Narrative Review

Temporomandibular disorders. Part 1: anatomy and examination/diagnosis

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Temporomandibular disorders (TMD) are a heterogeneous group of diagnoses affecting the temporomandibular joint (TMJ) and surrounding tissues. A variety of methods for evaluating and managing TMD have been proposed within the physical therapy profession but these sources are not peer-reviewed and lack updates from scientific literature. The dental profession has provided peer-reviewed sources that lack thoroughness with respect to the neuromusculoskeletal techniques utilized by physical therapists. The subsequent void creates the need for a thorough, research informed, and peer-reviewed source regarding TMD evaluation and management for physical therapists. This paper is the first part in a two-part series that seeks to fill the current void by providing a brief but comprehensive outline for clinicians seeking to provide services for patients with TMD. Part one focuses on anatomy and pathology, arthro- and osteokinematics, epidemiology, history taking, and physical examination as they relate to TMD. An appreciation of the anatomical and mechanical features associated with the TMJ can serve as a foundation for understanding a patient's clinical presentation. Performance of a thorough patient history and clinical examination can guide the clinician toward an improved diagnostic process.

Keywords: Diagnosis, Physical examination, Review, Temporomandibular joint disorders

The temporomandibular joint (TMJ) has long since been established as a source of pathology[1] but did not become a central focus of research until the 1980s.[2] Collectively, pathoanatomical dysfunctions of the TMJ have been defined as temporomandibular disorders (TMD). Currently, both dentists and physical therapists provide patient services for TMD.

A variety of methods for evaluating and managing TMD have been proposed within the physical therapy profession.[3–8] These sources are not peer-reviewed and lack updates from scientific literature. The dental profession has provided peer-reviewed sources that lack thoroughness with respect to the neuromusculoskeletal techniques utilized by physical therapists.[9–13] The subsequent void creates the need for a thorough, research informed, and peer-reviewed source regarding TMD evaluation and management for physical therapists.

The purpose of this paper is to provide the reader with clarity through: (1) a review of relevant anatomy and epidemiology; (2) a presentation of the examination process; and (3) a discussion regarding differential diagnosis. A second manuscript (part two of this series) will examine strategies appropriate for the management of TMD.

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Review of Anatomy

The TMJ is located just anterior to the external auditory meatus, consists superiorly of the temporalis bone and inferiorly of the mandible, contains an intraarticular disk within the joint capsule, and its contractile tissues are the muscles of mastication. Figures 1 and 2 provide superficial and deep views of TMJ anatomy, respectively. The mandibular condyle and glenoid fossa of the temporalis bone form the foundation of the TMJ.[14] A biconcave intraarticular disk divides the joint into upper (discotemporal) and lower (discomandibular) joint spaces. Under normal circumstances the mandibular condyle can have variable shapes[15] and can be asymmetrical side-to-side. Condyle shapes have been previously described as convex, flat, angular, and rounded.[16] During childhood, the mandibular condyle undergoes significant changes in size and shape.[17] Under pathological circumstances, mandibular condyle shape can vary to greater extents. Certain mandibular abnormalities are only visible upon imaging or entry into the joint whereas others are profound enough to cause distortion of facial features. One classification

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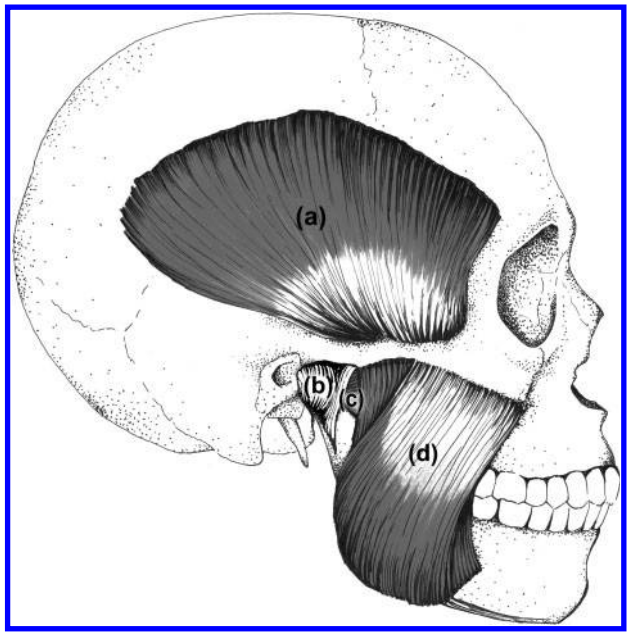

Figure 1 Superficial view of temporomandibular joint (TMJ) anatomy. (a) temporalis muscle, (b) temporomandibular ligament, (c) lateral pterygoid muscle, and (d) masseter muscle. © Jennifer Lenox.

