compulsive feelings, and psychologic stress were predictors of TMD onset.[61] Emotional stress predisposes to clenching and bruxism which in turn contribute to orofacial pain.[63] Results from a case-control study indicate that management of stress and anxiety can mitigate the signs and symptoms of TMD.[64] Depression, anxiety, post-traumatic stress disorder, psychologic distress, and sleep dysfunction may influence TMD prognosis and symptoms.[64] Higher pain intensity in the orofacial region correlated with greater impact on quality of life including difficulty with prolonged jaw opening, eating hard/soft foods, and sleeping.[64]
5. Systemic and pathologic factors: Systemic factors contributing to TMD include connective tissue diseases such as rheumatoid arthritis, systemic lupus erythematosus, juvenile idiopathic arthritis, and psoriatic arthritis.[25,65,66] These systemic diseases occur as a result of imbalance of pro-inflammatory cytokines which causes oxidative stress, free radical formation, and ultimately joint damage.[67] Other systemic factors may include joint hypermobility, genetic susceptibility, and hormonal fluctuations. Generalized joint laxity or hypermobility (e.g., Ehler Danlos

syndrome) has been cited but has a weak association with TMD.[68,69] Pathologic hyperplasia, and condylar tumors represent a unique category of TMDs.[66]

6. Genetic and hormonal factors: There is little research regarding genetic susceptibility for development of TMD. Recently, study of catechol-O-methyl-transferase haplotypes found that the presence of one low pain sensitivity haplotype decreased the risk of developing TMD.[61] The role of hormones in the etiology of TMD is debatable. Randomized controlled trials indicate that estrogen does not play a role in the etiology of TMD, whereas cohort and case-controlled studies show the opposite.[27] Although the biological basis for gender-based disparity in TMD is unclear, the time course of symptoms is of note in females. Additional studies have shown that TMJ pain and other symptoms vary in relation to phases of the menstrual cycle.[70] The suggestion of a hormonal influence in development of TMD is supported clinically by a study of 3,428 patients who sought treatment for TMD. This study revealed that 85.4 percent of patients seeking treatment were female and the peak age for treatment seeking was 33.8 years.[70] In a similar study of adolescents,[71] 15.1 percent of all patients evaluated for TMD were less than 20 years of age, and girls accounted for 89.9 percent of patients aged 15-19 seeking care and 75.5 percent of patient six-14 years of age.

Diagnosing TMD

All comprehensive dental examinations should include a screening evaluation of the TMJ and surrounding area.[72,73] Diagnosis of TMD is based upon a combination of historical information, clinical examination, and/or craniocervical and TMJ imaging.[27] The findings are classified as symptoms and signs.[72] These symptoms may include pain, headache, TMJ sounds, TMJ locking, and ear pain.[24] Certain medical conditions are reported to occasionally mimic TMD. Among these differential diagnoses are trigeminal neuralgia, central nervous system lesions, odontogenic pain, sinus pain, otological pain, developmental abnormalities, neoplasias, parotid diseases, vascular diseases, myofascial pain, cervical muscle dysfunction, and Eagle's syndrome.[8] Other common medical conditions (e.g., otitis media, allergies, airway congestion, rheumatoid arthritis) can cause symptoms similar to TMD.[24]

Clinical and physical assessment of the patient may include history and determination of joint sounds, evaluation of mandibular range of motion, appraisal of pain, evaluation for signs of inflammation, and select radiographic examination.[24] A screening history, as part of the health history, may include questions such as:[25,27]

- do you have difficulty opening your mouth?
- do you hear noises within your jaw joint?
- do you have pain in or around your ears or your cheeks?
- do you have pain when chewing, talking, or using your jaws?
- do you have pain when opening your mouth wide or when yawning?
- has your bite felt uncomfortable or unusual?
- does your jaw ever lock or go out?
- have you ever had an injury to your jaw, head, or neck? If so, when? How was it treated?
- have you previously been treated for a temporomandibular disorder? If so, when? How was it treated?

Physical assessment should include the following:[24,25,27]

1. palpation of the muscles of mastication and cervical muscles for tenderness, pain, or pain referral patterns;
2. palpation of the lateral capsule of the TMJs;
3. mandibular function and provocation tests;
4. palpation and auscultation for TMJ sounds; and
5. mandibular range of motion.

