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Temporomandibular Muscle and Joint Disorders

Several surveys of persistent orofacial symptoms indicate that approximately 7% or 13 million Americans suffer from an orofacial disorder causing face or jaw pain.[1-3] Clinical subpopulations comprising those whose problems are sufficiently severe to prompt them to seek care include more women than men.[3,4] This issue of *Pain: Clinical Updates* reviews the evaluation, diagnosis, and management of temporomandibular muscle and joint disorders (TMJDs). Typical signs of this subtype of temporomandibular disorders (TMDs) include joint noise, tenderness of masticatory muscles and joints, and pain, limitation, and deviation in the range of motion of the mandible, while the most common symptoms include jaw pain, facial pain, headache, distressing or disturbing joint noises, and difficulty with jaw function.

Physical Examination

Diagnosis of TMD relies upon measurement of range of motion, assessment of temporomandibular joint (TMJ) function, and palpation of the muscles and joints using standard and reliable procedures.[5]

Range of motion of the jaw is measured from incisal edge to incisal edge of the central incisor with a millimeter rule. Minimum normal jaw opening is considered to be about two finger widths at the knuckles of the patient's dominant hand, or approximately 40 mm. Lateral motion should be 7–10 mm to both the right and left. Normal protrusive range is between 6 and 9 mm. *Limitation in range of motion* suggests a condition such as contracture of one or more of the jaw closing muscles, a nonreducing anterior displacement of the disk (closed lock), coronoid process interference, fibrous ankylosis of the joint, a hematoma, neoplasm, infection, or a systemic condition such as scleroderma.

TMJ sounds may be detected by palpation of the joint during repetitive opening, closing, and lateral movements. They are common, and their presence does not imply the need for treatment.[6] They may result from normal or pathological mechanisms including deviation in form or function of the disk, joint osteoarthritis, or anterior or medial TMJ disk displacement. Accompanying joint pain, limitation in movement, or joint tenderness suggest the need for therapeutic intervention.

Muscle and joint palpation is necessary to determine the presence of tenderness in the muscle, joint, and other soft tissue structures as the only sign found in masticatory pain disorders such as myofascial pain, myositis, TMJ synovitis, or capsulitis. Unfortunately, intra- and interexaminer reliability of muscle palpation is low and requires training and calibration to improve its consistency and replicability.[7]

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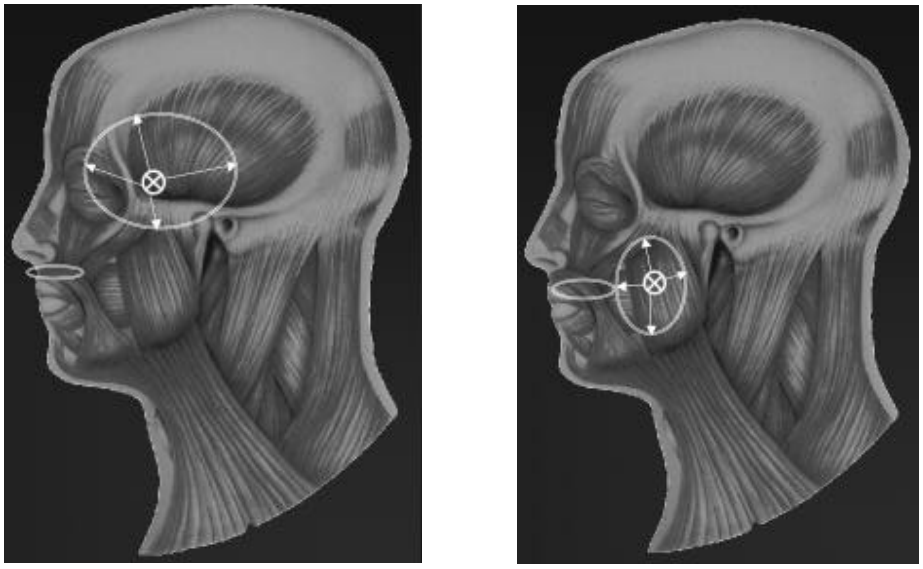

Fig. 1. The most common muscles associated with masticatory muscle pain include the temporalis and masseters with associated pain referral patterns. *Left:* temporalis refers pain to temples and frontal, retroorbital, and maxillary teeth. *Right:* masseter refers pain to the jaw, ear, and retromandibular and mandibular teeth. Stars show the trigger point location, and arrows within ovals show the referral patterns.

