
Clinics in
Physical
Therapy

Temporomandibular
Disorders

Second Edition

Edited by

Steven L. Kraus

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7 Physical Therapy Management of TMD

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Physical therapy in the management of TMD “is well recognized as an effective, conservative method of treatment for TMD”¹ and should be routinely used in TMD therapy.² Some studies suggest, however, that physical therapy provides only minimal, if any, therapeutic value in the treatment of TMD.^{3,4} There are several basic explanations for differing conclusions on the effectiveness of physical therapy for TMD. The first and most apparent explanation is the misuse and abuse of the term *physical therapy*. Health professionals and lay practitioners who are not physical therapists should not suggest that exercises, ice packs, and moist heat treatment are physical therapy.⁴ Patients who are told to purchase a sporting goods mouth appliance or told to purchase an over-the-counter medication are not misled that they are receiving dentistry or medicine. There should be no doubt by the patient or insurance companies that when physical therapy is administered for TMD or for other musculoskeletal disorders, a licensed professional physical therapist is providing evaluation and treatment. If treatment is not offered by a physical therapist, then said treatment should be referred to as simply a modality or an exercise, nothing more.

Physical therapists, specialized in musculoskeletal dysfunction, offer patients a thorough evaluation and comprehensive treatment plan. Treatment may focus on instructions in specific exercises or application of modalities and manual procedures. The physical therapist will be able to assess and modify the treatments based on the change in the patient’s signs and symptoms. Physical therapy management of TMD provides a therapeutic and cost-effective approach. Physical therapy will be a primary source of treatment for most patients experiencing TMD. For other patients, physical therapy may be an important

adjunct to treatment(s) such as occlusal appliances and nonsteroidal anti-inflammatory medication.

Criteria used for "patient selection" offer a second explanation for differences in physical therapy efficacy in the management of TMD. Let us assume that the objectives of a research paper were to investigate the effectiveness of a particular treatment on a TMJ patient population. After reading the methodology section of this research paper, it was clear that the authors used inaccurate criteria to establish a TMJ patient population. The conclusions reached in this paper as to the effectiveness of a treatment(s) would not be valid for the true TMJ population. Also, if criteria used for patient selection are not the same for all studies, any attempt to compare treatment outcomes between studies would be difficult.^{5,6} Signs and symptoms of what constitute the TMD patient population have reached a level of general acceptance only quite recently.^{1,5,6} A great deal of work is needed to repeat past research on the effectiveness of different treatments because we now have a better understanding as to what disorders of the TMJ we are treating. Furthermore, studies investigating the effectiveness of physical therapy in the treatment of TMD should clearly state whether a licensed physical therapist is actually involved in the administration of such modalities or procedures if the effectiveness of physical therapy is to be validated or rebuked.

To be able to classify a patient into any one or combination of the various categories of TMD, the clinician will need to acquire an understanding of the subset diagnostic classification system of TMD that is endorsed by the American Academy of Orofacial Pain.^{1,5,7} The reader is referred to Chapter 3 as well as to the References^{1,8} to develop an insight into understanding the diagnostic classifications for TMD.

When treatments are discussed for TMD, the reader must not be misled into thinking this is a "cookbook" approach. Treatments are for a specific condition and not for a specific patient with a condition. Patients often present with disorders of the TMJ but with involvement in adjacent areas. Disorders involving the muscles of mastication, occlusion, and cervical spine are frequently additional sources for the patient's signs and symptoms. Sequencing of treatments for patients with multiple functional disorders and emotional disturbances that accompany pain (see Ch. 13) is beyond the scope and objectives of this chapter.

Whether treatments offered for TMD include a home exercise program, use of an occlusal appliance, or medication, patient education and patient compliance are essential. In a recent study, a critical factor in promoting patient compliance was the patient-clinician relationship. The most frequently cited reason for noncompliance was the patient's dislike of the clinician.⁹ Patient education is inherently connected with physical therapy and is an essential part of most treatment regimes.¹⁰ The kind, quantity, and quality of patient education along with patient attitude and therapist behavior are all related to therapeutic results of treatment and patient compliance.¹⁰

The subset diagnostic categories of TMD that are best managed by a physical therapist are *inflammation*, *hypermobility*, and *hypomobility*. These clas-

sifications provide a means of focusing the reader's attention on three broad conditions of the TMJ from which a physical therapy treatment program can be formulated. It does not intend to replace existing classification systems.

Progression from one treatment to the next is based on the degree of inflammation, hypermobility, and hypomobility and the patient's response (signs and symptoms) to the previous treatment(s). When possible, the patient should be encouraged to continue those exercises that can be included in a home exercise program. Questions pertaining to the frequency and repetitions of a procedure or exercise are dependent on the patient's condition and life style.

INFLAMMATION

Of the various disorders associated with the TMJ, I believe that inflammation is the most common source for patient symptoms and should be addressed first. Although inflammation often accompanies conditions such as hypermobility and hypomobility, one should not assume these other conditions are the primary cause for the inflammation. Hypermobility and hypomobility have a high occurrence in the nonpatient population.

Tissues subject to inflammation are the synovium (synovitis), which includes the retrodiscal tissue, and the capsule (capsulitis).¹ These tissues can become inflamed secondary to blunt trauma to the mandible or secondary to maintaining an open-mouth position as in various dental procedures. A less obvious cause but perhaps the most common cause is excessive or prolonged loading to the joint. Although the TMJ is a load-bearing joint,¹¹ excessive or prolonged loading may occur during functional activities (chewing or talking) and parafunctional activities (clenching or bruxism) and with habits such as fingernail biting, gum or ice chewing, and leaning the chin on hand.

No attempt to distinguish a specific treatment for synovitis or capsulitis will be made because it is difficult to differentiate between the two during physical examination. From the physical therapist's perspective, treatments for inflammation related to polyarthritides¹ (i.e., rheumatoid arthritis [RA], juvenile rheumatoid arthritis, spondyloarthropathies, and crystal-induced disease) do not differ from treatment for common inflammatory conditions. Such polyarthritides will require additional dental and/or medical input. The reader is referred to the References for additional information on treatment related to rheumatologic diseases.¹²

Treatment

Habit Awareness and Oral Modification

Treatment for inflammation of the TMJ will center on the avoidance of unnecessary or excessive loading to the joint. Habit modification of fingernail biting, gum or ice chewing, leaning the chin on hand, or any other activities

that do not involve talking, chewing food, and drinking fluid is strongly encouraged. The patient should avoid excessive talking and should consider a soft food diet. In a study that examined the relationship between treatment outcome and diverse psychological factors for patients with TMD,¹³ the authors concluded that "the patient's awareness of the dysfunction as a problem over which he or she has some degree of control may be one of the essential and common ingredients for successful outcome." They suggest that educating patients about exacerbating factors (i.e., fingernail biting, gum chewing, etc.) may be enough to relieve pain if the patient makes a concerted effort to control these same factors. Controlling parafunctional activity that contributes to excessive loading of the TMJ will be covered next.

Tongue Up/Teeth Apart/Breath/Swallow

Muscle hyperactivity plays a perpetuating if not a predisposing and precipitating role in inflammation and other disorders of the TMJ.¹⁴ Masticatory muscle hyperactivity causes excessive loading to the joint. Parafunctional activity involves masticatory muscle hyperactivity. Parafunction can be defined as repetitive activity, frequently contributing to dental, periodontal, or *neuromuscular damage*.¹⁵ Parafunction consists of repetitive activity involving clenching and/or bruxism (tooth grinding). Most patients are unaware of the nature, intensity, and frequency of their parafunctional activity. Parafunction may occur as diurnal or nocturnal or both. Diurnal activity is best controlled through the exercises that will be discussed below.

Diurnal parafunction usually results from stressful situations such as office or home conflicts or is related to "type A" behavior (hurried, pressured, controlling, demanding). Whatever the environmental and/or emotional cause, diurnal parafunction does not have to occur if emphasis is placed on "self-awareness." An informed patient who feels some degree of control over parafunction can take appropriate action as to how to respond to stress. The neuromuscular re-education exercise consisting of tongue up/teeth apart/breath/swallow (TTBS) should be instructed to the patient as a means of controlling diurnal parafunction. TTBS is a way of initiating cortical awareness and control toward "normal" muscle activity of the jaw at rest or moving. Once a harmful activity is recognized consciously, steps can be taken to replace it with a therapeutic activity. TTBS provides the patient a tool to "self-correct." Motivation by the patient to perform TTBS is essential. Motivation is largely fueled by the clinician's understanding of the physiology behind TTBS and the ability to demonstrate and communicate the application of this and other neuromuscular re-educational exercises in a meaningful way.

TTB aims to achieve a rest position of the mandible known as the upright postural position of the mandible.¹⁶ A rest position of the mandible is one of minimal masticatory muscle activity. It is identified by an absence of movement of the mandible and by positioning the teeth of the upper and lower arches apart. The purpose of educating the patient on the normal sequence of swal-

lowing (S) is to ensure that the patient is not using unnecessary/excessive muscle activity during swallowing and that swallowing is performed with teeth apart.

Tongue Up. The tongue is active during most oral-mandibular functions. The tongue assists in mixing food and in delivery of food into the posterior part of the mouth for swallowing, and it plays an important role in the action of swallowing. The tongue not only has many sensory functions but also acts efficiently in discriminating the characteristics of food as well as contributing to speech. The very fact that we seldom bite our tongues during normal oral function is due to the highly developed, skillfully coordinated neurofunctions operating between the tongue and the mandibular muscles. The coordination between the tongue and mandibular muscles is dependent on the jaw-tongue reflex.^{17,18}

The tongue is composed of various intrinsic and extrinsic muscles. The genioglossus is the main muscle responsible for positioning the tongue in the oral cavity. The genioglossus muscle is primarily responsible for establishing and maintaining the rest position of the tongue and is active in elevating and protruding the tongue.^{19,20} "Tongue up" refers to the position of the tongue when at rest. The rest position of the tongue or "postural position" is up against the palate of the mouth¹⁹ (Fig. 7-1). The most anterosuperior tip of the tongue will lie in an area against the palate just posteriorly to the back side of the upper central incisors. No pressure by the tongue should be made against the back side of the upper central incisors. The remaining portion of the tongue, at least the first half of the tongue, will be against the palate. To be sure the



Fig. 7-1. Rest position of the tongue. The anterosuperior tip of the tongue lies against the palate just posterior to the upper central incisors. In this position, the teeth of the upper and lower arches are apart. (From Kraus,¹⁶³ with permission.)

patient does not "poke" the tongue into this position, instruct the patient to let the tongue "flatten out from side to side" as it lies against the palate. In this position, the most posterior part of the tongue will form the anterior wall of the pharynx.²¹

The position of the tongue at rest not only encourages the tongue muscles to maintain a resting muscle tone but also encourages the muscles that elevate the mandible (temporalis, masseter, internal pterygoid) to maintain a resting muscle tone (jaw-tongue reflex).^{17,18,22} Unless the patient is chewing, talking, coughing, swallowing, or licking their lips, their tongue should be in the rest position at all times. If the patient has a maxillary occlusal appliance, the appliance, if possible, should not cover the palate of the mouth. Palatal coverage by the appliance could interfere with the rest position of the tongue. Patients who are sensitive to a proper tongue position at rest would respond best to an occlusal appliance that does not cover the palate.

Teeth Apart. Informing the patient of the simple fact that the back teeth should be apart, is at times, all that is needed to be therapeutic in reducing masticatory muscle hyperactivity. Instructing the patient on the rest position of the tongue will assist the patient in self-awareness of keeping teeth apart. Have the patient focus on the tongue position at rest. Then ask the patient to bring the back teeth together. The patient will do one of two things. The patient will have to pull the tongue back out of the way or end up biting the tongue.

Patients who have either a maxillary or mandibular appliance should be told that the appliance is not there for them to "bite" into even if it is referred to as a "bite appliance." Reason with patients by telling them that the appliance is not to stop them from doing parafunctional activities. Instead a properly "balanced" appliance is to minimize the harmful effects of parafunctional activities on the teeth, TMJ and associated muscles of mastication, and cervical spine. Patients must become aware of tongue up and teeth apart with or without an appliance.

Comments on Nocturnal Parafunction: Nocturnal parafunction is more difficult to control than diurnal parafunction. Because the etiology of nocturnal parafunction is still being investigated, this author would offer the following suggestions from the physical therapist's perspective. Nocturnal parafunction is usually suspected with patients who, on awakening during the night or morning, report headaches, facial, jaw, and tooth/teeth symptoms. It has been my observation that nocturnal parafunction can be influenced in a positive way by addressing the presence of a symptomatic cervical spine disorder (see Ch. 11) along with educating the patient in proper sleeping postures to include the use of proper cervical support for the neck. Attention given to the cervical spine has appeared to decrease nocturnal parafunction as identified by symptomatic improvement in the morning. I would suggest as a topic for future research the relationship of a symptomatic or asymptomatic cervical spine disorder and nocturnal parafunction.