Evaluation of jaw movements including assessment of mandibular range of motion using a millimeter ruler (i.e., maximum unassisted opening, maximum assisted opening, maximum lateral excursion, maximum protrusive excursion) and mandibular opening pattern (i.e., symmetrical vs. asymmetrical) may be helpful in the diagnosis of TMD. In addition, both limited and excessive mandibular range of motion may be seen in TMD.[25,27]

TMJ imaging is recommended when there is a recent history of trauma or developing facial asymmetry, or when hard-tissue grinding or crepitus is detected.[74] Imaging should also be considered in patients who have failed to respond to conservative TMD treatment.[36] TMJ imaging assessment may include:

- panoramic radiograph;
- mandible radiographs including oblique views;
- conventional computed tomography (CT) or cone-beam computed tomography (**CBCT**);
- magnetic resonance imaging (both open and closed mouth to view disc position); and
- ultrasound.

TMJ arthography is not recommended as a routine diagnostic procedure.[75-77] The readily available panoramic radiograph is reliable for evaluating condylar head morphology and angulation but does not permit evaluation of the joint space, soft tissues, or condylar motion.[25] The panoramic radiograph may indicate osseous changes, but negative findings do not rule out TMJ pathology.[78] CBCT can be used to detect boney abnormalities and fractures and to assess asymmetry,[76-78] but it generates a much higher radiation burden than the panoramic image. Magnetic resonance imaging provides visualization of soft tissues, specifically the position and contours of the TMJ disc, and can be used to detect inflammation.[25,74,77] Ultrasound is a noninvasive imaging method for viewing superficial lateral aspects of the TMJ.[79]

TMD has been divided into two broad categories, TMJ disorders and masticatory muscles disorders,[77] which are listed below.

I. TMJ disorders:
   A. joint pain:
      1. arthralgia.
      2. arthritis.
   B. joint disorders:
      1. disc-condyle complex disorders (disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction with limited opening, disc displacement without reduction without limited opening).
      2. hypomobility disorders (ankylosis, bony ankylosis, fibrous adhesions).
      3. hypermobility disorders (subluxation, luxation).
   C. joint diseases:
      1. osteoarthritis (degenerative joint disease, condylysis/idiopathic condylar resorption, osteochondritis dissecans, osteonecrosis).
      2. systemic arthritides such as rheumatoid arthritis, idiopathic juvenile arthritis, spondyloarthropathies, psoriatic arthritis, infections arthritis, Reiter syndrome, and crystal induced disease.
      3. neoplasms.
      4. fractures (open and closed condylar and subcondylar).
II. Masticatory muscle disorders:
   A. muscle pain limited to orofacial region (myalgia, myofascial pain with spreading, myofascial pain with referral, tendonitis, myositis, spasm).
   B. muscle pain due to systemic/central disorders (centrally mediated myalgia, fibromyalgia).
   C. movement disorders (dyskinesia, dystonia).
   D. other muscle disorders (contracture, hypertrophy, neoplasm).

Treatment of TMD

The goals of TMD treatment include restoration of function, decreased pain, decreased aggravating or contributing factors, and improved quality of life.[80,81] Few studies document success or failure of specific treatment modalities for TMD in infants, children, and adolescents on a long-term basis. It has been suggested that simple, conservative, and reversible types of therapy are effective in reducing most TMD symptoms in children.[81,82] The focus of treatment should be to find a balance between active and passive treatment modalities. Active modalities include participation of the patient whereas passive modalities may include wearing a stabilization splint. In a randomized trial, adolescents undergoing occlusal appliance therapy combined with information attained a clinically significant improvement on the pain index.[83] Combined approaches may be more successful in treating TMD than single treatment modalities.[81]

Treatment of TMD can be divided into reversible and irreversible treatment. Reversible therapies may include:

- patient education (e.g., explanation in clear and simple terms describing the nature of the disorder, the significance of predisposing, precipitating, and perpetuating factors, anatomy of the TMJ, management options, and goals of therapy).[27,81]
- physical therapy (e.g., jaw exercises or transcutaneous electrical nerve stimulation [TENS], ultrasound, iontophoresis, massage, TMJ distraction and mobilization, thermotherapy, coolant therapy).[27,36,81,84-86]
- behavioral therapy (e.g., biofeedback, relaxation training, cognitive behavioral therapy [CBT]) for developing behavior coping strategies and modifying perceptions about TMD, habit reversal and awareness of daytime clenching and bruxing, avoiding excessive chewing of hard foods or gum, voluntary avoidance of stressors, treatment of co-morbid behavioral health conditions, obtaining adequate, uninterrupted sleep).[36,81,86]
- prescription medication (e.g., non-steroidal anti-inflammatory drugs, anxiolytic agents, muscle relaxers). While antidepressants have proved to be beneficial, they should be prescribed by a practitioner familiar with pain management.[27,36,81,87]
- occlusal splints. The goal of an occlusal appliance is to provide orthopedic stability to the TMJ. These alter the patient's occlusion temporarily and may be used to decrease parafunctional activity and pain.[83,88-90] Occlusal splints may be made of hard or soft acrylic. The stabilization type of splint covers all teeth on either the maxillary or mandibular arch and is balanced so that all teeth are in occlusion when the patient is closed and the jaw is in a musculoskeletally stable position.[8,36]

Additional reversible therapies may include TMJ arthrocentesis, TMJ injections, nerve blocks, acupuncture, trigger point injections, and off-label use of botulinum toxin A injections.[91-95]

Irreversible therapies can include:

- occlusal adjustment (i.e., permanently altering the occlusion or mandibular position by selective grinding or full mouth restorative dentistry).[96] A systematic review and meta-analysis demonstrated that occlusal alteration seems to have no effect on TMD.[97]
- orthodontics. This may include mandibular positioning devices designed to alter the growth or permanently reposition the mandible (e.g., headgear, functional appliances). There is little evidence that orthodontic treatment can prevent or relieve TMD.[27,98,99]
- surgery. Surgical interventional includes orthognathic surgery, open joint TMJ surgery to removed diseased synovium, and TMJ reconstruction.[66] Data suggests surgery is limited in most situations to cases of severe joint degeneration or destruction following trauma or tumor resection.[66,81,100]

Controversy surrounds the significance of signs and symptoms in children and adolescents, the value of certain diagnostic procedures, and what constitutes appropriate therapy.[58,101,102] It is not clear whether these signs and symptoms constitute

normal variation, preclinical features, or manifestations of a disease state.[103] Whether these signs and symptoms warrant treatment as predictors of TMD in adulthood is questionable.[42,103]

Recommendations

Every comprehensive dental history and examination should include a TMJ history and assessment.[73] The history should include questions concerning the presence of head and neck pain and mandibular dysfunction, previous orofacial trauma, and history of present illness with an account of current symptoms.[102] In the presence of a positive history and/or signs and symptoms of TMD, a more comprehensive examination (e.g., palpation of masticatory and associated muscles and the TMJ's, documentation of joint sounds, occlusal analysis, and assessment of range of mandibular movements including maximum opening, protrusion, and lateral excursions) should be performed.[102] Joint imaging may be recommended in some cases[74] Referral should be made to other health care providers, including those with expertise in TMD, oral surgery, or pain management, when the diagnostic and/or treatment needs are beyond the treating dentist's scope of practice.[27]

Reversible therapies should be considered for children and adolescents with signs and symptoms of TMD.[83,104] Because of inadequate data regarding their effectiveness, irreversible therapies should be avoided.[83,96,99] Referral to a medical specialist may be indicated when primary headaches, otitis media, allergies, abnormal posture, airway congestion, rheumatoid arthritis, connective tissue disease, psychiatric disorders, or other medical conditions are suspected.