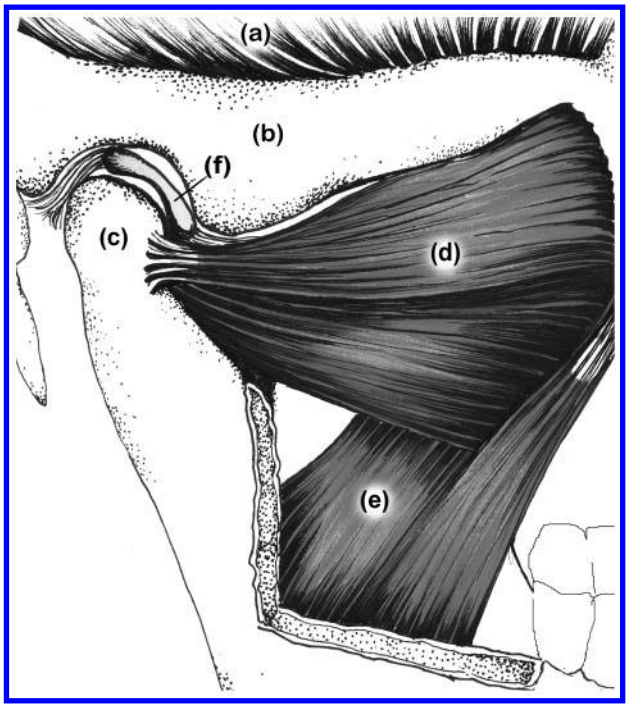

Figure 2 Deep view of temporomandibular joint (TMJ) anatomy. (a) temporalis muscle, (b) temporalis bone, (c) mandibular condyle, (d) lateral pterygoid muscle, (e) medial pterygoid muscle, and (f) intraarticular disk. © Jennifer Lenox.

method involves naming the relative bone growth in terms of aplasia, hypoplasia, or hyperplasia.[18]

The articular surfaces of the TMJ are highly incongruent and consist of fibrocartilage, not hyaline cartilage like other synovial joints.[19] The TMJ is subject to degenerative changes, though the temporal bone and upper joint space generally undergo less degeneration relative to the mandibular condyle and lower joint space. Both local and extensive degenerative changes can occur. When local changes occur, the lateral aspect of the articular tubercle of the temporal bone is most likely to be affected but no one part of the mandibular condyle is at greater risk.[20] Extensive changes can culminate in a total loss of articular cartilage. There is no relationship between degenerative changes seen on radiographic imaging and verbal reports of TMJ pain, palpable tenderness of the TMJ, mandibular mobility, and pressure pain thresholds.[21] The intraarticular disk attaches both to the medial and lateral aspects of the mandibular condyle. It has direct connections to the surrounding ligamentous capsule (discocapsular complex) and musculature that ensure the disk and condyle move together under the temporal bone when tissue is taut. Additionally, the disk attaches anteriorly to the capsule and posteriorly to the retrodiscal tissue. The inferior surface of the disk undergoes degenerative changes roughly 3.3 times more frequently than the superior aspect. The intraarticular disk can displace in the anterior, medial, lateral, or posterior directions.[22–24] Attempts to relate disk position (normal vs displaced) and the presence of degenerative changes have not been successful.[25]

The joint capsule is lined by a synovial membrane, contains synovial fluid, and possesses a lateral ligamentous thickening (temporomandibular ligament) that reinforces the joint (Fig. 1).[15,26] The capsular pattern of the TMJ has been reported as opening, protrusion, and lateral deviation[27] but no scientific evidence exists to verify this claim. Under normal circumstances, the capsule of the lower joint space does not extend past the mandibular condyle. Accordingly, under normal conditions the upper joint space extends farther forward than the lower joint space.[28] This relative relationship is likely due to arthrokinematic rolling in place of the lower joint space whereas the upper joint space translates anteriorly (see the Arthrokinematic section). In joints with anterior disk displacement, the anterior joint capsule of the lower joint space extends as far anterior as the disk displaces, which is considerably past the margin of the mandibular condyle.[28] This represents a significant alteration in the joint capsule.

Musculature located in the head, face, and cervical spine contributes to movement and stability of the TMJ.[29] Select musculature is represented in Figs. 1 and 2. The primary muscles are referred to as muscles of mastication because of their involvement with mechanical digestion.[15] Muscles of mastication are split into two groups: openers and closers. Opening is sometimes referred to as mandibular depression whereas closing is sometimes referred to as mandibular elevation. The lateral pterygoid is the primary opener and is the strongest contributor to both