Breathing. "Nasal breathing is essential to the normal well being of the body."²³ Nasal breathing permits the air to be warmed, moistened, and cleansed before it reaches the lungs. Nasal breathing will call on a more ideal use of the diaphragm, the principal driver of respiration. Proper use of the diaphragm allows ideal ventilation of the lungs. Diaphragmatic breathing is an excellent way to promote general relaxation of the body.

Diaphragmatic breathing occurs more easily by breathing through the nose. A correct rest position of the tongue forces nasal-diaphragmatic breathing. This occurs more easily in the absence of any resistance in the upper airway cavity (i.e., colds, allergies, nasal septum deviations, etc.).

Breathing through the mouth decreases the effects of diaphragmatic breathing and increases use of accessory muscles of breathing. Primary accessory muscles are the scalenes and the sternocleidomastoid (SCM).²⁴ The physical therapist may need to apply various manual techniques to enhance proper use of the diaphragm. Rib cage and thoracic spine mobility will also need to be evaluated because these factors influence diaphragmatic breathing.

Swallowing. The act of swallowing food, liquid, and saliva occurs throughout the day. Excessive masticatory muscle activity is suggested to occur in patients who acquire an altered sequence of swallowing in which a tongue thrust occurs. The most frequently cited signs of tongue thrust activity during swallowing include protrusion of the tongue against or between the anterior teeth and excessive circumoral muscle activity.²⁵ A strong relationship does appear to exist between a tongue thrust and pediatric anterior open bites.^{26,27} However, in the absence of a pediatric tongue thrust and the frequently associated dental and skeletal changes, I have observed that an adult can acquire a tongue thrust, which is here referred to as "an acquired adult tongue thrust." It is theorized that tongue movement and positioning in the oral cavity are influenced by dysfunctional mobility and positioning of the cervical spine.²⁸ A recent paper suggests that positional changes of the head may have an effect on genioglossus muscle activation thresholds.²⁹ The genioglossus muscle is the primary muscle that protrudes the tongue.¹⁹ Attempt to look up at the ceiling and swallow. Not only is it difficult to swallow with such an extended head position, but to complete the swallowing cycle, the teeth will be brought together firmly.

The literature is not clear in clarifying whether humans swallow with the teeth together or apart. This debate may occur because cervical spine mobility and positioning have not been a variable that has been fully recognized and controlled in past studies.³⁰ This author observes that in the presence of good mobility and positioning of the cervical spine, swallowing occurs with teeth out of contact. In the presence of a cervical spine disorder contributing to an acquired adult tongue thrust, not only is it suggested that tooth contact occurs but an increase in duration of the teeth in occlusion occurs. An acquired adult tongue thrust may therefore contribute to masticatory muscle hyperactivity but may also contribute to symptoms such as difficulty in swallowing, scratching

sensations in the throat that do not become a sore throat, and shortness of breath.²⁸

The evaluation used by Barrett and Hanson³¹ to determine the presence of a pediatric anterior tongue thrust is not helpful in determining the presence of an acquired adult tongue thrust. Barrett and Hanson appear to rely on dental and skeletal changes when deciding if a tongue thrust is present. The following evaluation is recommended by this author to help in determining the presence of an "acquired adult tongue thrust":

1. Have the patient swallow water two to four times, pausing briefly between each swallow. During each swallow, palpate the hyoid bone (Fig. 7-2). A quick up and down movement of the hyoid bone (like a flicker) should normally be felt. With an acquired adult tongue thrust, a slow up and down movement of the hyoid bone is felt.

2. Palpation of the suboccipital muscles is performed simultaneously with step 1 (Fig. 7-2). As the patient swallows, little if any contractions should be felt to occur in the suboccipital muscles. With an acquired adult tongue thrust, suboccipital muscle contractions will occur.

3. During a normal swallow, no head movement should be observed. With an acquired adult tongue thrust extension of the head on the neck and, in more



Fig. 7-2. Evaluation for the presence of an acquired adult tongue thrust. The clinician's left hand is palpating hyoid bone movement while the right hand is palpating suboccipital muscle contraction. Head and neck movement along with lip activity are observed for by the clinician.

severe cases, an actual forward craning movement of the entire head and neck will be observed.

4. During a normal swallow, no excessive lip activity should be observed. Lip activity will be seen with the acquired adult tongue thrust. This is the least observable activity with the acquired adult tongue thrust.

5. While the patient swallows, have the patient become aware of the tongue movement and position during swallowing, especially the anterior tip of the tongue. During normal swallowing, the patient should not be aware of the tip of the tongue pressing forward. With an acquired adult tongue thrust, the patient will typically state that the tip of the tongue presses firmly against the back side of his front teeth or straight forward or down against the back side of his bottom teeth.

Treatment of acquired adult tongue thrust consists of treatment of cervical spine disorder. Chapter 11 provides an overview of treatment for a cervical spine disorder. In addition to the cervical spine treatment, the patient will need to be instructed on the normal sequence of swallowing (Fig. 7-3):

Stage 1. Instruct the patient where the tongue should be positioned at rest (Fig. 7-3, stage 1).

Stage 2. When water enters the oral cavity, the tongue will have dropped down from the rest position (Fig. 7-3, stage 2).

Stage 3. The initial phase of swallowing occurs when the tip of the tongue goes back to its rest position (Fig. 7-3, stage 3). From that point on, no pressure should be felt with the tip of the tongue pressing against the teeth.

Stage 4. The main force of swallowing will occur with the middle one-third of the tongue (Fig. 7-3, stage 4). The tongue should be perceived as moving like a "wave." Although the wave will start at the tip of the tongue, its main force will occur with the middle one-third of the tongue. Inform the patient that the posterior teeth should not come into contact while swallowing.

Stage 5. The tongue returns to its rest position, completing the swallowing cycle (Fig. 7-3, stage 5).

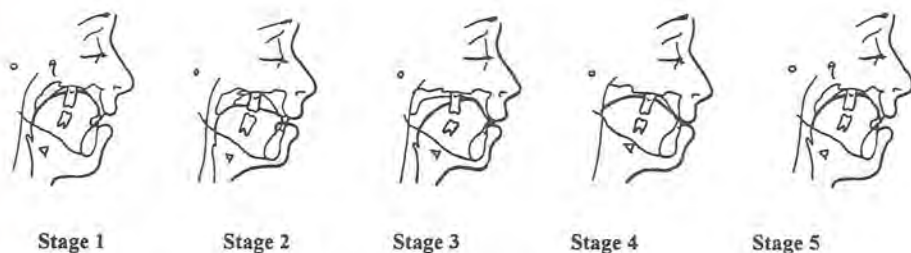


Fig. 7-3. Normal sequence of swallowing. (From Kraus,¹⁶³ with permission.)

Tongue Up and Wiggle

Tongue up and wiggle is an exercise to be performed when the patient is suspected of "bracing" their mandible with their muscles. Bracing would be defined as masticatory muscle hyperactivity but with teeth out of occlusion.

Patients who brace their mandible would be identified by:

- Palpation to determine the presence of masticatory muscle hyperactivity
- Minimal or no occlusal wear
- Patient denial of diurnal parafunction
- Reports of no symptoms on awakening to suggest the absence of nocturnal parafunction
- Minimal therapeutic value received from habit awareness, oral modification, and TTBS

The patient is instructed on the rest position of the tongue. From this tongue up position and teeth apart position, the patient is asked to oscillate or "wiggle" the jaw from side to side. Great care is taken not to have the patient oscillate the mandible through a large range of lateral motion for two reasons. First, excessive lateral excursions mean the joint contralateral to the side of movement is translating. If the joint is inflamed, translation may further increase inflammation. Second, if the patient has a disc displacement that reduces, large lateral excursions may produce joint noises related to the disc displacement. Repetitively reproducing joint noises associated with a disc displacement with reduction may cause an asymptomatic disc displacement to become painful.

To control for excessive lateral excursion that may occur with this exercise, the patient is asked to place the tips of the index fingers to each side of the chin, approximately 1 mm from the skin (Fig. 7-4). When the patient oscillates the mandible from side to side, the index fingers will provide proprioceptive feedback to control excessive lateral excursions. Once the importance of limiting the amount of movement is understood by the patient, speed of the movement may be increased. The objective of mandibular oscillations is to teach an exercise that counters habitual jaw bracing.

Tongue Up and Open and Close With Speed

Hypomobility may be associated with inflammation because the patient is reluctant to open the mouth. The objective of this exercise is to avoid immobility by encouraging movement that avoids translation.

This exercise involves having the patient open and close the mouth wide while keeping the tongue in its rest position (Fig. 7-5). Tongue up while opening allows the condyles to rotate but not to translate. It is the translation of the condyle that often perpetuates inflammation. Tongue up while opening permits at least 20 to 25 mm of mandibular opening. Once controlled opening is under-

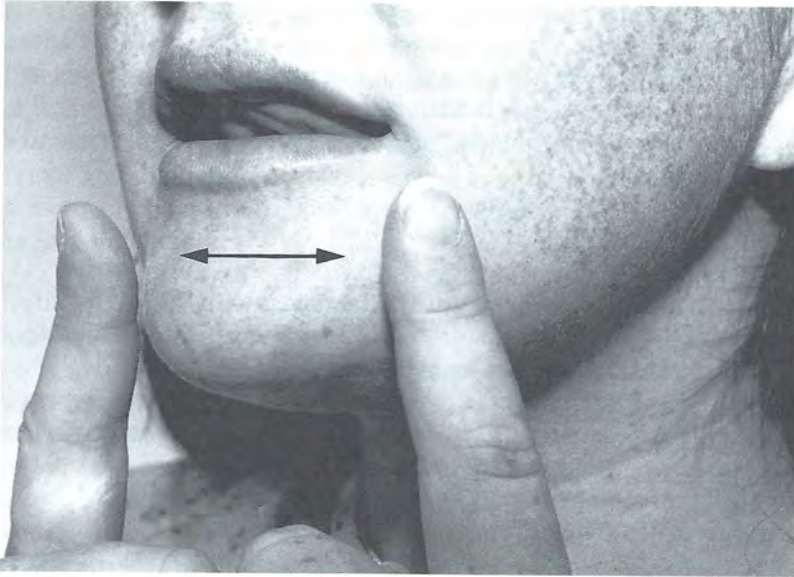


Fig. 7-4. Tongue up and wiggle. This exercise is instructed when the patient is suspected of bracing the mandible with teeth out of occlusion. Note the rest position of the tongue and the minimal space between the tip of the index fingers and the chin as appreciated with the patient's right index finger.



Fig. 7-5. Tongue up and open and close with speed. Exercise allows for condylar rotation while controlling translation. This exercise would primarily be performed for inflammation or for inflammation secondary to arthroscopy or arthrotomy. When yawning, tongue up is performed to restrict mandibular opening.

stood by the patient, the patient can increase the speed of movement. Increasing the speed of opening and closing would be similar to oscillating, which may provide a secondary benefit of enhancing relaxation of the muscles of mastication. A patient who becomes used to opening to 20 to 25 mm will be less reluctant to increase the opening beyond 20 to 25 mm when it is time to do so.

Cervical Spine Disorders

The role of the cervical spine in the management of TMD is covered in Chapter 11. A cervical spine disorder can cause masticatory muscle hyperactivity. As with TMD, there are many subset diagnostic categories of cervical spine disorders. One common category is cervical spine muscle hyperactivity. Cervical spine muscle hyperactivity can cause masticatory muscle hyperactivity, which, in turn, can cause or perpetuate TMJ inflammation. Treatment offered for TMJ inflammation may be indirect through treatment of the cervical spine, which will often relax the muscles of mastication.

Intraoral and Extraoral Massage/Stretching

As mentioned earlier, decreasing masticatory muscle hyperactivity can provide a significant therapeutic outcome in controlling inflammation. Decreasing the "tone" of certain muscles of mastication that may be hyperactive or tight may require intraoral and extraoral massage or stretching techniques by the physical therapist. Direction, force, duration, and movement of a massage or stretch along with the clinician's skill and knowledge of anatomy may influence the therapeutic outcome of such techniques. No effort will be made in this chapter to discuss a particular massage or stretching technique that enhances masticatory muscle hyperactivity. As with many manual techniques, it is not so much the "technique" but more the attention and skill of the clinician that makes the technique therapeutic.

Modalities

The modalities I most commonly use for controlling inflammation are cold, nonthermal ultrasound, phonophoresis, and iontophoresis. Management of masticatory muscle hyperactivity usually involves modalities. Heat/cold, thermal ultrasound, various electrical stimulation parameters, and flourimethane spray are those I most commonly select.