References

1. American Academy of Pediatric Dentistry. Guidelines for temporomandibular disorders in children and adolescents. Chicago, Ill.: American Academy of Pediatric Dentistry; 1990.
2. American Academy of Pediatric Dentistry. Acquired temporomandibular disorders in infants, children, and adolescents. Pediatr Dent 2015;37(special issue):272-8.
3. deLeeuw R, Klasser GD. Diagnostic classification of orofacial pain. In: Orofacial Pain: Guidelines Assessment, Diagnosis, and Management. 6th ed. Hannover Park, Ill.: Quintessence Publishing; 2018:57.
4. Okeson J. Etiology of functional disturbances in the masticatory system. In: Management of Temporomandibular Disorders and Occlusion. 8th ed. St. Louis, Mo.: Elsevier Mosby, Inc.; 2020:102-23.
5. Stohler CS. Clinical perspectives on masticatory and related muscle disorders. In: Sessle BJ, Bryant PS, Dionne RA, eds. Temporomandibular Disorders and Related Pain Conditions. Vol 4. Seattle, Wash.: International Association for the Study of Pain Press; 1995:3-30.
6. Kopp S. Degenerative and inflammatory temporomandibular joint disorders. In: Sessle BJ, Bryant PS, Dionne RA, eds. Temporomandibular Disorders and Related Pain Conditions. Vol 4. Seattle, Wash.: International Association for the Study of Pain Press; 1995:119-32.
7. Dolwich MF. Temporomandibular joint disk displacement. In: Sessle BJ, Bryant PS, Dionne RA, eds. Temporomandibular Disorders and Related Pain Conditions. Vol. 4. Seattle, Wash.: International Association for the Study of Pain Press; 1995:79-113.
8. Okeson JP. Temporomandibular joint pains. In Bell's Oral and Facial Pain, 7th edition. Chicago, Ill.: Quintessence Publishing; 2014:327-69.
9. Alamoudi N, Farsi N, Salako N, Feteih R. Temporomandibular disorders among school children. J Clin Pediatr Dent 1998;22(4):323-9.
10. List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: Prevalence of pain, gender differences, and perceived treatment need. J Orofac Pain 1999;13(1):9-20.
11. Paesani D, Salas E, Martinez A, Isberg A. Prevalence of temporomandibular joint disk displacement in infants and young children. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87(1):15-9.
12. Al-Khotani A, Naimi-Akbar A, Albadawi E, Ernberg M, Hedenberg-Magnuson B. Prevalence of diagnosed temporomandibular disorders among Saudi Arabian children and adolescents. J Headache Pain 2016;17(41):1-11.
13. da Silva CG, Pacheco-Pereira C, Porporatti AL, et al. Prevalence of clinical signs of intra-articular temporomandibular disorders in children and adolescents: A systematic review and meta-analysis. J Am Dent Assoc 2016;147(1):10-8.
14. HongXing L, Anstrom AN, List T, Nilsson IM, Johansson A. Prevalence of temporomandibular disorder pain in Chinese adolescents compared to an age-matched Swedish population. J Oral Rehabil 2016;43(4):241-8.
15. Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temoporomandibular disorders: A systematic review of axis I epidemiologic findings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112(4):453-62.
16. Nilsson IM. Reliability, validity, incidence and impact of temporomandibular pain disorders in adolescents. Swed Dent J Suppl 2007;(183):7-86.
17. Schiffman E, Ohrbach R, Truelove E, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache 2014;28(1):6-27.
18. Graue AM, Jokstad A, Assmus J, Skeie MS. Prevalence among adolescents in Bergen, Western Norway, of temporomandibular disorders according to the DC/TMD criteria and examination protocol. Acta Odontol Scand 2016;74 (6):449-55.
19. Köhler AA, Helkimo AN, Magnusson T, Hugoson A. Prevalence of symptoms and signs indicative of temporomandibular disorders in children and adolescents. A cross-sectional epidemiological investigation covering two decades. Euro Arch Paediatr Dent 2009;10(1):16-25.