Imaging

Imaging of the TMJ includes panoramic, tomographic, and arthrographic radiography, magnetic resonance imaging (MRI), and computed axial tomography (CT). *Panoramic radiographic imaging* of the jaw is convenient and inexpensive for TMJ screening. Although gross degenerative, traumatic, or dysplastic changes can be detected with panoramic radiographs, subtle condylar changes and abnormal disk/condylar/fossa relationships cannot be evaluated. *Lateral open and closed mouth tomography or CT scans* of the TMJ are usually recommended. *MRI* can provide a definitive diagnosis in most cases of suspected TMJ disk displacement. Patients with joint locking or restricted condylar motion, as demonstrated clinically or with lateral tomography, can be evaluated with MRI to determine disk position and morphology. In addition, MR imaging can be used to detect joint effusions or altered circulation due to inflammation using gadolinium-DTPA enhancement. Dynamic MRI can also be used to determine the functional relationships between the condyle and disk during rotatory and translatory movement of the condyle. Limitations of MRI include the relative lack of definition of bony surfaces of the joint and restriction to patients without magnetic metallic implants.

Temporomandibular Muscle Disorders

Temporomandibular muscle pain disorders or masticatory myalgia are characterized by pain arising from pathological or dysfunctional processes in the masticatory muscles.[6,8] Pain is usually experienced over the involved muscle but is sometimes referred to distant structures, confusing the diagnostic process. There are several distinct types of masticatory muscle pain subtypes in the masticatory system.

Myofascial pain, the most common systemic muscle pain disorder, is characterized by regional pain associated with tender areas (trigger points) in taut bands of skeletal muscles, tendons, or ligaments.[9,10] Although pain typically occurs over the trigger point, pain can be referred to distant areas (e.g., the temporalis referring to the frontal area and the masseter referring into the ear). Reproducible pain upon palpation of the trigger point is diagnostic. Myofascial pain is the most common cause of masticatory pain, accounting for over 60% of all TMD cases.[3,4] Although the etiology of myofascial pain is unclear, current theories hypothesize that macro- or microtrauma disturbs normal or weakened muscle through injury or sustained contraction (e.g., bruxism or clenching). Such processes may induce peripheral and central changes that sensitize muscle nociceptors, resulting in tenderness and both local and referred pain.[6-10]

Myositis is a less common acute condition involving inflammation of the muscle and connective tissue and associated pain and swelling. It may be septic or aseptic. Most areas of the muscle are tender, and there is pain within active range of motion. The inflammation is usually due to local causes such as acute overuse, local infection from an impacted third molar pericoronitis, trauma, or cellulitis.

Muscle spasm is another acute disorder characterized by transient involuntary tonic contraction of a muscle. It can occur following overstretching of a previously weakened muscle, protective splinting of an injury, or acute overuse. A muscle in spasm is shortened and painful, producing limited range of jaw motion. Lateral pterygoid spasm on one side can also cause a shift of the occlusion to the contralateral side.

Muscle contracture is a chronic condition characterized by persistent shortening of the muscle. It can begin after trauma, infection, or prolonged hypomobility. If the muscle is maintained in a shortened state, muscular fibrosis and contracture may develop over several months. Pain is often decreased by voluntary or involuntary guarding, or by avoiding use of the muscle.

Temporomandibular Joint Disorders

TMJ pain or arthralgia is usually due to capsulitis or synovitis, with associated joint inflammation, tenderness, pain, and fluid accumulation or effusion. Effusions and inflammation can be detected by MRI scans. The difficulty in diagnosing joint problems lies in determining whether pain in the area of the joint is due to muscle disorder, joint disorder, or a systemic disorder. Most TMJ arthralgias cause pain anterior to the ear, with occasional referral to surrounding (e.g., temporal) regions; digital palpation and normal joint use are painful.[6,8]