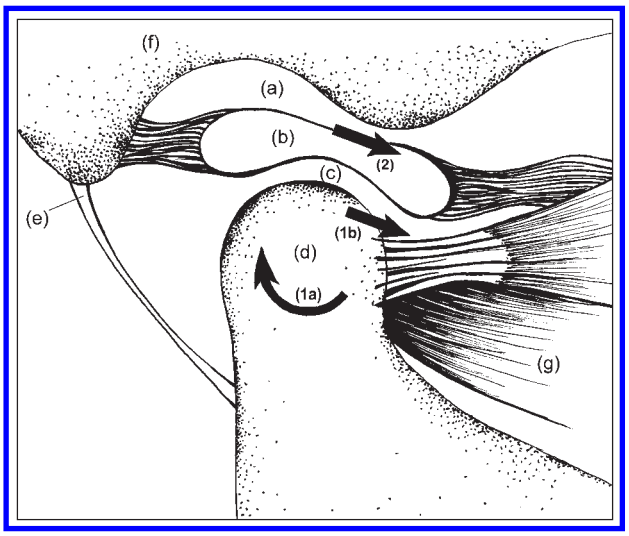

Figure 3 Temporomandibular joint (TMJ) arthrokinematics during mouth opening. (a) discotemporal space, (b) intraarticular disk, (c) discomandibular space, (d) mandibular condyle, (e) posterior joint capsule, (f) temporalis bone, (g) upper and lower heads of the lateral pterygoid muscle, arrow 1a: posterior rolling of mandibular condyle, arrow 1b: anterior-caudal translation of mandibular condyle, and arrow 2: anterior-caudal translation of disk and mandibular condyle. Discomandibular rotation involves a combination of arthrokinematic posterior rolling (arrow 1a) and anterior translation (arrow 1b). Discotemporal anterior translation occurs as both the intraarticular disk and mandibular condyle simultaneously glide in an anterior-caudal direction along the inferior slope of the temporalis bone (arrow 2). © Jennifer Lenox.

protrusion and medial/lateral deviation of the jaw, both of which are required for normal mastication. Other muscles including the geniohyoid, mylohyoid, and the digastric muscles assist in opening.[30] The primary closers include the temporalis, masseter, and medial pterygoids. These muscles originate on the cranium and insert on the mandible.[15]

One of the primary muscle tissue dysfunctions affecting patients with TMD is myalgia. The two primary precipitating factors associated with TMD related myalgia are parafunctional habits and the formation of symptomatic myofascial trigger points (MTrP). Importantly, despite the fact that clenching and bruxism (teeth grinding) are frequently associated with TMD and TMD-based myalgia, no significant difference in EMG readings has been noted between patients with TMD and control groups.[31–33]

Arthro- and Osteokinematics

The TMJ has been described as a hinge and sliding joint[34] but is known to utilize both spinning and compression movements as well.[6] During muscular contraction, the right and left joints act synergistically as the semi-rigid mandible moves relative to the maxilla, temporal bone, and cranium. When mouth opening is initiated, there is a combination of rotation in the discomandibular space and anterior translation in the discotemporal space (Fig. 3).[35–37] Mouth opening is commonly divided into a two-part sequence such that the discomandibular motion occurs first and discotemporal motion second.[38,39] Evidence, however, demonstrates that the relationship between the two movement subcomponents is more linear in nature and that both movements occur throughout the available range.[40] Additionally, during opening, not all joints move in the same pattern and any one joint can utilize different axes of rotation on different movement attempts.[41]

Arthrokinematically, condylar head movement during lateral deviation has been described as ipsilateral lateral rotation (spinning) with contralateral anterior translation and medial rotation.[38,42] However, while the ipsilateral mandibular condyle does initially spin laterally, it is usually followed by an anterolateral glide. Additionally, the condyle can move posteriorly such that it pushes the disk into the posterior aspect of the temporal bone. The contralateral condyle glides anteriorly but possesses considerable variability between subjects with respect to its movement pattern.[43] Temporomandibular protrusion appears to be as simple as bilateral anterior translation of the mandibular condyles,[38,42,44] though there is a paucity of available studies on this movement pattern.

Epidemiology

The prevalence of TMD can be difficult to determine because many studies utilize different diagnostic qualifications and investigative designs. Prevalence estimates range from 5 to 60%.[45–50] A recent meta-analysis estimated management needs for TMD in adults at 16%.[52] A portion of the variability may arise from the fact that TMD symptoms have been observed to fluctuate over time.[49] Additionally, data suggest that both a progression to severe pain and dysfunction as well as a recovery from frequent symptoms are both rare.[49]

Diagnostic Classifications

The evaluating clinician must remember that TMD is a heterogeneous group of disorders. Historically, a variety of diagnostic approaches to TMD exist and the process was not standardized until the development of the research diagnostic criteria for temporomandibular disorders (RDC/TMD).[53] The original RDC/TMD was published in 1992.[54] In 2010, the latest revised version was published.[55] The RDC/TMD possesses inherent simplicity and has been validated. The criteria are widely utilized by researchers, so their implementation in the clinic helps ensure that research is clinically relevant. Schematic presentations of the criteria are available elsewhere.[55]

Despite their strengths, there are three primary downsides to the RDC/TMD. First, the criteria are too limited relative to the diverse manner in which patients with TMD present clinically. Comprehensive clinicians can utilize the criteria as a foundation but many patients will not fit into just one RDC/TMD category and certain patients may not fit into any category. Second, the RDC/TMD do not account for cervical spine involvement, which is crucial to thorough evaluation and management. Third, the RDC/TMD do not take into account pain science. Any patient identified as experiencing symptoms such as hyperalgesia and/or allodynia should be managed accordingly despite the fact that these variables are not addressed by the diagnostic criteria.