It is a matter of clinical judgment and experience as to the sequence and choice of modalities. As a means of cost containment, I typically use mandibular exercises and manual therapy before escalating to the use of modalities other than those a patient can use at home (i.e., heat and ice). Patient education regarding condition along with a home exercise program plus manual treatments

offered to the cervical spine and muscles of mastication have produced a greater predictable benefit than the use of modalities. The therapeutic value of the modalities in the treatment of inflammation as well as for masticatory muscle hyperactivity should not be underestimated. If a patient is receiving only modalities with no other treatment, it should be of great concern to patients, physicians, and insurance companies. The reader is referred to reference 32 as well as to Chapter 10 (*Postarthroscopic Surgery*) of this text for additional information on modalities.

Summary

In the vast majority of uninvolved patients (i.e., multiple surgeries, multiple diagnoses, high stress, etc) who receive the above treatments, inflammation will be resolved within the first 4 to 6 weeks. Masticatory muscle hyperactivity is considered to play a perpetuating if not a predisposing and precipitating role in inflammation. Treatment for masticatory muscle hyperactivity will usually be offered during this 4 to 6 week time period. Treatments will concentrate on awareness exercises, treatment of cervical spine disorder(s), and modalities. This author places a great deal of emphasis on patient education and the management of the symptomatic cervical spine for controlling masticatory muscle hyperactivity (see Ch. 11). If a patient continues to demonstrate signs and symptoms of inflammation after 4 to 6 weeks of treatment, it is usually due to uncontrolled masticatory muscle hyperactivity that is perpetuating the inflammatory process. In the presence of inflammation and/or muscle hyperactivity that continues beyond 4 to 6 weeks, the patient will need to consult with a dentist. At this stage, the dentist will often offer an appropriate occlusal appliance and nonsteroidal anti-inflammatory medication (see Ch. 6).

HYPERMOBILITY

Hypermobility is identified when the condyle functions beyond the articular crest onto the articular tubercle. The condyle when functioning onto the articular tubercle can be said to be functioning outside its physiologic range but within its anatomic range. Through the contraction of muscles that elevate the mandible, it is possible for the condyle to return to the articular eminence. If the condyle(s) cannot return to the articular eminence by the contraction of muscles but instead remains within the area of the articular tubercle, condylar dislocation is present. Dislocation occurs when the condyle is outside both its physiologic and anatomic boundaries.

The diagnosis of hypermobility can be made by taking radiographs of the TMJ with the patient's mouth fully opened. Hypermobility is such a benign condition that the expense and exposure to radiation does not justify radiographs for the sole purpose of identifying hypermobility. Evaluation of hyper-

mobility can be performed instead when the clinician palpates the lateral pole(s) and feels excessive excursion of the lateral poles during mandibular opening.⁸ Often associated with excessive lateral pole excursion is a combination of mandibular deflection away from the side of hypermobility, possible joint noises, and opening in excess of 40 mm.⁸

The etiology of TMJ hypermobility is unknown. Potential predisposing factors have been suggested that range from joint laxity to psychiatric disorders to skeletal abnormalities.³³ A recent investigation suggests systemic hypermobility (ligament laxity) may be closely related to TMJ hypermobility.³⁴ However, most studies on systemic hypermobility have investigated whether a correlation exists between systemic hypermobility and disc displacements/osteoarthritis of the TMJ.^{35,36} In one study, the authors concluded that disc displacements of the TMJ are a symptom of "joint hypermobility syndrome" (articular complaints in hypermobile subjects who have no diagnosed rheumatic disease).³⁵ However, another study showed that generalized joint hypermobility was not a predisposing factor to TMJ disc displacements and osteoarthritis.³⁶ Regardless of the proposed etiologic factors to TMJ hypermobility, the only way the condyle can translate sufficiently enough to achieve an anterior position on the articular tubercle is through the contraction of the muscles that depress the mandible.

The occurrence of hypermobility is seen frequently with asymptomatic patients. Because hypermobility is as common as disc displacements, one can conclude such conditions may be a variation of the normal. Knowing that hypermobility is going to be present with many patients, the question is, when is it important to treat hypermobility? *Hypermobility is important to treat when inflammation is present or when the patient has pain with full opening.*

Treatment

In the presence of inflammation, if the patient were to open the mouth wide, such as during periods of yawning, excessive translation may perpetuate the inflammatory condition. However, repetitive excessive opening during acts of singing, yelling, etc., or prolonged full opening that occurs during various dental procedures or intubation performed for general anesthesia may be sufficient force to cause inflammation or some other subset diagnostic category of TMD in a previously asymptomatic TMJ.³⁷ If the clinician diagnoses a patient as having an asymptomatic hypermobile joint, it would be appropriate to educate the patient on the recommended treatment for hypermobility for the purpose of prevention. If a prolonged dental procedure is required, the patient should be given frequent rest periods from the open-mouth position.

Treatment for hypermobility should fall way short of surgery for the vast majority of patients. Surgeries such as eminectomy, condylotomy, sectioning of the lateral pterygoid muscle, intracapsular injection of sclerosing solutions, and increasing the height of the articular eminence to block anterior movement of the condyle are suggested surgical treatments for hypermobility.^{38,39} Surgery

performed for hypermobility should only be performed when all other conservative care has been tried.

The following are treatments for hypermobility listed in the order I follow. How far the clinician escalates in the instruction of the exercise depends on the needs of the individual patient. Treatments focus on patient self-awareness and neuromuscular re-educational exercises used to control excessive translation associated with hypermobility. If inflammation is present, one would pursue the course of treatment discussed in the section on inflammation.

Do Not Open Wide

The patient is instructed to avoid opening the mouth so wide. Help the patient to identify activities that encourage wide opening such as yawning, singing, yelling, eating a large sandwich, or dental work. Should a patient require intubation for general anesthesia, the patient should inform the anesthesiologist to take the necessary precautions during intubation. Of the activities listed above, yawning occurs most frequently at a subconscious level and is thus more difficult to control.

Yawn With Tongue Up

Instruct the patient on the rest position of the tongue. The inferior surface of the tongue is connected with the mandible by a mucous membrane that lies over the floor of the mouth to the lingual surface of the gum.⁴⁰ The mucous membrane in its midline forms a distinct vertical fold, the frenulum. By keeping the tongue up during yawning, the frenulum (mucous membrane) is responsible for restricting the amount of mouth opening. Tongue up during mouth opening allows only rotation of the condyles and minimal if any translation of the condyles (Fig. 7-5). The clinician will need to reason with the patient that yawning in this manner may lack some of the satisfaction associated with a wide yawn but avoids the potential for pain.

Lateral Pole Palpation

In this exercise, the patient touches the lateral poles of the condyles with the middle or index fingers. The patient then places the tongue flat against the palate of the mouth. The patient is asked to open the mouth, keeping the tongue against the palate. While opening, the patient palpates the lateral poles (Fig. 7-6). During opening, the patient is asked to keep the lateral poles from moving forward, which should not occur if performed with tongue up. Proprioceptive feedback of the tongue against the palate while monitoring the lateral pole movement with the fingers will promote condylar rotation.

Once the patient can perform this exercise correctly, the patient drops the



Fig. 7-6. Lateral pole palpation. This exercise is for controlling hypermobility. Patient in this photograph has already dropped the tongue from its rest position. The necessary amount of translation may be identified by the patient palpating for a small impression posterior to the lateral poles, as shown by the patient's right index finger.

tongue away from the palate to allow translation. This time, however, the translation is controlled. The goal is to have the patient achieve 40 mm of mandibular opening. The necessary amount of translation may be identified by the patient palpating for a small impression posterior to the lateral pole, indicating controlled translation has occurred (Fig. 7-6). As with any exercise, repetition and the patient's conscious effort will determine the success of treatment in achieving neuromuscular control during mandibular opening.

Isometric Exercise

Isometric exercises classically involve resisting opening, closing, lateral, protrusive, and retrusive movements of the mandible.⁴¹ The resistance is usually offered by the patient's hand or fingers placed on the mandible. Isometric exercises have been prescribed to help with hypermobility but also to aid in "minimizing clicking, retraining muscles to contract symmetrically, overcoming zigzag opening patterns, and increasing mouth opening when it is restricted by muscle spasm."⁴²

Isometric muscular contraction occurs when muscle(s) are contracted against an unyielding resistance in which the proximal and distal attachments neither separate nor approximate (i.e., no physiologic joint motion is produced). The amount of muscle contraction (force) depends on the number of motor

units recruited. A motor unit consists of all the muscle fibers innervated by a single motor nerve fiber.⁴³ For the best results in treating hypermobility using isometrics, this author would suggest using *minimal* muscle contraction.

Isometric contraction of the elevator muscles of the mandible offers a good starting point to gain control over hypermobility. Hypermobility may also be controlled by resisting those muscles involved with mandibular depression, lateral excursion, and protrusion. Contraction of the muscles responsible for all mandibular movement may help in appropriately retraining (rhythmic stabilization) a very detailed, reflexly coordinated neuromuscular system. Isometrics for the purpose of controlling hypermobility of the TMJ are not so much for strengthening purposes but for the *control of movement*. Control of movement can also be implemented with isotonic contractions as well. Isotonic muscular contraction allows the proximal and distal attachments to either approximate (muscle shortening or concentric contraction) or separate (muscle lengthening or eccentric mode).

The patient is instructed to place the tongue in the rest position with teeth apart and place the tip of each index finger against the side of the jaw (Fig. 7-7). The patient commands him- or herself to "hold, do not let the jaw move," thereby making it a hold-relax technique versus a contract-relax technique. A hold-relax technique gives the patient more finesse in controlling the amount of pressure being applied to the jaw. The force of the isometric exercises is minimal. The direction of force applied to the mandible will be in various planes (i.e., sagittal, horizontal, frontal, and oblique), thereby contracting all muscles



Fig. 7-7. Isometric exercise. This hold-relax isometric exercise is performed for controlling hypermobility. The direction of force can be applied in various planes (i.e., sagittal, horizontal, frontal, and oblique).

used in positioning and movement of the mandible. The duration of resistance in any one plane is for only a short period of time.

Isometric exercises for conditions other than for hypermobility are listed below.

Joint Noises (the Reciprocal Click) Related to a Disk Displacement With Reduction. If isometric exercises are instructed with the intention of treating joint noises related to a disc displacement with reduction, such exercises should be performed with the disc in "proper" position. Proper disc position is assumed to have occurred once the patient opens the mouth wide enough for both the clinician and the patient to feel/hear the opening click. For isometric exercises to maintain the disc in proper position through muscle re-education and/or strengthening, the disc must first be in the reduced position. Clinically, this author would only attempt such a feat if the patient was very young, with a disc displaced for only a relatively short time and with the patient wearing an occlusal appliance.

The patient and the clinician should not assume that the absence of joint noises during opening and closing signifies the permanent reduction of a disc displacement regardless of the treatment offered. Patients with a disc displacement with reduction can rotate their condyles up to 20 to 25 mm of mandibular opening without eliciting any opening joint noise. Clinicians may think the treatment using isometrics or isotonics is treating joint noises related to a disc displacement with reduction, when in fact such exercises are simply not allowing for full mandibular opening to occur to expose the opening noise.⁴⁴ More discussion on disc displacements is covered later in this chapter.

Asymmetries of Mandibular Movement. Asymmetries of mandibular movement (deviation/deflection) are frequently seen during mandibular opening and closing as well as protrusion and to some extent during lateral excursions. When the TMJ evaluation is negative for etiologies that are known to be associated with mandibular deviations and deflections, the aberrant movement may be normal and may not require any form of treatment. Pantomographs of 200 asymptomatic female subjects showed the appearance of the TMJ varied widely.⁴⁵ There was at least some evidence of remodeling in nearly every joint. Condylar flattening and sclerosis were the more common changes. Age was a factor in the degree of remodeling. Another study raised the possibility that aberrant muscle attachments may be primarily or secondarily responsible for deviations in opening and closing movements of the mandible.⁴⁶ Instructing the patient on isometric exercises to correct mandibular deflections and/or deviations related to remodeling or aberrant muscle attachments would be unproductive. If mandibular dynamics are asymmetrical yet *functional and pain-free*, then no treatment is necessary.

Mandibular Muscle Weakness. I find that weakness of jaw muscles is the exception rather than the rule. The idea that a jaw muscle can be isolated to

“test” the muscle to see if it is weak is difficult to accept. Even if the muscle can be isolated, false-positive muscle testing can occur due to (1) the patient’s unwillingness to contract maximally, (2) pain-limiting maximum contraction, and (3) pseudo-weakness secondary to reflex inhibition.^{47,48} Isometric exercise for the purpose of strengthening suspected jaw muscle weakness needs to be re-evaluated. Only muscle weakness related to prolonged immobility (i.e., intermaxillary fixation postorthognathic surgery or trauma) would require me to instruct the patient in isometric strengthening exercises.