20. Bonjardim LR, Gavião MB, Carmagnani FG, Pereira LF, Castelo PM. Signs and symptoms of temporomandibular joint dysfunction in children with primary dentition. J Clin Pediatr Dent 2003;28(1):53-8.
21. Nilsson IM, Drangholt M, List T. Impact of temporomandibular disorder pain in adolescents: Differences by age and gender. J Orofac Pain 2009;23(2):115-22.
22. Song YL, Yap AU, Turp JC. Association between temporomandibular disorders and pubertal development: A systematic review. J Oral Rehabil 2018;45(12):1007-15. Available at: "https://doi.org/10.1111/joor.12704". Accessed August 10, 2019.
23. Nilsson IM, List T, Drangsholt M. Headache and comorbid pains associated with TMD pain in adolescents. J Dent Res 2013;92(9):802-7.
24. Brecher E, Stark TR, Christensen JR, Sheats RD. Examination, diagnosis, and treatment planning for general and orthodontic problems. In: Nowak AJ, Christensen, JR, Mabry TR, Townsend JA, Wells MH, eds. Pediatric Dentistry Infancy through Adolescence. 6th ed. Philadelphia, Pa.: Elsevier Inc.; 2019:562-87.
25. Howard JA. Temporomandibular joint disorders in children. Dent Clin North Am 2013;57(1):99-127.
26. Horswell BB, Sheikh J. Evaluation of pain syndromes, headache, and temporomandibular joint disorders in children. Oral Maxillofac Surg Clin North Am 2018;30 (1):11-24.
27. deLeeuw R, Klasser. Differential Diagnosis and Management of TMDs. In Orofacial Pain: Guidelines, Assessment, Diagnosis, and Management. 6th ed. Hannover Park, Ill.: Quintessence Publishing; 2018:144-207.
28. Greco CM, Rudy TE, Turk DC, Herlich A, Zaki HH. Traumatic onset of temporomandibular disorders: Positive effects of a standardized conservative treatment program. Clin J Pain 1997;13(4):337-47.
29. Fischer DJ, Mueller BA, Critchlow CW, LeResche L. The association of temporomandibular disorder pain with history of head and neck injury in adolescents. J Orofac Pain 2006;20(3):191-8.
30. Imahara SD, Hopper RA, Wang J, Rivara FP, Klein MB. Patterns and outcomes of pediatric facial fractures in the United States: A survey of the National Trauma Data Bank. J Am Coll Surg 2008;207(5):710-6.
31. Bae SS, Aronovich S. Trauma to the pediatric temporomandibular joint. Oral Maxillofacial Surg Clin North Am 2018;30(1):47-60.
32. Akhter R, Hassan NM, Ohkubo R, et al. The relationship between jaw injury, third molar removal, and orthodontic treatment and TMD symptoms in university students in Japan. J Orofac Pain 2008;22(1):50-6.
33. Leuin SC, Frydendall E, Gao D, Chan KH. Temporomandibular joint dysfunction after mandibular fracture in children: A 10-year review. Arch Otolarygol Head Neck Surg 2011;137(1):10-14.