Careful history taking and thorough clinical examination are the most important components in establishing the diagnosis of TMD. Table 1 provides a schematic of primary recurrent TMD clinical patterns that may be more helpful to advanced clinicians than the RDC/TMD. Being familiar with these clinical patterns and the fact that patients can simultaneously be ascribed to more than one diagnostic label can assist in history taking, physical examination, and management.

Patient History

The evaluating clinician should obtain the exact symptom location, pain intensity ratings, symptom type, symptom behavior, and related areas of involvement for each patient. Additionally, utilization of pain diagrams has been recommended for the documentation of symptom presentation,[56] which should include the clearing of all adjacent regions by specifically clarifying if they are involved.[57] Failure to do so could lead to acquiring a deceptively small clinical picture of the patient's presentation.

Pain ratings can be obtained using such tools as the numeric pain rating scale[58] or the visual analog scale.[59] When discussing symptom, the clinician should distinguish between descriptors such as constant versus intermittent, dull versus sharp, pain versus tightness or fatigue, and numbness versus tingling. Additionally, the clinician should discern precisely when and how the symptoms started, the number and duration of past episodes, and whether or not any differences have existed between different episodes. Moreover, it is important to learn what examination and/or management strategies have been utilized previously, who implemented them, and to what extent they were successful.

It is important to inquire about corrective equipment utilized to alter the position of teeth, regional trauma, participation in parafunctional habits, the presence of joint noises, joint noises progression, the patterns of symptom provocation and alleviation

Table 1 Classification and clinical patterns of primary recurrent TMD

Myogenic	Arthrogenic	Disk displacement with reduction	Disk displacement without reduction	Cervical spine involvement
Associated with stress, anxiety, clenching, bruxism; secondary component to all other forms of TMD	Associated with joint line pain, arthritis or arthrosis, arthralgia, hypermobility, and joint pain with movement	Associated with joint noises (popping/clicking) and blocked opening; may resolve spontaneously	Associated with blocked opening and possibly a history of displacement with reduction	Generally present across all patients with TMD
Palpable tenderness of musculature (temporalis, masseter, pterygoids)	Palpable joint line tenderness	Opening and/or reciprocal noise	May have a history of opening and/or reciprocal noise	Upper cervical spine and/or head pain
Palpable MTrPs of TMJ musculature	Crepitus (palpable or audible to the patient and/or clinician)	Generally not associated with severe locking of the joint	Locking that does not permit functional range	Accessory movement restrictions
Provocation with activity (mastication, bruxing, etc.)	Positive joint compression test	Positive joint compression test	Positive joint compression test	Multiple levels may be involved
Often bilateral when the primary disorder	Accessory motion irregularities	Generally unilateral	Generally unilateral	Unilateral or bilateral
Confirmed through muscular management techniques and patient education to reduce contributing factors	Confirmed through joint techniques including joint mobilization when applicable, patient education for hypermobile joints	Confirmed through response to joint interventions; poor clinical differentiation of different disk displacements	Confirmed through response to joint interventions; poor clinical differentiation of different disk displacements	Confirmed through manual therapy and symptom reduction (high error rate with diagnostic imaging)

TMD: temporomandibular disorders; MTrPs: myofascial trigger points; TMJ: temporomandibular joint.

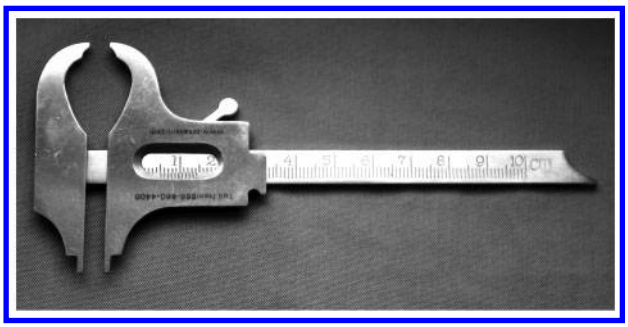

Figure 4 Boley gage. When measuring mouth opening, the upper notch facing left is stabilized on the inferior aspect of the upper incisors. Once stabilized, the portion of the Boley gage with the lower notch facing left is slid down the measurement scale until the lower notch contacts the superior aspect of the lower incisors. The instrument's scale is then read and the opening range obtained.