Several joint conditions can be associated with arthralgia. *Disk displacement with reduction* is characterized by clicking of the TMJ on opening and closing. The opening click reflects the condyle moving beneath the posterior band of the disk until it snaps into its normal relationship on the concave undersurface of the disk. The closing click reflects reversal of this process. The condyle moves under the posterior band of the disk until it snaps off the disk and onto the posterior attachment. The opening click occurs at a wider incisal opening than the closing click and at different points of incisal opening. Momentary dysfunction of the disk has been theorized to reflect articular surface irregularity, disk-articular surface adherence, synovial fluid degradation, disk-condyle incoordination as a result of abnormal muscle function, increased muscle activity around the joint, or disk deformation. As the disk becomes more dysfunctional, it begins to interfere with normal translation of the condyle, and may even cause periodic jaw locking. An occasional patient has excessive opening due to ligament laxity and joint hypermobility and becomes at risk for open locking or subluxation of the joint.

Disk displacement without reduction is characterized by marked limited mouth opening due to interference with normal condylar sliding on the disk due to disk adhesion, deformation, or dystrophy. In this situation, the opening is usually restricted to 20–30 mm with a deviation of the jaw to the affected side on opening. Joint noise is minimal because little joint translation occurs. The masticatory muscles and joint frequently become tender and painful in response to the joint dysfunction. After the disk is permanently displaced, soft-tissue remodeling of the disk and associated ligaments in the joint occurs. After a permanent locking occurs, routine daily jaw function encourages the posterior attachment and collateral ligaments to accommodate to allow normal jaw opening and abatement of pain. Further adaptation within the joint includes remodeling of the surfaces of the condyle, fossa, and articular eminence, with corresponding radiographic changes. Disk perforation may cause degenerative changes and coarse crepitus upon opening and closing. Successful remodeling allows patients to regain normal opening with minimal pain, but joint noise often persists. Sometimes, however, bony degenerative changes progress with severe erosion, loss of vertical dimension, occlusal changes, worsened joint and muscle pain, and greatly compromised jaw function.

The genesis of disk disorders and TMJ arthralgia has been at least partially attributed to abnormal biomechanical forces on the condyle, which alter the shape, form, and function of articular tissues.[6,8] Friction due to abnormal jaw function and malposition of the disk may exacerbate both jaw displacement and changes to the form and function of the disk. In other cases, a blow to the jaw, inadvertent biting of a hard object, or excessive chewing may be inciting factors. Occasionally, whiplash injury contributes to TMJ arthralgia and disk displacement.[11]

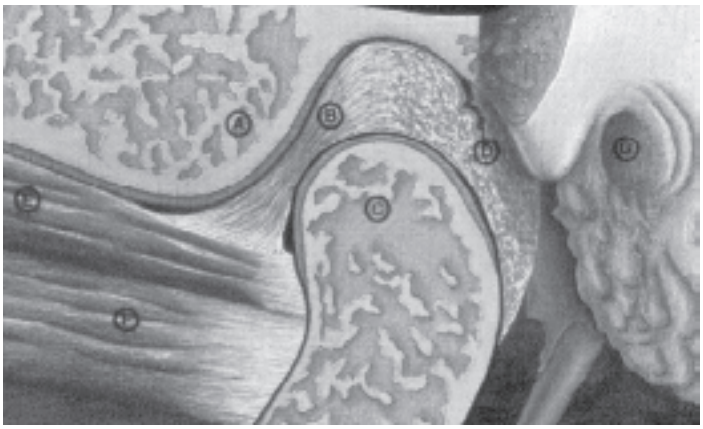

Fig. 2. The normal TMJ includes: (A) articular eminence, (B) fibrocartilage articular disk at the 11:00 position, (C) condyle, (D) innervated posterior attachment, (E and F) lateral pterygoid muscles, and (G) external auditory canal.