Mandibular Muscle Relaxation. Contracting one muscle or group of muscles causes reflex inhibition of the antagonist muscle or group of muscles. In the jaw, an example is to contract the depressor muscles of the mandible to cause a reciprocal inhibition of the elevator (antagonist) muscles. Questions of duration and what amount of resistance is needed to initiate inhibition of the antagonist muscles in a dysfunctional state remain unanswered.^{49,50}

An isometric contraction of a muscle(s) producing a specific movement may induce relaxation of the muscle(s). Muscles that elevate the mandible (i.e., temporalis, masseter, and internal pterygoid) are often in need of inhibition. For effective inhibition, the elevator muscles should be in a position of slight stretch. The patient contracts the elevator muscles maximally against an unyielding force (patient’s fingers draped over the lower incisors). For the elevator muscles to relax reflexly, a great amount of tension is required to stimulate the Golgi tendon organs (GTOs). No physiologic information is available as to how long this inhibition persists.⁵¹ The concern I have is the effects that a maximum isometric contraction has on the presence of symptomatic muscles (elevator muscle of the mandible) and TMJ(s). I prefer not to overcontract muscles or overload joints that are symptomatic. Good clinical decision making is mandated in this instance. I prefer minimal isometric contraction. Minimal contraction will give the patient cortical awareness of the muscle contracting and then relaxing. Over time, this form of light isometric contraction may provide relaxation if performed in conjunction with other forms of treatment. Isometric exercises for the purpose of encouraging relaxation of the elevator muscle of the mandible are applied in a similar way as isometrics for controlling hypermobility (Fig. 7-7).

HYPOMOBILITY

Hypomobility is defined here as a limitation in functional movements of the mandible. Mandibular hypomobility may result from disorders of the mandible or cranial bones that include aplasia, hypoplasia, hyperplasia, dysplasia, neoplasia, and fracture.¹ Masticatory muscle disorders such as myofascial pain, myositis, spasm, protective splinting, contracture, and neoplasia may also contribute to hypomobility.¹ TMDs that can contribute to mandibular hypomobility are ankylosis (bony or fibrosis); arthritides, especially polyarthritides involving

the periarticular tissue (capsule) and structural bony changes; disc displacement (acute disc displacement that does not reduce); and inflammation (i.e., joint effusion).

Disorders of the mandible/cranial bones are managed by the dental and medical professions. Disorders of the masticatory muscles are managed by any one or combination of the dental, physical therapy, or psychological professions. Other than inflammation addressed earlier, the tissue conditions contributing to hypomobility for which physical therapy is most helpful are *periarticular tissue tightness* and acute disc displacement that does not reduce.

The physiologic and neurophysiologic sequelae of TMJ hypomobility and response to treatments are not well documented. The physiologic and neurophysiologic effects that hypomobility has on other diarthrodial joints of the body are well documented.⁵²⁻⁵⁷ The effects of hypomobility/immobility on the immediate tissues associated with the TMJ will be extrapolated from what is known about other joints and applied to the TMJ. The following discussion of the effects of hypomobility does not purport to be comprehensive but only to highlight the clinical need for treatment of TMJ hypomobility.

Hypomobility Affecting Kinematics

The nature of movement or kinematics at any joint is largely determined by the joint structure, including the shape of the joint surfaces. The traditional structural classification of the TMJ is ginglymoarthrodial. *Ginglymus* means a simple hinge joint. *Arthrodia* means a joint in which the articular surfaces are flat and glide over or against each other during movements.⁵⁸ The traditional classification of joint movement includes the following⁵⁹:

1. *Angled*—indicating an increase or decrease in the angle formed between two bones (e.g., flexion–extension at the elbow).
2. *Circumduction*—the movement of a bone circumscribing a cone (e.g., circumduction at the hip or shoulder)
3. *Rotation*—movement occurring about the longitudinal axis of a bone (e.g., internal–external rotation at the shoulder)
4. *Sliding*—one bone sliding over another with little or no appreciable rotation or angular movement (e.g., movement occurring between carpals)

This type of movement classification describes osteokinematic movement. Osteokinematics^{60,61} deals primarily with the overall movement of bones (mandible), with little reference to their related joints. An analogy of this would be describing the movement of a door (the mandible) without consideration of its hinges (the joints). Arthrokinematics,^{60,61} however, is concerned with the intimate mechanics of the movements occurring between joint surfaces (condyle–articular eminence).

Osteokinematics

Three basic mandibular movements exist within the mandible. The motions can be described as (1) depression, (2) protrusion, and (3) lateral excursions.⁶² These three basic movements can be combined to produce an infinite variety of mandibular movements. Closing or retrusion are not osteokinematic movements that are evaluated in the same way as other movements. Restriction in closing or retrusion may occur in the last few degrees of jaw closing, when the patient is unable to bring the back teeth together. This usually is due to, but not limited to, any one or combination of joint effusion, hyperactivity of the lower head of the external pterygoid, prolonged use of an appliance such as an anterior repositioning appliance, posterior disc displacement (uncommon), or a malocclusion.

Hypomobility can hinder the patient's ability to function during acts of chewing (involving lateral excursions), talking, yawning, etc. The goals of treatment of hypomobility are to restore osteokinematics as follows:

Depression: Functional depression describes the ability to open the mouth actively to 40 mm measured by placing a millimeter ruler between the tips of the right or left maxillary and mandibular central incisors. Ideally no deflection or deviation should be present.

Protrusion: Functional protrusion is the ability to actively protrude the mandible so that at least an edge-to-edge position can be achieved between maxillary and mandibular central incisors. Ideally, the mandibular central incisors should move past the maxillary central incisors by several millimeters. Ideally, no deflection or deviation should be present.

Lateral excursion: Functional lateral excursion is the ability to actively move the mandible laterally so that at least the mandibular canine achieves an end-to-end position in relation to the maxillary canine. Ideally, the mandibular canine should move past the maxillary canine by several millimeters.

Arthrokinematics

As stated earlier, arthrokinematics are concerned with the intimate mechanics of the movements occurring between joint surfaces (condyle-articular eminence). In orthopaedic physical therapy, a particular jargon has evolved in the area of arthrokinematics. Unfortunately, the use of certain terms is often inconsistent.

Accessory Movements. Arthrokinematics of any joint involves a study of accessory joint movements. Accessory movements are those motions available between joint surfaces that allow for a full, pain-free osteokinematic movement to be present. Accessory movements can consist of either active or passive accessory movements.

Active Accessory Movements. Active accessory movements occur in response to muscle contractions but are guided by the shape of the articulating surfaces and by the periarticular tissues. Active accessory movements include⁶³⁻⁶⁵ *spin*, *roll* (rotation), *slide* (translation), *distraction*, and *compression*.

Active accessory movements occur largely in response to muscle contractions. It would follow that treatments would center on actively moving the mandible into the identified restricted active accessory motion. If, for example, the active accessory movement of translation is restricted, the patient can actively protrude the mandible. By actively protruding the mandible, the active accessory movement of translation of the condylar head is restored and thus the osteokinematic movement of protrusion. However, if osteokinematic movement requires a combination of two or more active accessory movements, a slightly different approach to treatment is needed. For example, the osteokinematic movement of depression involves a combination of the active accessory movements of rotation and translation of the condylar head. If depression is restricted and the clinician actively forces the mouth open, he or she is disregarding the importance of accessory movements. Instead, the clinician will need to address separately the active accessory rotation and translation movements of the condylar head. The patient can be told to protrude the mandible first to regain condylar translation. Once condylar translation is improving, active opening of the mouth can follow.

Restricted accessory movements may also be restored passively through the application of intraoral techniques addressing passive accessory movements. The choice of using active or passive accessory movements or both is entirely based on the clinical presentation of the patient and the etiology of the hypomobility.

Passive Accessory Movements. Accessory movements of a joint that cannot be produced by the action of muscle contractions but instead are produced passively in response to an outside force are referred to as *passive accessory movements* or *joint play movements*.⁶⁶ Joint play movements include any one or combination of spin, rotation, translation, distraction, and compression, as described for active accessory movements. An additional joint play movement that does not double as an active accessory movement is lateral glide.

Joint play movements can occur in any particular joint position. Joint play movements are the inherent quality of the joint to "give." The "built-in" factor of joint play is critical to promote efficient functional movements.⁶⁷ An analogy is a hinge on a door that has play between its components to allow the door to open and close smoothly and easily. A loss or decrease in the joint play movement(s) of the TMJ may be a primary restricting factor to osteokinematic movements of the mandible as well as to active accessory movements.

Summary of Accessory Movements. Five active accessory movements (spin, rotation, translation, distraction, and compression) and six passive accessory movements (spin, rotation, translation, distraction, compression, and lateral

glide) may seem overwhelming to evaluate and treat when osteokinematic movement is restricted. Without oversimplifying the kinematics of the TMJ, this author finds certain accessory movements to be more restricted than others. Accessory movements restricted secondary to periarticular tissue tightness and disc displacements are active and passive accessory movements of *translation* and *distraction* and the passive accessory movement of *lateral glide*. Of these three accessory movements, *translation* is the primary accessory movement that causes the most limitation in osteokinematic movement of the mandible and the more difficult one to restore.

Hypomobility Affecting Articular Cartilage

Joints lacking full range of motion (ROM) have a distinct reduction in supply of blood to the joint capsule.⁶⁸ A reduction in blood supply decreases nutrients going to the cells that make up the synovial membrane, which, in turn, produces synovial fluid.⁶⁹ Synovial fluid supplies oxygen and nutrients to the articular cartilage. Without full range of joint movement, there will be inadequate mixing of the synovial fluid. Waste products of metabolism will accumulate on the surfaces of the cartilage causing cartilage cell dystrophy. Joint immobilization can therefore initiate an arthritic process.⁶⁸

Articular cartilage's main function is to distribute compressive forces to the underlying subchondral bone.^{53,70} Hypomobility alters the biomechanics of the joint, resulting in improper loading of articular cartilage. Hypomobility will cause certain areas of the articular cartilage to receive higher than normal impact loads, leading to potential fatigue failure and arthritic changes in the articular cartilage. The effects hypomobility has on articular cartilage are dependent on the amplitudes, frequency, duration, and rate of application of loading.⁷¹

Research on the effects of immobilization on the primate TMJ⁷² concluded that prolonged immobilization of the TMJ results in degenerative changes in the articular cartilage. The degenerative changes of immobilization may be reversed once remobilization is established.

Hypomobility Affecting Mechanoreceptor Activity

Clinicians need to acknowledge the importance of the mechanoreceptors of the TMJ and how mechanoreceptor activity can be affected by hypomobility. The TMJ, as with all mammalian synovial joints, contains four types of receptor nerve endings, which can be differentiated on the basis of morphologic and functional characteristics.^{73,74} TMJ synovial receptors are located in the fibrous joint capsule, the lateral ligament, and the posterior articular pad but are absent from the intra-articular disc (central portion) and synovial tissues. Terminating on the receptors are the deep temporal, masseter, and auriculotemporal nerves, which originate from the mandibular division of cranial V.^{75,76} For clarity pur-

poses, emphasis will be placed on hypomobility affecting the joint capsule (periarticular tissue), which contains an abundance of type I, II, III, and IV receptors.

Type I receptors are continuously discharging because of their low-threshold and slow-adapting characteristics. Continuous discharging occurs, even when the mandible is at rest. The type I receptors provide continuous kinesthetic and postural perception of the mandible. Type I receptors also exert powerful reciprocally coordinated, facilitory, and inhibitory reflex effects on motor unit activity to the mandibular muscles.⁷⁴

Type II receptors have low-threshold and rapid-adapting characteristics. They fire briefly as mandibular movements are initiated and exert transient coordinated reflex effects on the related musculature.⁷⁴

Type III receptors are high-threshold and slow-adapting receptors, which do not fire under normal circumstances but become active only when excessive tension is developed in the lateral TMJ ligament. Type III activation has been demonstrated to result reflexively in pterygoid and mylohyoid muscle spasms and temporalis and masseter muscle inhibition.⁷⁴

Type IV receptors constitute the pain receptor system of the articular tissues and are entirely inactive in normal circumstances. They become active when the TMJ articular tissues (joint capsule, posterior pad, and TMJ ligament) are subjected to marked mechanical deformation, tension, or direct chemical irritation.⁷⁷

Afferent discharges from types I, II, and III, as well as other receptors in the skin, subcutaneous tissue, and muscles about the synovial joints, all converge on inhibitory interneurons, segmentally and intersegmentally. This convergence modulates the centripetal flow of nociceptive afferent activity derived from the joint tissues having type IV receptors. The degree of joint (TMJ) pain experienced by a patient depends not only on the intensity of type IV irritation but also on the frequency of ongoing afferent discharges from the various types of mechanoreceptors embedded in the same joint capsule (TMJ), related soft tissues, and muscles.⁷⁸ Deliberate stimulation of the type I, II, and III mechanoreceptors in the TMJ capsule and adjacent tissues by the use of transcutaneous electrical nerve stimulation (TENS) or intraoral manual oscillatory techniques may help enhance the modulating effect of the primary afferent activity on the type IV receptors of the TMJ. If capsular tightness (fibrosis) is the primary cause of type IV activation, complete alleviation of pain may occur when proper intraoral arthrokinematic techniques are applied and capsular extensibility is restored.