Figure 5 TheraBite range-of-motion (ROM) scale. When measuring mouth opening, the notch at the lower left portion of the scale is stabilized on the superior aspect of the lower incisors. Once stabilized, the instrument is rotated up toward the inferior aspect of upper incisors until contact is made between the scale and the upper incisors. The instrument's scale is then read and the opening range obtained.

with respect to activity participation and/or time of day, and whether symptoms are improving, getting worse, or staying the same. Symptom details should be precisely outlined and repeated back to the patient to ensure the clinician has obtained a thorough understanding of the patient's experience. Failure to do so could negatively impact the remaining evaluation, the differential diagnosis process, and/or the management phase.

While taking a patient history, it is important to establish symptom irritability, which can be defined in terms of pain intensity in context of both how easily the level of pain is elevated and the duration required for the pain to subside.[57] Or, in other words, if symptoms are not irritable, they could be of low intensity, require a relatively high-level of stimulation to promote an increase in perceived symptoms, and, when elevated, require a relatively short period of time before a return to, or near, baseline. On the contrary, if symptoms are irritable they could be of high intensity, required a relatively low-level of stimulation to promote an increase in perceived symptoms, and, when elevated, require a relatively long period of time before they return to or near baseline. Importantly, irritability should be seen as a continuum and not a dichotomy of painful presentations. Assessing irritability will assist in properly dosing evaluation and management techniques.

Each patient should be screened for the presence of red flags.[60,61] Important findings may include but are not limited to a history of emotional or psychological stress, medication usage, symptoms of vertebrobasilar insufficiency, upper cervical spine instability, cardiac dysfunction, central nervous system dysfunction, cranial nerve dysfunction, infection, and unexpected weight loss or gain. Some clinicians may choose to accomplish screening by means of intake questionnaire but verbally reviewing the information is advisable.

Clinical Examination

Observation

With respect to observation, the examiner should record general postural deficits, relative prominence of the facial and neck musculature, gross mandibular size and shape, regional symmetry, mandibular resting position, and both skin temperature and color. Oral structures such as the teeth, gingivae, frenula, tongue, soft and hard palates, tonsils, and uvula should be visualized and inspected for abnormalities. Relevant extra-oral structures such as arteries, veins, lymph nodes, and both the parotid and submandibular glands should be inspected as deemed necessary. Many physical therapists may first require familiarizing themselves with the normal and pathological appearances of orofacial structures.

Active range-of-motion (AROM) testing

Active range-of-motion testing includes mouth opening, right and left lateral deviation, and protrusion. A common method for measuring opening is to determine interincisor distance.[62] This can be measured in a variety of ways, including with a Boley gage (Fig. 4) or TMJ measurement scale such as the TheraBite range-of-motion (ROM) scale (Fig. 5). A Boley gage is a metal instrument with notches designed to fit on the upper and lower incisors. For this reason, it tends to be more precise and cost effective over the long-term when compared to the disposable (paper) TheraBite ROM scale. However, both are clinically advantageous and sufficiently accurate for professional usage. Other measurement instruments, such as the trimeasure tool, do exist and should be considered for clinical use. In the event that an instrument intended for TMJ ROM measurements is unavailable, a ruler can be utilized.

To measure lateral deviation the relative displacement between incisors of the mandible and maxilla or

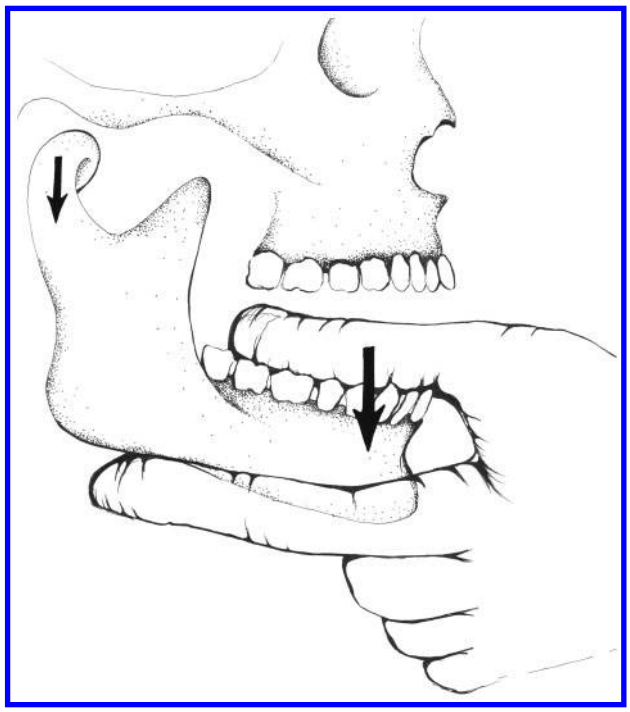

Figure 6 Hand placement for intraoral passive accessory motion testing. Large arrow: distraction force placed through the ipsilateral lower molars and premolars by the first digit while the second digit provides a counterforce on the inferior aspect of the ipsilateral mandibular body. Utilizing the third digit to provide additional counterforce on the inferior aspect of the contralateral mandibular body may maximize patient comfort. Small arrow: direction of the distraction movement of the mandibular condyle at the temporomandibular joint (TMJ). © Jennifer Lenox.