34. Kaban L. Acquired abnormalities of the temporomandibular joint. In: Kaban LB, Troulis MJ, eds. Pediatric Oral and Maxillofacial Surgery. Philadelphia, Pa.: WB Saunders; 2004:340-76.
35. Güven O. A clinical study on temporomandibular joint ankylosis in children. J Craniofac Surg 2008;19(5):1263-9.
36. Dym H, Israel H. Diagnosis and treatment of temporomandibular disorders. Dent Clin North Am 2012;56(1): 149-61.
37. American Academy of Sleep Medicine. Sleep related bruxism. In: International Classification of Sleep Disorders. Diagnosis and Coding Manual, 3rd ed. Westchester, Ill.: American Academy of Sleep Medicine; 2014:182-5.
38. Cheifetz AT, Osganian SK, Allred EN, Needleman HL. Prevalence of bruxism and associated correlates in children as reported by parents. J Dent Child 2005;72(2): 67-73.
39. Barbosa Tde S, Miyakoda LS, Pocztaruk Rde L, Rocha CP, Gavião MBD. Temporomandibular disorders and bruxism in childhood and adolescence: Review of the literature. Int J Pediatr Otorhinolaryngol 2008;72(3): 299-314.
40. Castelo PM, Gavião MB, Pereira LJ, Bonjardim LR, Gavião MBD. Relationship between oral parafunctional/nutritive sucking habits and temporomandibular joint dysfunction in primary dentition. Int J Paediatr Dent 2005;15(1): 29-36.
41. Winocur E, Gavish A, Finkelshtein T, Halachmi M, Gazit E. Oral habits among adolescent girls and their association with symptoms of temporomandibular disorders. J Oral Rehabil 2001;28(7):624-9.
42. Carlsson GE, Egermark I, Magnusson T. Predictors of signs and symptoms of temporomandibular disorders: A 20-year follow-up study from childhood to adulthood. Acta Odontol Scand 2002;60(3):180-5.
43. Magnusson T, Egermarki I, Carlsson GE. A prospective investigation over two decades on signs and symptoms of temporomandibular disorders and associated variables. A final summary. Acta Odontol Scand 2005;63(2):99-109.
44. Gesch D, Bernhardt O, Mack F, John U, Kocher T, Dietrich A. Association of malocclusion and functional occlusion with subjective symptoms of TMD in adults: Results of the Study of Health in Pomerania (SHIP). Angle Orthod 2005;75(2):183-90.
45. Alamoudi N. Correlation between oral parafunction and temporomandibular disorders and emotional status among Saudi children. J Clin Pediatr Dent 2001;26(1):71-80.
46. Turp JC, Schindler H. The dental occlusion as a suspected cause for TMD: Epidemiological and etiological considerations. J Oral Rehab 2012;39(7):502-12.
47. De Boever JA, Carlsson GE, Klineberg IJ. Need for occlusal therapy and prosthodontic treatment in the management of temporomandibular disorders. Part I. Occlusal interference and occlusal adjustment. J Oral Rehabil 2000;27(5):367-79.