Clinical Implications

Capsular tightness affecting mechanoreceptor activity needs to be investigated when the patient perceives that the "bite is off." Patient perception of an "uneven bite" may be due to a malocclusion. If the attending dentist cannot

identify occlusal factors contributing to the patient's bite "not feeling right," altered mechanoreceptor activity needs to be considered. Altered mechanoreceptor activity contributing to improper proprioceptive feedback along with muscle activity may contribute to the patient's perception of a "pseudo" malocclusion. If capsular tightness was identified and treated, the patient's perception of the initial tooth/teeth contact during jaw closing may then be perceived as being "normal."

Dental procedures that place the condyle in a position that "strains" the capsule may need to be re-examined. The condyle position for recapturing a disc displacement with an anterior repositioning appliance (ARA) illustrates the potential for capsular strain. The ARA often places the condyle in an overcorrected position anteriorly and could be considered a strained position for the joint capsule. An overcorrected position may not be conducive to the articular receptor system of the TMJ capsule. This may especially be true when it appears that the mechanoreceptors located in the anterior region of the joint capsule make a facilitory contribution to supramandibular muscle activity.⁷⁹

An acute disc displacement without reduction is a hypomobile condition. Capsular tightness secondary to a loss of full joint mobility may occur. Procedures performed that are successful at reducing the disc may be followed by an ARA to maintain disc position. Poor tolerance to the appliance may occur for reasons mentioned above. Exacerbation of symptoms may result from an untreated capsular restriction in response to hypomobility secondary to an acute disc displacement without reduction.

Certain techniques used by dentists to establish centric relation (CR) may be a strained position for the capsule. CR is a clinical concept intended to provide a reproducible jaw relationship during occlusal adjustments and reconstruction. There is controversy over the exact definition, condylar position, and technique used for CR.⁸⁰ The basic objective for achieving CR is to arrive at an occlusal relationship that will promote neuromuscular harmony of the muscles of mastication. Capsular tightness affects mechanoreceptor activity, which in turn influences mandibular muscle activity. The objective of achieving neuromuscular harmony may be better accomplished if capsular tightness as well as cervical spine disorders, which can also affect mandibular muscle activity (see Ch. 11), are dealt with before establishing CR through irreversible occlusal adjustments and/or reconstruction.

Treatment

Dysfunctional osteokinematic movements of the mandible secondary to periarticular tissue tightness and an acute disc displacement that does not reduce are discussed. If functional mandibular movements are restored, therapeutic effects of increased mobility on kinematics, articular cartilage, and mechanoreceptors of the TMJ will occur.

Hypomobility Caused by Periarticular Tissue Tightness

Periarticular tissue refers to the capsular-ligamentous tissue of joints. The entire lateral aspect of the TMJ capsule is thickened, forming the temporomandibular (TM) ligament, and the TMJ ligament should thus be regarded as part of and inseparable from the capsule.⁸¹ A capsule is a "sac-like envelope which encloses the cavity of a synovial joint by attaching to the circumference of the articular end of each involved bone."⁸² The capsule of the TMJ, although somewhat deficient anteriorly, is circumferentially attached to the rim of the glenoid fossa and articular eminence of the temporal bone above and to the neck of the condyle below. The capsule is dense, irregular connective tissue with two layers. The outer fibrous layer consists mostly of collagen, and the inner layer is the synovial lining.

Etiology of Capsular Tightness. Biochemical and biomechanical changes occur in the capsule when normal ROM of the joint is decreased. Changes of this type have been documented in the literature.⁸³⁻⁸⁵ Biochemically, a reduction in water and glycosaminoglycans (GAG) results. GAG and water form a semifluid viscous gel that acts as a lubricant between collagen fibers making up the outer layer of the capsule. Free gliding of collagen fibers over one another is essential for the extensibility of a joint capsule. Biomechanically, when there is a reduction in water and GAG, the capsule becomes tight because of loss of free gliding of collagen fibers. The following is a list of common etiologies that can contribute to capsular tightness of the TMJ.

Macrotrauma. The human body's response to injury is always the same regardless of the location or the type of injury (i.e., a direct blow or surgical intervention).⁸⁶ The response to trauma is vasodilation (*redness*), swelling (*exudate and bleeding from torn vessels*), increase in blood flow and/or chemical and metabolic activity (*heat*), and irritation of nerve endings (*pain*). Hypomobility that follows trauma is due to pain, reflex muscle guarding, and joint effusion. Subsequent loss of function may result from a combination of active destruction of tissue and dense scar formation in the injured joint capsule and other involved soft tissue.⁸⁶

Direct trauma to the joint capsule would also involve **joint effusion**, especially if the joint capsule was torn or stretched. Joint effusion can cause the appearance of capsular tightness due to distention of the joint capsule. Parts of the capsule that are normally lax to allow for a specific ROM are no longer lax because of capsular distention. It is important for the clinician to recognize that significant joint effusion can cause hypomobility. Stretching the joint capsule would be contraindicated in the presence of joint effusion. Instead, the clinician should assist in the resolution of the acute intracapsular inflammatory process (see Inflammation). Once the inflammation is controlled, treatment for capsular tightness, including stretching, may be necessary.

Adhesions, which develop secondary to joint effusion, may develop between the collagen fibrils of the capsule as well as between the joint surfaces and the intra-articular disc. The potential for adhesions to follow trauma or open joint surgery for various joint disorders is likely unless proper kinematics of the joint are restored soon. Adhesions unrelated to trauma may also occur in the upper joint space secondary to an acute disc displacement without reduction.^{87,88}

Microtrauma. Microtrauma may occur with a "malocclusion of the teeth resulting in a change of the maxillo-mandibular relationship and therefore in a change in joint position and in the pattern of capsular stress."⁸⁹ Habits can be an additional source of microtrauma to the capsule. Gum chewing, biting on pencils, and leaning the jaw on the hands need to be avoided to prevent unnecessary stress to the capsule.

Postarthrotomy. During an open joint procedure, it is clear that the capsule will have been traumatized. Physical therapy treatments for rehabilitating the TMJ after arthrotomy will follow procedures discussed in this section and in Chapter 10 (*Postarthrotomy Surgery*) as well as those proposed by Bertolucci.⁹⁰ The clinician should not assume that hypomobility postarthrotomy is due only to the traumatized incised capsule. The objectives of the surgery itself can contribute to hypomobility. If, for instance, alloplastic or autogenous material is placed in the joint, mandibular movement will more than likely be restricted in the initial phases of recovery. If the posterior tissues are shortened surgically, a restriction in mandibular dynamics may result. It is important for the physical therapist to recognize that hypomobility postsurgery may be due to a variety of reasons other than capsular tightness. Treatments, therefore, must be tailored to individual situations. If the physical therapist has any questions about the contraindications of a particular technique/procedure, a discussion with the oral surgeon is in order.

Postarthroscopy. Trauma to the joint capsule is not as extensive after arthroscopy as it would be for arthrotomy. Most patients postarthroscopy that have restrictions in mandibular dynamics recover their ROM quickly with physical therapy treatments. Physical therapy treatments for rehabilitating the TMJ after arthroscopy will follow procedures discussed in this section as well as in Chapter 10 (*Postarthroscopic Surgery*). Additional articles discussing physical therapy protocol postarthroscopic can be obtained from the bibliography.⁹¹⁻⁹³

Postorthognathic Surgery. Mandibular hypomobility is sometimes a complication of orthognathic surgery.⁹⁴ As discussed with arthrotomy, mandibular restriction may be related to factors other than capsular tightness. Reduced mobility may be related to surgery-induced changes in condyle position,⁹⁴ the degree of surgical trauma,⁹⁵ duration of maxillomandibular fixation,⁹⁵ and non-rigid fixation.⁹⁶ The biochemical and biomechanical changes of capsular tissue

after hypomobility, more likely postintermaxillary fixation, contribute to a decrease in interincisal opening. Early restoration of mobility postorthognathic surgery is discussed in Chapters 9 and 10 (*Postorthognathic Surgery*).

Polyarthritides. As mentioned in the section on inflammation, polyarthritides are best treated by the medical/dental profession. The end result of some polyarthritides is an increase in collagen fiber content, contributing to the loss of capsular extensibility.⁹⁷ The more destructive the process, the more vigorous is the repair response and collagen production during resolution. Increase in capsular tissue collagen production secondary to the polyarthritides becomes a more difficult situation to resolve. Remodeling of the excess collagen and realignment of the collagen fibers and abnormally placed cross-links among the collagen fibers are all factors that may hamper normalization of capsular extensibility.^{85,97} Fortunately, polyarthritides of the TMJ are rare.¹

Examination. Insight into the history and physical examination of periarticular tightness may increase the awareness of the clinician to a condition that is often overlooked as a contributing cause to restriction of mandibular dynamics. Specifics of the examination are not addressed.

History. Inquire about the occurrence of possible etiologies of capsular tightness previously covered.

Physical Examination. Translation is most often the accessory movement that is restricted. Whenever translation is restricted, rotation of the condyle still permits up to 20 to 25 mm of mandibular opening.^{98,99} If unilateral capsular involvement is present, the following **osteokinematic restrictions and aberrant movements** of the mandible will be observed:

1. Less than functional opening with deflection to the side of the involved joint with mandibular depression
2. Less than functional protrusion with deflection to the side of the involved joint
3. Normal lateral excursion to the side of the involved joint; less than functional lateral excursion to the opposite side of the involved joint

Inflammation and masticatory muscle hyperactivity associated with periarticular tightness will influence the overall amount of active movement and degree of mandibular deflection. The previous restrictions in osteokinematic movements associated with periarticular tightness are similar to those associated with an acute disc displacement that does not reduce. Depending on treatment goals (i.e., restore mandibular dynamics regardless of cause or to attempt to reduce a nonreducing disc), a differential diagnostic evaluation will need to be performed to know which condition the patient may have.

As part of a differential diagnosis, especially if inflammation and/or mas-

tatory muscle hyperactivity is present, the clinician may need to examine for capsular tightness by assessing the amount of **passive accessory movements** with intraoral passive mobility examination techniques. Hand placement, direction of force, and stabilization of the patient for the application of these joint play examination techniques will be covered under the treatment section. The main differences between examination and treatment using intraoral techniques are the force and duration used.

When evaluating for joint play, the force is a slow, steady, deliberate pressure to feel a "yield" at the end of the expected range. The amount of time applying the force to determine the "yield" is very short (i.e., 1 to 2 seconds). If the force is applied for a longer period of time, the examination becomes a treatment. The stabilizing hand should be positioned so that an index or middle finger can be placed over the lateral pole to assess movement (Fig. 7-8). A capsular restriction is determined by the clinician's conceptualization of "normal" for the movement tested. A "gummy" end feel describes what the end range of a pathologic tight capsule feels like. If possible, the state of the dysfunctional joint can be compared with the noninvolved contralateral joint. The patient's report of irritability is to be considered. Clinician knowledge of anat-



Fig. 7-8. Hand placements for intraoral examination and treatment. Patient lies supine with the cervical spine supported. At the same time that the right hand stabilizes the patient's head, the middle or index finger palpates the lateral pole to assess movement. The thumb of the other hand is placed in the patient's mouth. Thumb position will be better appreciated in Figures 7-11, 7-12, and 7-13. Hand placements are the same for both the examination and treatment of passive accessory movements and for the treatment of an acute disc displacement without reduction (ADDWoR).

omy and kinematics and clinician expertise with respect to application of force and patient stabilization will aid assessment of passive accessory movements.

As a general rule, this author would like at least 20 to 25 mm of active mandibular opening before initiating the treatment procedures that follow. In the absence of translation, rotation will allow 20 to 25 mm of opening. Anything less than 20 to 25 mm typically indicates either inflammation and/or masticatory muscle hyperactivity. Inflammation and masticatory muscle hyperactivity should be addressed before implementing techniques to treat capsular tightness.