the upper and lower frenula can be measured. Obtaining a precise measurement assists in comparing ranges in either direction but the ranges obtained may not be as accurate as opening measurements because it is more difficult to stabilize the measurement tools against the teeth during lateral deviation, especially if trying to maintain line of sight with the frenula. It can be more practical to simply visually inspect to see that the ipsilateral canine of the mandible passes the ipsilateral canine of the maxilla during the movement, though not all patients will have canine teeth. To measure protrusion, the distance between the incisors could be measured. However, it is generally only necessary to visually inspect that the lower incisors move forward past the upper incisors. During both lateral deviation and protrusion, if the mandibular teeth pass their intended target during lateral deviation or protrusion, the movement is considered functional.[6] In each instance, the range should be assessed for patient experience including but not limited to pain, discomfort, tightness, clicking or popping, and apprehension. Overpressure can be applied to the mandible at the end of each movement if necessary for the assessment of end feel and/or symptom provocation. Testing passive ROM is very similar to active testing but may be difficult in patients with TMD due to muscle guarding. When appropriate, ranges and symptom provocation should be assessed and compared to active measurements so that appropriate conclusions can be made but in many cases true ranges will not be identified because of guarding. Table 2 provides information on opening, lateral deviation, and protrusion ranges by age and sex.[63–65] It should be noted that clinical experience informs us that so-called normal ROM for the TMJ is highly variable and that every patient should be individually assessed within the variables associated with their particular case and clinical presentation.

Passive accessory movement testing

Accessory movement testing includes distraction, anterior glide, medial/lateral glide, and CAM glide of each mandibular head and sometimes requires intraoral placement of the fifth digit (Fig. 6). The second part of this series will include images of these techniques as they relate to management and joint mobilization as well. Distraction is tested one side at a time with the examiner typically standing opposite to the side being tested. The mobilizing hand is gloved and positioned such that the fifth digit rests atop the ipsilateral mandibular teeth and the first and second digits align with the ipsilateral and contralateral mandibular bodies, respectively, if the examiner is standing contralateral to the involved side. When standing ipsilaterally, the first and second digits will contact the contralateral and ipsilateral mandibular bodies, respectively. The stabilizing hand, which may or may not be gloved, can be placed on the forehead while one digit from the

Table 2 TMJ AROM measurements by age and sex

	Age			
Active motion	6 yrs	12–14 yrs	18–25 yrs (women)	18–25 yrs (men)
Mean opening (mm) (±SD)	44.8 (±4.3) Range 33–60	53.9 (±5.9) Range 41–73	51.0 (±5.7) Range 39–75	55.5 (±7.1) Range 42–77
Mean Lat. Dev. (mm) (±SD)	8.2 (±1.3) Range 5–13	10.0 (±1.7) Range 6–15	9.7 (±1.1) Range 5–15	10.0 (±2.1) Range 6–16
Mean Prot. (mm)	0.6	1.4	2.3	3.0

TMJ: temporomandibular joint; AROM: active range-of-motion; SD: standard deviation; Lat. Dev.: lateral deviation; Prot.: protrusion; mm: millimeters; yrs: years (Refs. 63–65).

stabilizing hand palpates the joint line for movement. Hand placement can vary based on patient needs and the size of the examiner's hands. The maneuver can be challenging when teeth are missing, sharp, or pathological, in which case caution should be utilized. The examiner generates a force in the caudal direction with their mobilizing hand while providing a posteriorly directed force with the stabilizing hand. The digit palpating the joint line should note a gapping motion as the mandibular condyle moves caudal relative to the temporalis bone (Fig. 6).

Anterior glide should be assessed in two different ways. First, in either sitting or supine, the movement is palpated externally during active opening, lateral deviation, and protrusion. Simultaneous, bilateral palpation allows for a better comparison of relative movement quantities. The clinician should attempt to discern if the condyle is gliding too early, late, far, or not far enough by comparing the involved side with the uninvolved side. If both sides are involved, observations are based on the clinician's experience. Care should be taken to insure the palpating digits are symmetrically positioned so as to not improperly bias the findings.

Second, anterior glide is assessed passively in various amounts of mouth opening. This can be accomplished by first grasping the mandible as previously described for intraoral techniques (Fig. 6). For some clinicians it is helpful to stand on the side of the treatment table that permits the examiner's dominant hand to be utilized as the testing hand while the non-dominant hand stabilizes the patient's forehead, but standing contralaterally may be more important. The gliding force is applied by gently pulling the mandible in an anterior-caudal direction and should be tested in a variety of ranges if tolerated/necessary. Whenever possible, a digit on the stabilizing hand should again be utilized to palpate the mandibular head and joint line for movement. The maneuver should be compared side-to-side for relative mobility and symptom provocation.