48. Taskaya-Yilmaz N, Öğütcen-Toller M, Saraç YŞ. Relationship between the TMJ disc and condyle position on MRI and occlusal contacts on lateral excursions in TMD patients. J Oral Rehab 2004;31(8):754-8.
49. Henrikson T, Nilner M. Temporomandibular disorders, occlusion and orthodontic treatment. J Orthod 2003; 30(2):129-37; discussion 127.
50. Egermark I, Carlsson GE, Magnusson T. A prospective long-term study of signs and symptoms of temporomandibular disorders in patients who received orthodontic treatment in childhood. Angle Orthod 2005;75(4): 645-50.
51. Henrikson T, Nilner M, Kurol J. Symptoms and signs of temporomandibular disorders before, during and after orthodontic treatment. Swed Dent J 1999;23(5-6):193-207.
52. Henrikson T, Nilner M, Kurol J. Signs of temporomandibular disorders in girls receiving orthodontic treatment. A prospective and longitudinal comparison with untreated Class II malocclusions and normal occlusion subjects. Eur J Orthod 2000;22(3):271-81.
53. Kim MR, Graber TM, Viana MA. Orthodontics and temporomandibular disorder: A meta-analysis. Am J Orthod Dentofac Orthop 2002;121(5):438-46.
54. Bilgic F, Gelgor IE. Prevalence of temporomandibular dysfunction and its association with malocclusion in children: An epidemiologic study. J Clin Pediatr Dent 2017;41(2):161-5.
55. Thilander B, Rubio G, Pena L, De Mayorga C. Prevalence of temporomandibular dysfunction and its association with malocclusion in children and adolescents: An epidemiologic study related to specified stages of dental development. Angle Orthod 2002;72(2):146-54.
56. Phillips JT. What skeletal and dental characteristics do TMD patients have in common? Funct Orthod 2007;24 (1):24-6, 28, 30.
57. Pahkala R, Qvarnström M. Can temporomandibular dysfunction signs be predicted by early morphological or functional variables? Euro J Orthod 2004;26(4):367-73.
58. Manfredini D, Segu M, Arveda N, et al. Temporomandibular joint disorder in patients with different facial morphology. A systematic review of the literature. J Oral Maxillofac Surg 2016;74(1):29-46.
59. Sonnensen L, Bakke M, Solow B. Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment. Eur Orthod 2001;23(2):179-92.
60. Budelmann K, von Piekartz H, Hall T. Is there a difference in head posture and cervical spine movement in children with and without pediatric headache? Eur J Pediatr 2013; 172(10):1349-56.
61. Fillingim RB, Ohrbach R, Greenspan JD, et al. Potential psychosocial risk factors for chronic TMD: Descriptive data and empirically identified domains from the OPPERA case-control study. J Pain 2011;12(11 Suppl): T46-60.
62. List T, Wahlund K, Larsson B. Psychosocial functioning and dental factors in adolescents with temporomandibular disorders: A case-control study. J Orofac Pain 2001;15(3): 218-27.
63. Barbosa TS, Castelo PM, Leme MS, et al. Association between sleep bruxism and psychosocial factors in children and adolescents: A systematic review. Clin Pediatrics 2012;18(7):469-78.
64. Karibe H, Goddard G, Aoyagi K, et al. Comparison of subjective symptoms of temporomandibular disorders in young patients by age and gender. Cranio 2012;30(2): 114-20.
65. Granquist EJ. Treatment of the temporomandibular joint in a child with juvenile idiopathic arthritis. Oral Maxillofac Surg Clin North Am 2018;30(1):97-107.
66. Choinard AF, Kaban LB, Peacock ZS. Acquired abnormalities of the TMJ. Oral Maxillofac Surg Clin North Am 2018;30(1):83-96.
67. Milam SB, Zardeneta G, Schmitz JP. Oxidative stress and degenerative temporomandibular joint disease: A proposed hypothesis. J Oral Maxillfac Surg 1998;56(2): 214-33.
68. Buckinham RB, Braun T, Harinstein DA, et al. Temporomandibular joint dysfunction syndrome: A close association with systemic joint laxity (the hypermobile joint syndrome). Oral Surg Oral Med Oral Pathol 1991;72(5): 514-9.
69. Magnusson T, Carlsson GE, Egermark I. Changes in clinical signs of craniomandibular disorders from the age of 15 to 25 years. J Orofac Pain 1994;8(2):207-15.
70. LeResche L, Manci L, Sherman JJ, Gandara B, Dworkin SF. Changes in temporomandibular pain and other symptoms across the menstrual cycle. Pain 2003;106(3): 253-61.
71. Nilsson IM, List T, Drangsholt M. Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. J Orofac Pain 2005;19(2):144-50.
72. Dean JA. Examination of the mouth and other relevant structures. McDonald and Avery's Dentistry for the Child and Adolescent. 10th ed. St. Louis, Mo.: Elsevier Inc.; 2016:5-7.
73. American Academy of Pediatric Dentistry. Record keeping. Pediatr Dent 2018;40(6):401-8.
74. Hammer MR, Kanaan Y. Imaging of the pediatric TMJ. Oral Maxillofacial Surg Clin North Am 2018;30(1):25-34.
75. Loos PJ, Aaron GA. Standards for management of the pediatric patient with acute pain in the temporomandibular joint or muscles of mastication. Pediatr Dent 1989; 11(4):331.
76. Brooks, SL, Brand JW, Gibbs SJ, et al. Imaging of the temporomandibular joint: A position paper of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1997; 83(5):609-18.