Treatment. Techniques that follow are applied clinically in the same order as they are introduced here. A technique is continued as long as improvement is noted by assessing the patient's signs and symptoms. It is difficult to give guidance as to how much force, how long, and how often the technique should be repeated. The subjective and objective presentation of the patient will help to identify individual therapeutic parameters. Clearly, if hypomobility is caused by surgical intervention to the TMJ, the surgeon needs to understand what treatments the physical therapist will be offering, and the physical therapist needs to have a clear understanding of what surgical procedures were performed and to what tissue. Communication between health professionals will deter any complications that could arise during the rehabilitation process. It is important to emphasize that the following treatments are not to be offered in a cookbook fashion, but instead such treatment must be rendered by a physical therapist using sound clinical judgment.

Tongue Up and Open and Close With Speed. The instructions given to the patient for this exercise were covered in the section on Inflammation (Fig. 7-5). The therapeutic value of this exercise is to get the patient's jaw moving in a controlled manner. Tongue up as discussed earlier will control translation. Movement is then performed to counter the effects of immobility. Increase in pain will seldom occur with this exercise. If pain is a factor, modalities to control pain can be administered.

The opening and closing movement regardless of movement velocity is postulated to have an effect of "pumping" similar to continuous passive motion (CPM).¹⁰⁰ Intra-articular pressure alternately raised and lowered through movement presumably facilitates the clearance of fluid and diffusable particles from the joint space into the interstitial tissues.¹⁰¹ Postarthrotomy, this exercise is postulated to permit therapeutic stress on repaired tissues without inciting inflammatory reactions in these same tissues.⁸⁶ When performed in the upright position, gravity offers active assistance in enhancing ROM. Opening and closing can be performed continuously based on the patient's motivation.

Finger Spread Exercise. The patient rests supine, with the clinician standing at the head of the patient. Using the hand opposite the involved joint, the clinician places his or her thumb on the tip of the patient's lower central incisors and index finger on the tip of the top central incisors (Fig. 7-9). The patient is



Fig. 7-9. Finger spread exercise. This exercise is performed for the diagnosis of periarticular tissue tightness or ADDWoR. The clinician's free hand is performing an ultrasound treatment during the finger spread exercise.

asked to open actively as the clinician follows with his or her fingertips on the patient's incisors. At the end of the available range, overpressure is applied with the clinician's fingertips.

An important modification to this manual exercise is performed at the time the patient can actively achieve 20 to 25 mm. The patient is instructed to first protrude the mandible forward (1 to 2 mm) and then open the mouth. This will encourage the condyle to enter into the translation phase to avoid possibly forcing rotation beyond 20 to 25 mm. Ultrasound can simultaneously be applied to the involved joint while performing this exercise. Also, this same exercise can be shown to the patient to do at home.

Touch and Bite Exercise. Capsular tightness affecting the mechanoreceptor activity will alter afferent input to the central nervous system (CNS) about jaw position and movement. What appears to be a limitation in active mandibular movement may be related to a problem in coordination and proprioceptive feedback. The touch and bite exercise aids in the retraining of mandibular protrusion and lateral excursion.

The patient is lying supine, with the clinician standing at the patient's head. Using the hand opposite the involved joint, the clinician places his or her index finger on the outside of the patient's maxillary canine, opposite to the involved joint (Fig. 7-10A). The clinician asks the patient to "reach over and bite my finger." Mandibular movement toward the canine encourages active lateral excursion to that side and condylar translation on the opposite side. Touching

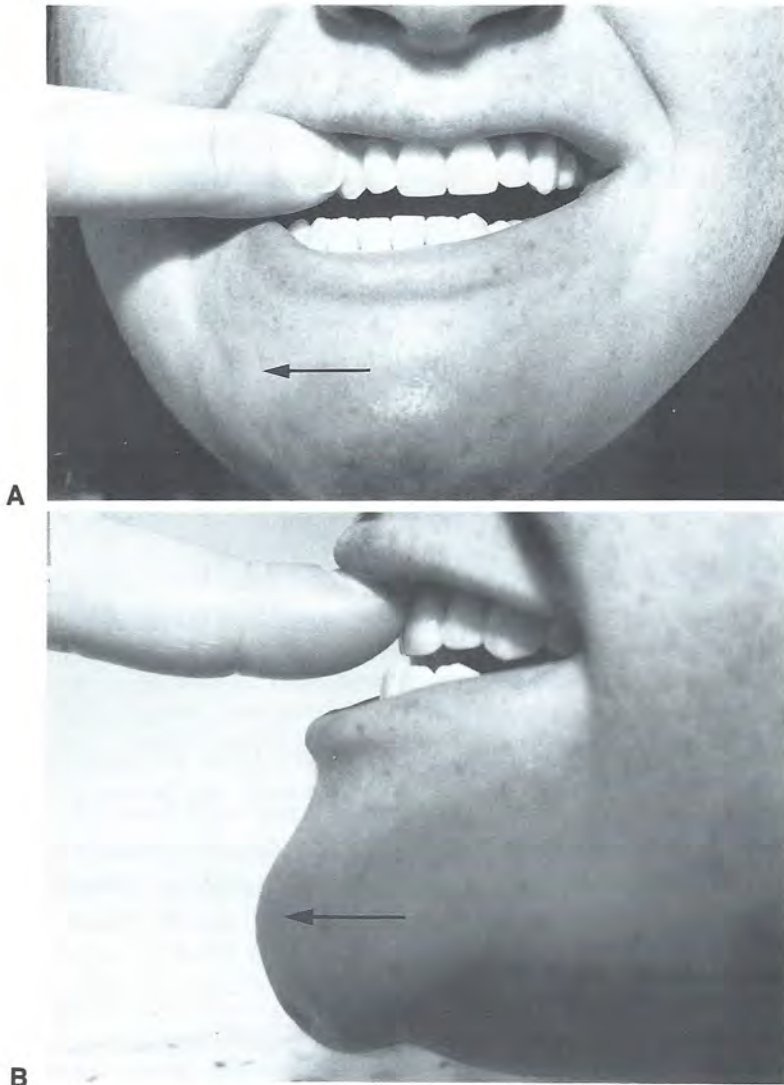


Fig. 7-10. Touch and bite exercise. (A) This exercise is used to coordinate movement of lateral excursion through proprioceptive feedback as well as to treat restricted translation secondary to periarticular tissue tightness and an ADDWoR. In this photograph, the movement is right lateral excursion. The joint that would be restricted in translation would be the left. This exercise can be performed with the patient in the supine position with the clinician standing at the top of the patient's head, touching the patient's right maxillary canine. The clinician's other hand could be performing an ultrasound to the involved joint. (B) This exercise is for coordinating movement of protrusion through proprioceptive feedback as well as to treat restricted translation secondary to periarticular tissue tightness and an ADDWoR. This exercise can be performed by the clinician as described in Figure A. The clinician, however, touches the patient's maxillary central incisors with one hand as the other hand could be performing an ultrasound to the involved joint.

the canine gives proprioceptive feedback to the patient as to the required direction of movement. This exercise can also be performed for protrusion (Fig. 7-10B). The clinician would instead touch the front of the patient's central incisors.

While doing this exercise, ultrasound can be applied to the involved joint. This exercise can also be shown to the patient to do at home.

Joint Mobilization Techniques. *Joint mobilization* is a very general term that might be applied to any active or passive attempt to increase movement of a joint. Passive joint mobilization has been a popular treatment for the restoration of joint motion for many years. Passive intraoral joint mobilization techniques will be those techniques applied to the TMJ to address more specifically the restoration of the passive accessory movements of distraction, translation, and lateral glide. Identifying restrictions in passive accessory movements will be determined by performing the intraoral passive accessory movement examination techniques as covered in the previous section, *Physical Examination/Passive Accessory Movement*. Hand placements for examination and treatment will be identical for both. These techniques can be performed with the patient sitting rather than supine, but patient relaxation may be more difficult.

Distraction refers to a force applied parallel to the longitudinal axis of the bone, in this case, the mandible. Distraction is the first choice of the intraoral techniques to use due to the safety, ease, and effectiveness of application.

The clinician will be standing opposite the involved joint with the patient lying supine, with appropriate support given to the cervical spine (Fig. 7-11). The clinician's thumb is placed on the patient's molars on the side of the involved joint. The remaining fingers are wrapped around the chin comfortably. The clinician's other hand stabilizes the patient's cranium; the middle or index finger palpates the lateral pole for movement. If limitation of jaw opening prevents the placement of the thumb on top of the molars, the thumb may be positioned in the premolar area. Premolar contact will tend to encourage the novice clinician to induce osteokinematic depression versus arthrokinematic distraction unless the clinician is careful to generate the forces correctly on the mandible.

There are three stages of distraction¹⁰² that can be applied, depending on patient signs and symptoms:

Stage I: Piccolo: movement is so small that only the compression effect in the joint is released while the joint pressure is neutralized. The joint surfaces are not separated from each other.

Stage II: The slack is taken up moving the joint partner as far as the soft tissues allow using minimal force.

Stage III: This is a continuation and an extension of stage II, but uses more force to progress into the pathologic limits of the restricted tissue.

To enhance the mobilization technique of distraction, active participation



Fig. 7-11. Intraoral distraction. This exercise is for periarticular tissue tightness or ADDWoR. Clinician and patient positions are described in Figure 7-8. The clinician's thumb is positioned to apply a distraction force. *Arrows* demonstrate the direction of force applied with the left thumb and hand.

by the patient is encouraged. For example, while performing the distractional technique, have the patient actively open or close on command using *minimal* muscle contraction. When the patient relaxes, additional distraction forces can be applied. Performing the distractional technique during active participation by the patient allows the patient to experience a less stressful, less painful movement of the joint.

For **translation**, the clinician's body position and stabilizing and mobilizing hand placements are the same as in the distraction technique. The clinician's mobilizing hand will translate the condyle in an anterior direction. *Translation* is not just performed in the sagittal plane but also in an oblique plane slightly across midline (Fig. 7-12). Translation should be performed in the presence of either stage I, II, or III distraction, which will aid in patient comfort.

For **lateral glide**, the clinician's body position and stabilizing hand are the same as in the distraction technique. The thumb contact of the mobilizing hand, however, is different. Thumb contact for lateral glide technique is on the top/inside of the molars. The rest of the fingers wrap around the mandible comfortably. Lateral glide is performed by pressing laterally with the thumb, at the same time force is directed toward the table and patient's feet (Fig. 7-13). These multiple directions of force avoid discomfort on the contralateral side that would be likely if a lateral force alone is used.

Graded rhythmic oscillatory movements may be applied simultaneously



Fig. 7-12. Intraoral translation. This exercise is for periarticular tissue tightness or ADDWoR. Clinician and patient positions are described in Figure 7-8. The clinician's thumb is positioned to apply a translation force. The clinician will also be applying either a stage 1, 2, or 3 distraction. *Arrows* demonstrate the direction of force applied with the left thumb and hand.

while applying distraction, translation, and lateral glide joint play techniques. Rhythmic oscillatory movements are graded 1 to 4, whereas a grade 5 involves a thrust.¹⁰⁴ Grades of oscillations distinguish range and amplitude of oscillations (Fig. 7-14A). The range is based on the pathologic limits of range and not the limits of passive accessory movements for the joint under normal conditions (Fig. 7-14B).

Grade I: Small amplitude motion performed at the beginning of the available range

Grade II: Large amplitude motion performed within the available range

Grade III: Large amplitude motion performed up to the limit of range available

Grade IV: Small amplitude motion performed at the limit of range

Grade V: Manipulation, a high-velocity, low-amplitude thrust, performed at the limits of the available range. Clinically, I have never found the need to apply a thrust to the TMJ and would not advise to do so.

The rationale for applying oscillatory techniques during distraction, translation, and lateral glide movements is either neurophysiologic and/or mechanical.¹⁰³



Fig. 7-13. Intraoral lateral glide. This exercise is for periarticular tissue tightness. Clinician and patient positions are described in Figure 7-8. The clinician's thumb is positioned to apply a lateral glide force. *Arrows* demonstrate the direction of force applied with the left thumb and hand.

Stages I and II distraction and oscillatory techniques of grades I and II are primarily influencing the mechanoreceptors because these techniques are performed well within the available pathologic range. Increased ROM after these maneuvers derives from the **neurophysiologic effects** of a decrease in pain (gaiting) or decrease in masticatory muscle tone via joint mechanoreceptor influences.^{104,105}

The **mechanical effects** of joint mobilization are achieved with stage III distraction and grades III and IV oscillatory techniques and the grade V thrust technique. Neurophysiologic effects will no doubt accompany any mechanical forces applied to a joint.

Connective tissue responds to mechanical stress in a time-dependent or viscoelastic manner (Fig. 7-15). The force/load applied needs to exceed the elastic range of a tissue, otherwise, the tissue will return to its original shape and no permanent elongation of the tissue will have occurred.^{106,107} Beyond the elastic range or yield point is the plastic range of the tissue.^{106,107} Long-lasting or plastic elongation is dependent on the intensity and duration of force applied.^{108,109} If loading is continued too far into the plastic range (fatigue point), tissue damage may result.