When testing medial and lateral accessory glides, it can be helpful to be positioned at the head of the table such that the examiner's hands can be placed over either the proximal portion of each mandibular rami or one hand on a mandibular ramus (mobilization hand) while the other blocks the contralateral zygomatic arch (stabilization hand). One hand (mobilization hand) can be utilized to medially direct force through the ipsilateral ramus as the contralateral hand provides different levels of stabilizing force (stabilization hand). By utilizing different levels of relative force in both the mobilization and stabilization hands, the examiner can gain an appreciation for medial glide on the testing side as well as lateral glide on the stabilization side. In this sense, both sides are tested simultaneously. Additionally, more specific contralateral stabilization may be necessary for patient comfort and the prevention of apprehension as it is impossible to truly isolate one side during testing without contralateral stabilization. This should be repeated so as to examine both sides regarding relative mobility and symptom provocation in each direction.

Additionally, because of the location, direction, and relative contributions of the temporomandibular ligament, emphasis should be placed on a three-dimensional assessment when testing passive accessory motion of the TMJ. To accomplish this, perform an external maneuver similar to the medial/lateral glide technique with a combination of caudal, anterior, and medial forces (CAM glide). The mobilizing hand is placed over the proximal mandibular ramus of the ipsilateral side with the stabilizing hand again providing a contralateral force as required by the patient's experience. Testing should again be performed in various amounts of mouth opening if required.

Special testing

Special testing is limited in patients with TMD. The tongue blade test can be utilized to rule out mandibular fractures. This test has been defined differently by different authors but generally involves the patient unilaterally biting down on a tongue depressor as it lays in a posterior to anterior fashion. The patient bites down to stabilize the tongue depressor between their teeth while the examiner attempts to break it with a twisting movement.[66–68] The test can be performed first on the uninvolved side and, if negative, on the involved side. If the examiner is able to break the blade while the patient stabilizes it with their teeth, the test is negative and the patient does not undergo radiographic examination. Failure on the part of the patient to stabilize the blade due to pain, which then results in the examiner being unable to break it, is a positive test and indicates the need for radiographic examination to rule out mandibular fracture. Studies indicate the tongue blade test has 95% sensitivity[66,67] and 65% specificity.[67,68]

The joint compression test involves manually loading the intraarticular structures. One of the examiner's hands press the mandible in a posterior and cranial direction such that the mandibular head moves toward the articular surface of the temporal bone. This can be accomplished either with intraoral (Fig. 6) or extraoral hand placement. The other hand provides a counterforce in the opposite direction on the cranium. In isolation, the compression test's kappa value ranges from .19 to 1.00.[69,70] For this reason, it is important that it be utilized in conjunction with other testing but not in isolation.

Manual muscle testing

Patients can be screened for symptom provocation with resisted movements but the traditional manual muscle testing scale has little objective applicability with respect to TMD. Jaw dynamometry is not widely available despite considerable scientific data on the subject.[71–73] Additionally, more traditional neurological screening (including cranial nerve testing) can be helpful in the overall differential diagnosis process of patients with face, head, and neck symptoms but, because TMD is generally limited to articular, discal, and muscular components, those testing procedures will not be reviewed here.

Quantitative sensory testing

Quantitative sensory testing can be utilized to help differentiate between patients with a recurrent or nociceptive condition and those with a chronic or neuropathic condition.[74] For example, clinical presentations that either originated as or developed into a neuropathic condition may include signs and symptoms such as an expansion of hyperalgesia into adjacent and distant regions, allodynia, dysesthesias, and/or perceptual deficits. Quantitative sensory testing can be utilized to clinically evaluate these phenomena and can include testing of pain pressure threshold, mechanical allodynia and mechanical detection threshold, and vibration detection threshold.[74] It is not necessary to investigate these phenomena in all patients referred for TMD. Testing should be focused on those patients who report widespread, pain-dominant conditions that are likely to be chronic in nature and possess irritable symptoms. Additionally, those patients who display factors such as hyperalgesia or allodynia during clinical testing may require quantitative sensory testing.

Palpation

Relevant palpation findings include symptom provocation at the TMJ line, abnormalities in mandibular head movement, hypersensitivity of the retrodiscal tissue (palpated with an open mouth), crepitus, popping or clicking, regional tenderness, regional MTrPs, and changes in mass of the masseter, temporalis, pterygoids, and cervical spine muscles. Medial and lateral pterygoid muscles require intraoral palpation with a gloved hand. For the medial pterygoid, palpate along the medial aspect of the posterior mandible. The lateral pterygoid can be palpated just proximal to the medial pterygoid (Fig. 2). In most patients this is an exquisitely painful location so caution should be utilized. Gag reflexes may prove to be an obstacle with intraoral palpation. Additionally, it may be necessary to palpate regional arteries, veins, lymph nodes, and both the parotid and submandibular glands.