77. DeSenna BR, dos Santos S, Franca JP, Marques LS, Pereira LJ. Imaging diagnosis of the temporomandibular joint: Critical review of indications and new perspectives. Oral Radiol 2009;25(2):86-98.
78. Hunter A, Kalathingal S. Diagnostic imaging for temporomandibular disorders and orofacial pain. Dent Clin North Am 2013;57(3):405-18.
79. Katzburg RW Conway WF, Ackerman SJ, et al. Pilot study to show the feasibility of high-resolution sagittal ultrasound imaging of the TMJ. J Oral Maxillofac Surg 2017; 75(6):1151-62.
80. Svensson P, Sharav Y, Benoleil R. Myalgia myofascial pain, tension type headaches and fibromyalgia. In: Sharav Y, Benoliel R, eds. Orofacial Pain and Headache, 2nd ed. Handover Park, Ill.: Quintessence; 2015:302-99.
81. Scrivani SJ, Khawaja SN, Bavia PF. Nonsurgical management of pediatric temporomandibular joint dysfunction. Oral Maxillofac Surg Clin North Am 2018;30(1): 35-45.
82. Bodner L, Miller VJ. Temporomandibular joint dysfunction in children: Evaluation of treatment. Int J Pediatr Otorhinolaryngol 1998;44(2):133-7.
83. Wahlund K, List T, Larsson B. Treatment of temporomandibular disorders among adolescents: A comparison between occlusal appliance, relaxation training, and brief information. Acta Odontol Scand 2003;61(4):203-11.
84. Mina R, Melson P, Powell S, et. al. Effectiveness of dexamethasone iontophoresis for temporomandibular joint involvement in juvenile idiopathic arthritis. Arthritis Care Res(Hoboken) 2011;63(11):1511-6.
85. Medlicott, MS, Harris SR. A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training, and biofeedback in the management of temporomandibular disorder. Phys Ther 2006;86(7): 955-73.
86. Crider AB, Glaros AG. A meta-analysis of EMG biofeedback treatment of temporomandibular disorders. J Orofac Pain 1999;13(1):29-37.
87. List T, Axelsson S, Leijon G. Pharmacologic interventions in the treatment of temporomandibular disorders, atypical facial pain, and burning mouth syndrome. A qualitative systematic review. J Orofac Pain 2003;17(4):301-10.
88. Wahlund K, Larsson B. Long-term treatment outcome for adolescents with temporomandibular pain. Acta Odontol Scand 2018;76(3):153-60.
89. Simmons HC III, Gibbs SJ. Anterior repositioning appliance therapy for TMJ disorders: Specific symptoms relieved and relationship to disk status on MRI. Cranio 2005;23(2):89-99.
90. Fujii T, Torisu T, Nakamura S. A change of occlusal conditions after splint therapy for bruxers with and without pain in the masticatory muscles. Cranio 2005;23(2): 113-8.
91. Olsen-Bergem H, Bjornland T. A cohort study of patients with JIA and arthritis of the TMJ: Outcome of arthrocentesis with and without the use of steroids. Int J Oral Maxillofac Surg 2014;43(8):990-5.
92. Arabshahi, B, Dewitt EM, Cahill AM, et al. Utility of corticosteroid injection for tempomandibular arthritis in children with juvenile idiopathic arthritis. Arthritis Rheum 2005;52(11):3563-9.
93. Szperka CL, Gelfand AA, Hershey AD. Pattern of use of peripheral nerve blocks and trigger point injections for pediatric headache; Results of a survey of the American Headache Society Pediatric and Adolescent Section. Headache 2016;56(10):1597-607.
94. Fernandez AC, Duarte Moura DM, Da Silva, et al. Acupuncture in temporomandibular disorder myofascial pain treatment: A systematic review. J Oral Facial Pain Headache 2017;31(3):225-32.
95. Stark TR, Perez CV, Okeson JP. Recurrent TMJ dislocation managed with botulinum toxin type A injections in a pediatric patient. Pediatr Dent 2015;37(1):65-9.
96. Koh H, Robinson PG. Occlusal adjustments for treating and preventing temporomandibular joint disorders. J Oral Rehabil 2004;31(4):287-92.
97. List T, Axelsson S. Management of TMD: Evidence from systematic review and meta-analysis. J Oral Rehabil 2010; 37(6):430-51.
98. Jimenez-Silva A, Carnevali-Arellano R, Venegas-Aguilera M, Reyes-Tobar J, Palomino-Montenegro H. Temporomandibular disorders in growing patients after treatment of class II and III malocclusion with orthopaedic appliances: A systematic review. Acta Odontol Scand 2018; 76(4):262-73.
99. Rey D, Oberti G, Baccetti T. Evaluation of temporomandibular disorders in Class III patients treated with mandibular cervical headgear and fixed appliances. Am J Orthod Dentofacial Orthop 2008;133(3):379-81.
100. Resnic CM. Temporomandibular joint reconstruction in the growing child. Oral Maxillofac Surg Clin North Am 2018;30(1):109-21.
101. Manfredini D, Colcilovo F, Stellini E, Favero L, Guarda-Nardini L. Surface electromyography findings in unilateral myofascial pain patients: Comparison of painful vs. non painful sides. Pain Med 2013;14(2):1848-53.
102. Sharav Y, Benoleil R. The diagnostic process. In: Orofacial Pain and Headache, 2nd ed. Handover Park Ill.: Quintessence; 2015:16-54.
103. Fernandes G, van Selms MK, Goncalves Da, Lobbezoo F, Campariss CM. Factors associated with temporomandibular disorders pain in adolescents. J Oral Rehabil 2015;42(2):113-9.
104. Wahlund K, Larsson B. Predictors of clinically significant outcome for adolescents with temporomandibular disorders. Oral Facial Pain Headache 2017;31(3):217-24.