The clinician may not be able to maintain either the necessary force or duration of force required to achieve plastic elongation of the tissue with intraoral techniques. If patient tolerance of intraoral techniques is good but ROM

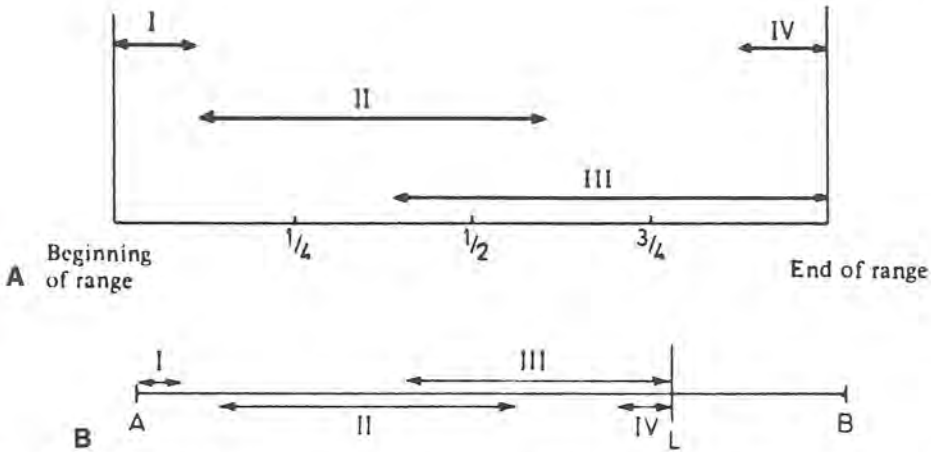


Fig. 7-14. (A) Grades of passive movement: I, small amplitude in beginning of range; II, large amplitude within the range; III, large amplitude up to the end of range; and IV, small amplitude up to the end of range. (B) Normal range of joint movement is limited. A, beginning of range of movement; B, average anatomic limit; L, pathologic limit of range. Grades III and IV are restricted to the new limit of the range. Grade II movements are restricted to smaller amplitudes. (From Maitland,¹⁰³ with permission.)

between treatments is not maintained, progression to the static tongue blade technique (Fig. 7-16) may be necessary.

General rules to follow when applying joint play intraoral techniques to the TMJ are

1. Patient and clinician must be properly positioned and relaxed.
2. Patient should be stabilized firmly.

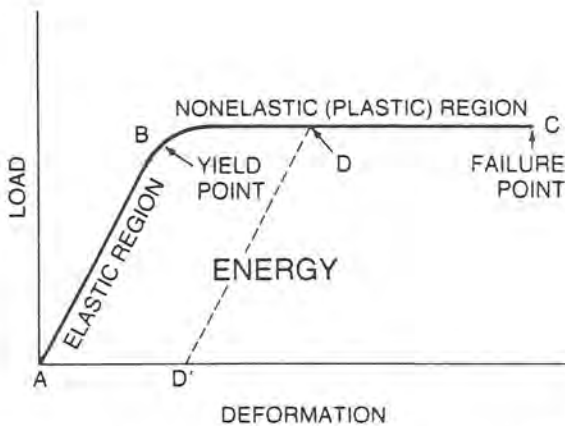


Fig. 7-15. Load–deformation curve. (From Frankel and Nordin,¹⁶⁴ with permission.)



Fig. 7-16. Static tongue blade exercise. The use of tongue blades is to apply a low-load prolonged stretch. This exercise can be performed for periarticular tightness, ADDWoR, or tight elevator muscles of the mandible that have gone through length-associated changes. The clinician can apply heat and/or ultrasound during the duration of the stretch.

3. Clinician must be willing to modify the technique based on the tissue's response and needs. The clinician must be able to "think" through his or her fingers. This is known as "tissue tension sense."

4. Clinician should use the minimum of force consistent with achieving the objective of restoring capsular extensibility.

Mobilization techniques when performed incorrectly or not indicated may result in the following:

1. Increase in pain
2. Increase in swelling and/or muscle guarding
3. Decrease in mobility

Cotton Roll Distraction. Cotton roll distraction is a home exercise that permits self-distraction to the involved joint (Fig. 7-17). This is a *passive* exercise and not active. The patient will be sitting in a comfortable supported position. The patient places a dental roll $\frac{1}{4}$ inch in diameter between the back molars on the side that is to be distracted. The patient places one hand (palm area) under the chin. The other hand is placed on the top of the head toward the front. Both hands are therefore in front of the dental roll. With the patient's jaw as relaxed as possible, the chin hand applies a slight pressure superiorly as the other hand stabilizes the head. Hand pressure in the presence of relaxed



Fig. 7-17. Cotton ball distraction. This exercise can be used when joint unloading is required for such conditions as inflammation, masticatory muscle hyperactivity, periarticular tightness, or attempting to reduce an ADDWoR. A stage I, II, or III can be performed by the patient with proper instructions. If this technique is performed to progress an AADWoR to a chronic disc displacement without reduction (CDDWoR), a stage I distraction is performed as the patient protrudes their jaw to address translation more aggressively.

jaw muscles creates a pivot over the dental roll with the end result being distraction of the condyle.

Static Tongue Blade Exercise. The use of tongue blades is for applying a low-load prolonged stretch (LLPS) to promote long-lasting elongation of the periarticular tissue. The effectiveness of LLPS has been well documented by laboratory studies.¹⁰⁹⁻¹¹¹ The patient should be positioned supine for this procedure. The patient is instructed to place tongue blades on the side of the involved joint in the area of the molars. (Fig. 7-16). As a general guideline, one tongue blade positioned on the molars is equal to approximately 3 mm of opening. The patient is told to "take up the slack and then some" with the tongue blades. If more than five tongue blades are used, try taping or glueing all but three of them together. The last tongue blade can be slid in or out between the remaining tongue blades. Working up to a 10- to 20-minute LLPS using tongue blades seems to be satisfactory. Actual duration of the LLPS will usually be dependent on patient tolerance.

Studies have shown that by raising the temperature of the tissue being stretched and allowing the tissue to cool in a loaded position, a greater elongation of the treated tissue(s) is produced.¹¹¹⁻¹¹³ Before the patient is placed on a LLPS, moist heat can be applied over the involved joint. The moist heat can be continued while the tongue blades are in place for 10 minutes. A 6- to 8-minute ultrasound can be applied with tongue blades still in place to complete the LLPS session. On completion of the session, moist heat can be applied again while the clinician or patient performs the finger spread exercise for an additional 2 to 4 minutes. This exercise can be performed as a home exercise. The patient is advised to use heat, applied as directed above.

Although not always recommended, some patients may need to grasp the end of the tongue blades and pry down. This will encourage osteokinematic opening rather than arthrokinematic distraction. Those patients with painless restriction who are responding slowly may require this technique to encourage increased mandibular opening.

Horizontal Tongue Blade Exercise. This exercise directly addresses limitation in translation. This is a home exercise for the patient. The patient places seven tongue blades, taped or glued together horizontally, between the upper and lower anterior teeth (Fig. 7-18). The patient does not bite on the tongue blades, but instead the tongue blades are held in position by the patient's hands.

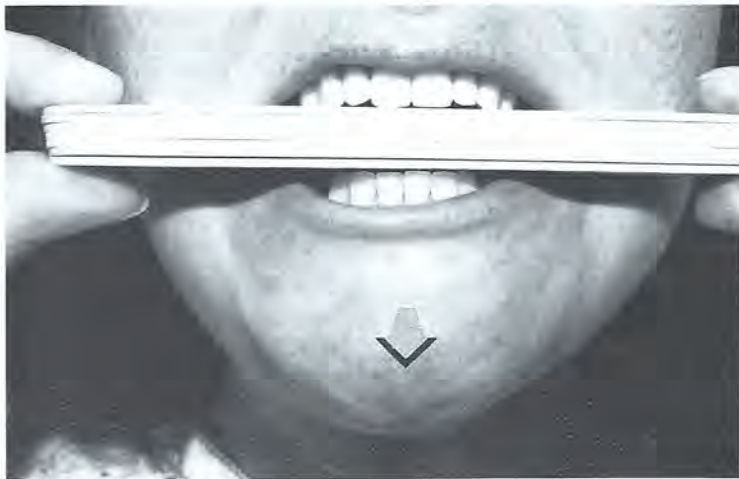


Fig. 7-18. Horizontal tongue blade stretch. This exercise addresses limitation in translation secondary to periarticular tightness or an ADDWoR. When treating periarticular tissue tightness, the patient holds seven tongue blades horizontally between the central incisors. Patients can actively move their jaw forward or forward and slightly toward the opposite side of the involved joint. If trying to progress an ADDWoR to a CDDWoR, the tongue blades are reduced to three or four.

Seven tongue blades equal approximately 11 mm. At approximately 11 mm, translation normally begins.^{98,99} With tongue blades in place, the patient will move the mandible forward and then back repetitively. The forward and back motion of the mandible will specifically address limitation in condylar translation. Should repetitive translation be performed with less than 11 mm of jaw opening, discomfort/pain will usually occur.

Continuous Passive Motion. The importance of initiating early motion during the inflammatory phase, especially after surgical intervention, is becoming widely accepted in the rehabilitation of other joints such as the knee.¹¹⁴ Use of passive motion on a continuous basis as was introduced by Salter et al in 1970 has become an important area of study.¹¹⁵ Salter¹¹⁵ has shown that CPM applied in experimental animal studies is beneficial to soft tissue healing, bone and cartilage healing, swelling, hemarthrosis, and joint function. It is reported that CPM in humans has resulted in positive effects on joint effusions, wound edema, pain, and reduction of capsular contractures and joint stiffness.^{100,114} Even though CPM has been used in a variety of orthopaedic conditions, present indications and clinical studies for the use of CPM have largely focused on the rehabilitation of various knee disorders.

Although the potential benefit of CPM is known, there is insufficient clinical research to define the most appropriate device and protocol for CPM use after postarthroscopy or arthrotomy to the TMJ. Measurable outcomes of the therapeutic value and cost-effectiveness of CPM for TMD have not been fully researched. CPM is more likely to be indicated after surgical interventions for ankylosed conditions or after total joint replacements secondary to polyarthritides. In the vast majority of post-TMJ surgical cases, timely physical therapy produces therapeutic outcomes acceptable to both the patient and surgeon, and the inconvenience of CPM may be avoided.

Secondary Benefits of Treatment. In the presence of hypomobility, the temporalis, masseter, and internal pterygoid muscles are unable to lengthen. Treatment for joint hypomobility will also thus influence the elevator muscles of the mandible.

Animal studies have shown when a muscle is subjected to changes in length, it undergoes anatomic, biochemical, and physiologic changes that are not immediately obvious nor readily considered by the clinician.¹¹⁶ These length-associated changes occur within a few hours, days, or weeks of being immobilized. Animal studies indicate muscles that cannot lengthen will undergo decrease in numbers of sarcomeres in both the young and adult. In the young, there will be a decrease in the rate of additional new sarcomeres, whereas in the adult, there is an absolute loss of sarcomeres.¹¹⁷ Biochemical changes that occur to a muscle that cannot lengthen demonstrate an increase catabolism and a concomitant loss of weight.¹¹⁸ Physiologically, the amount of passive and active tension developed by a shortened muscle is less than normal muscles.¹¹⁹ Studies indicate that when immobilization has been terminated, full recovery from anatomic, biochemical, and physiologic changes occurs.¹¹⁶ Re-

covery is time-dependent and may require from a few days to as long as 60 days after termination of immobilization of the muscle.

Length-associated changes in muscle emphasize the need to regain normal mandibular dynamics as soon as possible. The reader is cautioned not to confuse a tight muscle undergoing length-associated changes with a muscle demonstrating heightened tone secondary to an increase in γ motor neuron activity. If altered afferent input affects the cranial V motor neuron activity, an increase in muscle tone/tightness will exist with those muscles innervated by cranial V. Pertinent to this discussion are the elevator muscles of the mandible (i.e., temporalis, masseter, and internal pterygoid muscles). The clinician risks actually facilitating an increase in muscle tone (secondary to altered γ motor neuron activity) by placing the muscle and the associated shortened muscle spindles on stretch. This procedure could facilitate an increase in muscle tone, especially if performed too rapidly.¹²⁰ A muscle having a length-associated increase in tone is hypothesized to have less facilitation to stretch than a muscle that has an increase in tone secondary to altered γ motor neuron activity. Understanding why a muscle is tight (length-associated changes versus altered γ motor neuron activity) bears important implications when placing a tight/tense muscle on stretch. The following areas may contribute to altered γ motor neuron activity of the elevator muscles, resulting in a decrease in mandibular opening, and should therefore be managed first before placing the elevator muscles on stretch.