Cervical spine examination

Cervical spine involvement relative to the evaluation of patients with TMD has already been discussed as it relates to the contribution of cervical spine musculature to movement and stability of the TMJ, screening for upper cervical spine instability, palpation of cervical spine musculature, and the failure of the RDC/TMD to account for cervical spine involvement. Additionally, each patient should be assessed for concomitant cervical spine range deficits, accessory movement restrictions, and altered muscle recruitment patterns, though the description of these procedures is beyond the scope of this series. Failure to conduct a sufficiently thorough examination of the cervical spine in patients with TMD may lead to obtaining a deceptively narrow clinical picture such that the entirety of the patient's condition is not successfully managed.

Initial intervention

The final component of a comprehensive physical therapy evaluation for TMD involves implementation of an initial intervention or interventions. This serves to verify clinical findings. Additionally, the initial intervention functions as a method of discovery relating to which clinical finding or findings may be playing the most or least significant roles in the patient's clinical pattern. If the suspected primary symptom generator is successfully addressed but no subsequent change in symptom presentation is noted, then perhaps it is not the primary contributor. This process can be repeated in an attempt to address multiple findings if and when appropriate. It is important to recognize that not all patients will respond immediately but that this approach assists in transitioning to the management phase of rehabilitation regardless of the patient's response. In the event that the initial intervention immediately demonstrates improvement in function or symptoms, the results can be utilized to educate the patient on the importance of physical therapy services. With patients who do not respond immediately, initial management techniques may simply serve to get the rehabilitation process started as soon as possible to maximize potential benefit. Management techniques will be discussed in detail in the second part of this series.

Interpretation of Clinical Examination

A clinical framework that may be utilized to process the information identified during the evaluation includes the following questions. First, were any red flags identified that require the patient to be referred out for medical consultation? If so, an appropriate referral should be made. Second, how irritable are the symptoms experienced by the patient? If irritability is high, a more cautious approach should be utilized,

which may include limiting either the evaluation process itself and/or the implementation of management strategies. Subsequently, if it can be shown either that irritability has lowered or that the patient sufficiently tolerates interventions then more aggressive evaluation and/or management strategies can be utilized. Third, did clinical testing identify a limitation in motion? If so, is that limitation associated with a firm or empty end feel? In most cases with patients diagnosed with TMD, limitations will be associated with a firm end feel, which is likely to be associated with a capsular restriction, disk displacement, and/or guarding. All three can be addressed by joint mobilization but the clinician should proceed with caution until more is ascertained about the nature of the limitation (i.e. does the limitation improve after the implementation of joint mobilization). Empty end feels may be associated with more acute conditions, which may not respond well to joint mobilization. Fourth, what type of impairment does the most painful test point to? For example, in the event of a primary muscular pathology, such as that seen in patients with excessive clenching or bruxism causing myalgia, the primary indicator is likely to be a reproduction of symptoms with palpation of the associated muscle tissue. In the event that a capsular restriction is the primary impairment, passive accessory testing may be the most common pain sign. Regardless of the categorization of the test (e.g. muscular vs articular), the most painful test can help guide a clinician in deciding which direction to begin their management process. These questions can be repeated throughout the management process to help guide the clinician toward resolution of the symptoms.

Clinicians with more experience and confidence managing patients with TMD may elect a less structured approach. After a thorough evaluation process that has ruled out red flags, clinicians may choose to rank the relevant clinical findings in terms of which is believed to be most versus least likely to be contributing to the patient's clinical pattern. Then, utilizing comparable sign or the test–treat–retest approach, the clinician can experiment with different interventions to identify to what extend the implementation of those interventions impacts the identified clinical variables (e.g. ROM or pain). Based on the amount of improvement obtained with each intervention, the clinician can maintain or re-order the clinical findings in terms of their perceived level of contribution. This process can be repeated over time until the point at which a full recovery is obtained or a plateau in progress has been reached. When no further benefit is experienced or anticipated, the patient's physical therapy services can be ceased. Importantly, as opposed to simply following and addressing those clinical variables identified during the initial evaluation, attention should be paid to identifying any impairment that either was not identified during the initial evaluation or arose over time since the initial session. This is of particular importance in those patients who plateau in progress and are being considered for discharge.

Summary

Until now, physical therapists have not had access to a peer-reviewed or sufficiently research informed source on the evaluation and management of TMD. An appreciation of the anatomical and mechanical features associated with the TMJ can serve as a foundation for understanding a patient's clinical presentation. Performance of a thorough patient history and clinical examination can guide the clinician toward an improved diagnostic process. Using the RDC/TMD can assist in this process but should only serve as a basic diagnostic foundation. This is especially important for the implementation of comprehensive physical therapy services. A sample evaluation template is shown in Appendix A (available online) to assist physical therapists in the evaluation of patients with TMD.

Once a thorough history and clinical examination are completed, the clinician can decide upon management strategies appropriate for each patient. Part 2 of this series will discuss conservative management based on a comprehensive manual physical therapy approach. This will include a discussion of relevant modalities, patient education, therapeutic exercise, soft tissue techniques, joint mobilization, and oral splints.

Conflict of Interest

None

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