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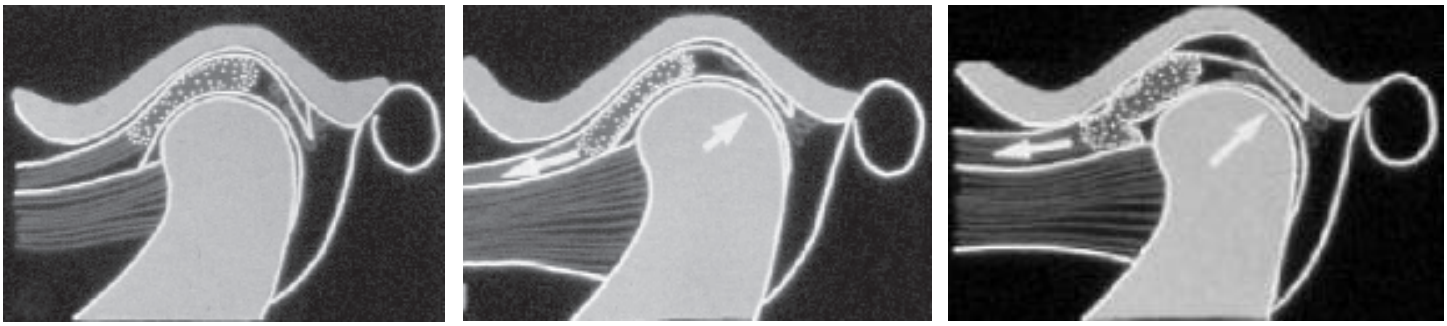
Disk displacements are common in the general population, but those affected generally function adequately without treatment.[12] When a patient seeks help for asymptomatic TMJ noises, continued observation, education about the condition, and self-care are sufficient (Table I). Pain, intermittent locking, and difficulty using the jaw mandate closer observation and possible intervention.

TMJ subluxation or dislocation with or without a disk displacement is characterized by hypermobility of the joint due to laxity of the ligaments. It may be provoked in the dental office when the mouth is held open for an extended period, particularly in patients with systemic hypermobility. The condyle is anteriorly dislocated with respect to the disk and articular eminence, unable to return to the closed position because normal posterior translation is blocked. In most cases, the condyle can be moved laterally or medially by the patient or clinician to disengage the locking and allow normal closure. If the lock cannot be immediately disengaged, jaw manipulation inferiorly and anteriorly may be required before the jaw can glide posteriorly.

Osteoarthrosis of the TMJ involves degenerative changes of the articular surfaces of the joint that cause crepitus, jaw dysfunction, and radiographic changes. In osteoarthritis, pain, inflammation, and tenderness of the joint accompany the degenerative changes. Osteoarthrosis can occur at any stage of a disk displacement as well as after trauma, infection, and other insults to the integrity of the joint, or with rheumatic or other conditions that cause polyarthritis. The latter include disorders such as systemic osteoarthritis, rheumatoid arthritis, psoriasis, lupus erythematosus, scleroderma, Sjogren's syndrome, and hyperuricemia. A rheumatology consultation is indicated if the joint, consistent with other joints, are painful and swollen, red, stiff, or crepitant.

Other joint disorders include ankylosis, traumatic injuries and fractures, neoplasms, and developmental abnormalities. Ankylosis or total lack of joint movement can be due to osseous or fibrous attachment of the condyle to fossa. Extracapsular conditions such as coronoid process interference or muscle contracture can also cause significant jaw limitation. Traumatic injuries usually result in either a contusion with joint hemorrhage, a sprain with tearing of the joint capsule and ligaments, or a fracture of the condylar neck or head or of the external



NORMAL | SLIGHT DISPLACEMENT (clicking) | ADVANCED DISPLACEMENT (locked)

Fig. 3. There are several stages of disk displacement relative to the temporomandibular joint. Each stage has different clinical characteristics.

auditory canal. TMJ injuries are usually accompanied by pain and limited range of motion. Developmental abnormalities, primary benign and malignant tumors, myxoma, fibrous dysplasia, and metastasis or local extension of neighboring malignancies to the TMJ can also occur but are rare.

Management

Management of all patients with temporomandibular disorders aims to: (1) reduce or eliminate pain, (2) restore normal jaw function, (3) reduce the need for future health care, and (4) restore normal lifestyle functioning.[6] Specific interventions and their sequencing parallel treatment of musculoskeletal disorders in general. A key determinant of success in chronic pain management is the success in educating the patient about the disorder to enhance adherence to the self-care aspects of management, including jaw exercises, habit change, and proper use of the jaw.[13] The treatments included here are supported by randomized controlled trials (RCTs).[14]

Self-Care

Most acute TMD symptoms are self-limited and resolve with minimal intervention. Therefore, initial treatment for masticatory myalgia and arthralgia should be a self-care program (Table I) to reduce repetitive strain of the masticatory system and encourage relaxation and healing of the muscles and joints. Most patients respond well to self-care in 4–6 weeks; if not, further assessment and treatment are indicated.