Occlusion: If a malocclusion is suspected, treat using an occlusal appliance.

TMD: If inflammation is present, follow guidelines discussed for treating inflammation.

Cervical spine disorder: If a symptomatic cervical spine disorder is present, treat with guidelines covered in Chapter 11.

Emotions: Treat with biofeedback using concepts discussed in the TTBS section and patient education. If necessary, professional counseling may be required.

Hypomobility Caused by Disc Displacement

Disc displacement is the most common TMJ arthropathy.¹ Several controversies are associated with treatment of disc displacement that center on the following questions:

1. Is the position of the disc important?
2. Should treatment be reversible or irreversible to be "successful" in treating a disc displacement?

An attempt to answer these two questions is not the intention or objective of this section. However, to introduce the role of physical therapy in management of disc displacements, a general response is necessary.

Disc displacement is commonly defined as an abnormal relation or misalignment of the articular disc and condyle.¹ By using the term *displacement*, it is implied "that the disc of internally deranged articulations had been in a normal position at an earlier time and was then displaced through some kind of precipitating event."¹²¹ Although the cause of disc displacement is not totally agreed on, it is believed that for the disc to displace, stretched or torn ligaments must precede displacement.¹²² The general consensus is that the direction of disc displacement is anterior or anteromedial to the condyle.¹²³ The end result is the posterior band of the disc lies in front of the condyle, with the condyle functioning on the posterior attachment. Once displaced, the disc can be subcategorized into¹

1. Disc displacement with reduction
2. Disc displacement without reduction: acute or chronic

The morbidity of the disc functioning off the condyle has not been demonstrated to be entirely pathologic.¹²⁴⁻¹²⁷ Imaging studies have documented the presence of disc displacements in many patients and nonpatients having no signs and symptoms of a disc displacement.^{128,131} So common are disc displacements with otherwise asymptomatic healthy joints that several authors suggest that disc displacements should be considered within the normal range of anatomic variability.^{128,132-134}

Treatments for disc displacements have focused in past years on occlusal appliances.^{135,136} In a review of the literature, Zamburlini and Austin¹³⁵ concluded that "the recapture of the disc is permanent in only a small percentage of patients suggesting that the use of irreversible procedures must be carefully evaluated." Improvement of mandibular opening and decrease in pain that frequently occurs after arthroscopy for disc displacements does not occur from altering the position of the displaced disc.^{88,137-139} Success from arthrotomy is not always based on a normal disc-condyle relationship despite improved condylar translation and positive patient response.^{140,141} In summary, success of treatment is not dependent on the positioning of the disc or the absence of joint noises, but instead success is defined as freedom from pain and functional limitations of the TMJ.^{142,143} Conservative treatment should be initiated first irrespective of the position of the disc.¹⁴²

Studies that investigate disc displacements in nonpatient and patient populations can be used for general guidance in the understanding and management of most patients experiencing TMD. However, each patient must be dealt with as an individual with clinical decisions based on the *individual's* signs and symptoms and goals of treatment. A decision to treat with a particular modality or procedure should be supported when possible by the literature, especially if the treatment is irreversible. Otherwise, treatment offered to an individual patient is based on clinical experience and expertise of the clinician, which is influenced by any one or combination of the following nine factors:

1. Age of the patient

2. Chronicity of the disc displacement complaint
3. Severity of the disc displacement's interference with the patient's function and life style
4. Past treatment that failed in which the clinician believes that past treatment did not meet his or her standards of excellence
5. Past treatments that the clinician believes have been properly executed but have failed for unknown reasons
6. Refusal by the patient to consider surgery under any circumstances
7. Criteria for success of treatment differ between clinician and patient
8. Compliance by the patient seriously doubted by the clinician
9. Clinician bias and treatment philosophy

This list is not meant to be all-inclusive. This list can also be applied to other disorders of the TMJ as well as other musculoskeletal problems in which similar dilemmas surrounding treatment choices exist.

Physical therapist and dentist are often confronted with patients who have a disc displacement. I would suggest that if the physical therapist or dentist is not "specialized" in the management of TMD, a consultation with such specialists to review/oversee the treatment program is advised. It is not uncommon for the working diagnosis to change as treatments are rendered. Having a team approach among health professionals will allow for a quicker and smoother change in treatment plan to occur if necessary.

Treatment. As stated earlier, disc displacements are not always painful. If pain/inflammation is present along with a confirmed disc displacement, the clinician should first try to reduce inflammation regardless of the disc displacement¹⁴⁴ (refer to Inflammation). If inflammation continues after 4 to 6 weeks of physical therapy, an appropriate occlusal appliance along with anti-inflammatory medication is then suggested to help control inflammation and masticatory muscle hyperactivity.¹⁴⁵

If inflammation continues for more than 1 to 3 months with continued physical therapy, an occlusal appliance, and medication, then the confirmed disc displacement may be the perpetuating cause of the inflammation and needs to be addressed. Treatment for a disc displacement without reduction may need to be started within the first 3 months because decrease in mandibular function is frequently present. However, it is not unusual for a nonreducing disc to reduce once inflammation and masticatory muscle hyperactivity is controlled.

General Comments on Treatment for an Acute Disc Displacement Without Reduction. Of the two categories of disc displacements (i.e., reducing and nonreducing), emphasis will be on the acute nonreducing disc because it contributes to hypomobility. The cardinal clinical sign for an acute disc displacement without reduction (ADDWoR) is locking.¹⁴⁶ Locking implies the inability to open the mouth beyond 20 to 25 mm.¹⁴⁷ However, an opening of 20 to 25 mm can also be caused by other nondiseased disorders such as inflammation,

periarticular tightness, and masticatory muscle hyperactivity. The history and physical examination will aid in a differential diagnosis.

Physical therapy objectives in the treatment of an ADDWoR can be one of the following:

1. To return an ADDWoR to its normal position
2. To make an ADDWoR become a disc displacement with reduction (DDWR)
3. To allow an ADDWoR to become a chronic disc displacement without reduction (CDDWoR)

To Return an ADDWoR to Its Normal Position: The reality of the disc returning to its normal position with physical therapy treatment is not likely. The only time this author may anticipate the disc to stay in place once it is reduced with intraoral techniques is with a very young patient. Disc position may be maintained after treatment in a young patient provided the lock is recent (within 72 hours) and trauma to the mandible is not an immediate precipitating event. Isometric exercises (see Hypermobility) may assist in this case. An occlusal appliance is often used in conjunction to the intraoral techniques and isometric exercises. The clinician should not offer false hope to the older patient that the disc position will be stable if it is reduced. Reoccurrence of disc displacement is high even with the use of an occlusal appliance.^{135,136}

To Make an ADDWoR Become a Disc Displacement With Reduction: Physical therapy treatments may allow an ADDWoR to become a DDWR. The clinical sign of a DDWR is usually the reciprocal click.¹⁴⁸ The primary benefit of an ADDWoR becoming a DDWR is a return of functional mandibular dynamics. If physical therapy is beneficial at allowing an ADDWoR to become a DDWR, several situations may follow:

1. The disc displacement stays as a DDWR without pain. No other treatment may be necessary.
2. The disc displacement stays as a DDWR but is painful. All efforts to control inflammation and masticatory muscle hyperactivity are unsuccessful. Treatments may need to progress with the application of an occlusal appliance as covered in Chapter 6. Other options with or without attempting an occlusal appliance can be surgery involving arthroscopy (see Ch. 8) or arthrotomy (see Ch. 9).
3. The disc displacement becomes a DDWR but returns quickly back to the state of an ADDWoR as soon as the patient brings the teeth into occlusion. One has several options in this situation:
 - a. Immediately after the physical therapist reduces the disc, the therapist places dental roles on the patient's back molars. The patient, who has already had a consultation with a dentist, goes to the dentist to receive an occlusal appliance (i.e., a nonrepositioning or an anterior repositioning appliance).

b. "a" option is unsatisfactory, and the patient is referred on to have surgery, either arthroscopy or arthrotomy.

c. The physical therapist, dentist, and patient are determined that surgery is not an option. The choice is made to progress the patient to a CDDWoR.

To Allow an ADDWoR to Become a Chronic Disc Displacement Without Reduction: When the disc is displaced, the condyle functions on the posterior attachment of the disc. The condyle exerts compressive forces onto the posterior attachments and can do so without the patient experiencing pain.¹⁴⁹ It appears that the tissues posterior to the disc are capable of remodeling and fibrosing when loaded in the presence of a disc displacement. Thus, a pseudo disc may be said to have developed.¹⁴⁹ In some patients, remodeling of the posterior attachment does not occur, occurs but is inadequate, or occurs and is adequate for a time and then fails.¹⁵⁰ In cases in which the posterior attachment fails to withstand compressive forces and pain results, surgical options can be investigated.

Treatment for an Acute Disc Displacement Without Reduction. Several studies have shown that intraoral mobilization techniques and exercises are successful as a conservative choice in the treatment of an ADDWoR.^{151,155}

Joint Mobilization Techniques. An increase in translation in the upper joint space is the primary objective of intraoral techniques. Increasing translation in the upper joint space allows for a return of functional mandibular dynamics. An increase in opening is probably achieved by elongation of the posterior attachment, with further displacement and advanced deformation of the disc.^{148,156} Nitzan and Dolwick¹⁵⁷ attribute an increase in translation to a release of adherence of the disc to the fossa, caused by a reversible effect such as a vacuum or viscous synovial fluid. Even though Nitzan and Dolwick's comments were made on the effects of a lavage in the superior joint space, one can hypothesize that intraoral techniques and exercises have similar effects. Several studies have shown that manual manipulation applied to an ADDWoR can restore mandibular ROM regardless of the duration the patient has been in an acute nonreducing disc state.¹⁵³ Instead of an ADDWoR taking its natural course at becoming a CDDWoR, the entire process is sped up by manual techniques because of the importance of regaining functional mandibular dynamics.^{131,158,159}

Hand placement for the treatment of an ADDWoR is the same as described in *Joint Mobilization Techniques: Treatment For Periarticular Tightness*. Intraoral techniques will include only distraction and translation. Lateral glide does not seem to be that beneficial for the treatment of an ADDWoR.

If the objective is to get the disc to reduce, then a stage III distraction followed by translation is performed. If instead the objective is simply to restore translation in the upper joint space, then a stage I or II distraction is applied

for patient comfort, followed by translation. The amount of force used depends entirely on joint irritability and the amount of masticatory muscle hyperactivity. In general, intraoral mobilization forces used in treating an ADDWoR are much greater than those used to treat for periarticular tightness, especially if periarticular tightness is secondary to arthrotomy.

I would suggest a frequency of three times a week for 4 to 6 weeks of treatments before determining if a return to functional mandibular dynamics can be achieved. During this 4- to 6-week period, a home exercise program to increase translation in the upper joint space will involve most exercises covered in Treatment for Periarticular Tightness. These exercises are

Finger spread exercise: Throughout the opening phase of this exercise, protrusion of the mandible is performed simultaneously with opening to place emphasis on translation.

Touch and bite exercise: Benefits protrusion as well as lateral excursion to the opposite side of the ADDWoR

Cotton roll distraction: Cotton ball is placed on the same side of the ADDWoR; less distraction is applied while the patient actively protrudes the mandible.

Static tongue blade exercise: Tongue blades are placed on the same side of the ADDWoR; A prying motion on the tongue blades may be helpful here.

Horizontal tongue blade exercise: The number of tongue blades is reduced to three or four, depending on the patient's comfort, to engage translation more.

If joint noises occur during treatment, the clinician will place little emphasis on them. Of the publications reviewed by Wabeke¹⁶⁰ and Spruijt,¹⁶¹ they found that little attention should be given to joint noises and that treatment should not be performed for noises alone. Clicking can also be related to factors other than a disc displacement with reduction.¹⁶⁰ Treatment for clicking should only be considered when the clicking is associated with pain or troublesome symptoms (e.g., restricted movement).^{160,161} In most cases involving disc displacements, the primary objective is to achieve functional mandibular dynamics regardless of disc position.

CONCLUSION

Physical therapy plays an important role in the management of the common disorders that affect the TMJ. A physical therapist can offer significant input into the evaluation and management of inflammation, hypermobility, and hypomobility conditions of the TMJ. Treatments should not be applied in a cookbook way. Sound clinical reasoning by a physical therapist aids in the choice, sequence, and duration of treatments. Therapist's knowledge of the physiologic rationale for treatment is essential for effective physical therapy management of patients with unusual and complex TMD presentations. In combination with

other health professionals (dental, medical, and psychological), physical therapists may facilitate improved scope and quality of care in the symptomatic TMD patient.

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