Pharmacotherapy

Common medications used for TMD pain are classified as nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, opioids, muscle relaxants, anxiolytics, hypnotics, and antidepressants.[15] Analgesics are used to allay pain; muscle relaxants and anxiolytics for anxiety, fear, and muscle tension; hypnotics for enhancing sleep; and antidepressants for pain, depression, and with certain agents, insomnia.[16]

RCTs of NSAIDs for TMD suggest adopting a low threshold for their use as a supplement to self-care. Long-term NSAID use is best approached with caution due to their systemic and gastrointestinal effects, although the safety of selective COX-2 inhibitors may be greater than that of nonselective NSAIDs. For more severe joint inflammatory symptoms, corticosteroids are efficacious in TMJ synovitis, either as brief, tapering oral doses ("dose packs"), injected, or given via iontophoresis.[14,17,18] Injection of hyaluronic acid is just as efficacious as corticosteroids without being associated with any risk of degenerative joint disease.[19] Repeated injections of corticosteroids can lead to chondrocyte apoptosis and acceleration of the degenerative process. [20] For myalgia, especially with limited opening, NSAIDs and benzodiazepines are effective.[21,22] Cyclobenzaprine has also been shown, in clinical trials of muscle pain, to be efficacious in reducing pain and improving sleep and can be considered when benzodiazepines cause daytime sedation or other side effects.[23]

In patients with chronic TMD pain, tricyclic antidepressants such as amitriptyline and nortriptyline significantly ameliorate insomnia, anxiety, and pain. These medications can be used chronically. Selective serotonin reuptake inhibitors (SSRIs) should be used with caution with TMD patients because these agents may increase masticatory parafunctional muscle tension and aggravate muscle pain [24]

Physical Medicine

Physical medicine interventions can be efficacious for patients with TMD pain and restricted motion.[14,25] Jaw exercise is the primary and often the only physical medicine treatment required. Jaw exercises include relaxation, rotation, stretching (range of motion), isometric exercise, and postural exercise. Stretching exercises, together with cold or heat, are effective in reducing pain and improving range of motion. Their benefit is enhanced when they are incorporated into the patient's daily routine in conjunction with relaxation techniques and a relaxed posture to reduce strain from sustained jaw contraction.

If exercises are ineffective or worsen pain, other physical modalities can be considered: ultrasound, short-wave diathermy, low-intensity laser, pulsed diathermy, iontophoresis, phonophoresis, superficial heat, cryotherapy (cold), and massage all have demonstrated efficacy. In the short term, such modalities can reduce jaw pain and increase range of motion, thereby allowing jaw exercises to proceed. When range of motion of the jaw is restricted by a TMJ disk displacement without reduction, short-term manipulation of the jaw by a physical therapist or self-mobilization by the patient can help in remodeling the disk to improve joint translation, range of motion, and pain.

Orthopedic Intra-oral Splints

The two most common splints include the anterior positioning splint and the stabilization splint. The anterior repositioning splint places a patient's mandible and TMJ into an anterior position so as to reduce a TMJ click that occurs on opening and closing of the jaw. The anterior repositioning splint is typically

placed on the maxillary arch with an anterior ramp that first engages mandibular teeth on initial closure and shifts the jaw forward into final closure, when all mandibular teeth contact the splint. The stabilization splint provides a flat passive occlusal surface that is adjusted with contact on all posterior teeth to allow passive protection of the jaw and reduction of oral habits. Although both splints can reduce TMD symptoms, the indications for each differ somewhat.[26]

Anterior repositioning splints can be efficacious for intermittent jaw locking with limited range of motion, especially upon awakening, or for persistent TMJ arthralgia not responsive to other therapy (including a stabilization splint). They are recommended only for short-term, part-time use, primarily during sleep, because they can cause occlusal changes if worn continuously or chronically.

The stabilization splint is most efficacious for masticatory myalgia and TMJ arthralgia, especially if the pain is worse upon awakening. This type of splint can also be used during the day for oral habit management. Such splints are designed to provide postural stabilization and to protect the TMJ, muscles, and teeth.

Partial coverage splints may cause occlusal changes in some patients. All splints should cover all of the mandibular or maxillary teeth to prevent movement of uncovered teeth, with malocclusion. The splint's occlusal surface can be adjusted to provide a stable occlusal posture by creating single contacts in all posterior teeth in the habitual closure position.

Cognitive-Behavioral Therapy

Approaches to changing maladaptive habits and behaviors such as jaw tensing and clenching and grinding of the teeth are important in treating painful tissues. Cognitive-behavioral therapies such as habit reversal, biofeedback, relaxation techniques, and stress management can be effective alone or in conjunction with other treatments.[14]

Behavior modification strategies such as habit reversal and overcorrection are the most common techniques used to change these habits. Although many simple habits are easily abandoned when the patient becomes aware of them, changing persistent habits requires a structured program that is facilitated by a clinician trained in behavioral strategies. Patients should be aware that habits do not change themselves and that they are responsible for initiating and maintaining behavior changes.

Habit correction can be accomplished by (1) becoming more aware of the habit, (2) knowing how to correct it (i.e., what to do with the teeth and tongue), and (3) knowing why to correct it. When this knowledge is combined with a commitment to conscientious self-monitoring and a focus upon the goal, most habits will change. Supplemental behavioral strategies such as biofeedback may also be helpful.

Even when clenching is unconscious or nocturnal, correcting it during the day will help reduce it at night. Splints may also increase patients' awareness of oral habits. If muscle tensing is the inciting factor, biofeedback and relaxation techniques may be indicated. Another major issue to address is pacing or hurrying related to a hectic day. For triggers such as depression and anxiety, psychological therapy can helpful. If the problem is a sleep disorder, sleep hygiene self-care can be instituted by the psychologist for nonpathological sleep disturbances, or the patient can be referred to a sleep laboratory for more detailed evaluation.

Table I.

Self-care for masticatory arthralgia and myalgia. This Program is typically provided to all TMD patients at their initial visit to encourage healing within the muscles and joints.

1. ***Apply moist heat or cold*** to the joint or muscles that are sore, whichever feels better. Either can reduce joint or muscle pain and relax the muscles. Apply heat for 20 minutes to the painful area several times daily. Microwave a wet towel until it is warm, and wrap it around a hot-water bottle to keep it warm longer. For cold, use ice wrapped in a thin washcloth for 10 minutes several times each day (apply it to the painful area just until the onset of numbness).

2. ***Eat a softer diet.*** Avoid hard foods, such French bread or bagels. Avoid chewy food, such as steak or candy. Cut fruits and steam vegetables and cut them in small pieces. Chew with your back teeth rather than biting with your front teeth. Avoid chewing gum!

3. ***Chew your food on both sides*** at the same time or alternate sides to reduce strain on one side.

4. ***Keep your tongue up, teeth apart, and jaw relaxed.*** Place your tongue lightly on the palate behind your upper front teeth, allowing the teeth to come apart, and relax the jaw muscles. The upper and lower teeth should not touch at rest, except occasionally with swallowing. Monitor your jaw position during the day to keep it in a relaxed, comfortable position.

5. ***Avoid caffeine.*** Caffeine may increase jaw tension and may contribute to jaw pain and headaches from overuse or withdrawal. Caffeine or caffeine-like drugs are present in coffee, tea, soda, and chocolate.

6. ***Avoid oral habits that strain the jaw muscles and joints.*** These include teeth clenching, teeth grinding (bruxism), teeth touching or resting together, biting the cheeks, pushing the tongue against the teeth, jaw tensing, and biting objects. Replace these habits with proper tongue position on the palate (see item 4).

7. ***Avoid resting your jaw on your hand*** to reduce strain on the TMJ and maintain jaw muscles in a rest position.

8. ***Avoid activities that involve excessive or prolonged wide opening of the jaw*** (yawning, prolonged dental treatments, etc.) for a period of time until the pain has been reduced.

9. ***Avoid stomach sleeping,*** which puts adverse forces on the jaw and neck muscles.

10. ***Use anti-inflammatory medications*** such as ibuprofen and aspirin (without caffeine) to reduce TMJ and muscle pain.

TMJ Surgery

If persistent pain is localized to the TMJ and is associated with specific structural changes in the joint, surgical intervention can be considered if comprehensive nonsurgical care is unsuccessful.[6,14] Muscle pain and associated contributing factors should be addressed and controlled prior to TMJ surgery. In general, the less invasive surgeries are as efficacious as those that are more invasive, so the health care provider should consider an arthrocentesis or arthroscopic procedure before more invasive interventions such as diskectomy or disk repair. Postoperative management includes appropriate medications, physical therapy, splint therapy when indicated, and continued psychological treatment as appropriate.

Dental Treatment

There is no consistent evidence from RCTs that altering the occlusion through occlusal adjustment will benefit TMD.[14,27] Likewise, other dental treatments such as prosthodontic and orthodontic treatments are not recommended as a primary treatment for the management or prevention of TD.[6,26] However, patients with TMD may require these procedures as part of normal dental care. In these cases, care should be exercised in minimize additional strain to the muscles and joints and aggravation of an existing TMD during these procedures.

Complex Patients

As treatment approaches are better defined and validated through clinical trials, triaging patients to appropriate treatment strategies will most likely result in more predictable improved outcomes. However, patients with similar diagnoses may have quite different histories, contributing factors, and outcomes. In some cases, the causative web of persistent pain is complex, and unraveling it may require a team that includes a dentist, physician, physical therapist, health psychologist, or other health professionals. Factors such as depression, fibromyalgia, and secondary gain may play a role in delaying recovery leading to chronic pain. Chronic TMD patients, like others with chronic pain, bear witness to the fact that chronic pain is a disease whose remission depends upon timely and appropriate application of drug and nondrug therapies.

References

1. Von Korff M, et al. Pain 1988; 32(2):173-183.
2. Lipton JA, et al. J Am Dent Assoc 1993; 124(10):115-121.
3. List T, et al. J Orofac Pain 1999; 13:9-10.
4. Schiffman E, et al. J Am Dent Assoc 1990; 120(3):295-303.
5. Dworkin SF, LeResche L. J Craniomandib Disord 1992; 6(4):301-355.
6. Okeson JP (Ed). Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management. Chicago: Quintessence, 1996.
7. Fricton J, Schiffman E. J Dent Res 1986; 65(11):1359-1364.
8. Fricton J. J Am Dent Assoc 1991; 122:25-32.
9. Travell J, Simons DG. Myofascial Pain and Dysfunction: The Trigger Point Manual. Baltimore: Williams & Wilkins, 1998.
10. Fricton J, Dall'Arancio D. J Musculoskel Pain 1994; 2(2):81-99.
11. Wiesenfeld D, Reade PC. Int J Oral Maxillofacial Surg 1994; 23(6 Pt 1):338-341.
12. Scapino R. J Craniomandib Disord 1991; 5:83-155.
13. Livengood J. Pain: Clin Updates 2004; XII(2).
14. Rosenbaum, R., ed. Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management: A Systematic Review of TMJD Diagnosis and Treatment. Chicago: Quintessence, 2004.
15. Wiffen P. Pain: Clin Updates 2000; VIII(1).
16. Fields HL, Liebeskind JC (Eds). Pharmacological Approaches to the Treatment of Chronic Pain: New Concepts and Critical Issues. Seattle: IASP Press, 1994.
17. Kopp S, et al. J Oral Maxillofac Surg 1985; 43(6):429-435.
18. Kopp S, et al. J Oral Maxillofac Surg 1987; 45(11):929-935.
19. Bertolami CN, et al. J Oral Maxillofac Surg 1993; 51(3):232-242.
20. Nakazawa F, et al. Clin Exp Rheumatol 2002; 20(6):773-781.
21. Harkins S, et al. J Craniomandib Disord 1991; 5(3):179-186.
22. Singer E, Dionne R. J Orofac Pain 1997; 11(2):139-146.
23. Dionne R. Oral Surg Oral Med Oral Pathol 1997; 83:134-142.
24. Lobbezoo F, et al. J Orofac Pain 2001; 15(4):340-346.
25. Schiffman EL. In: Fricton JR, Dubner R (Eds). Orofacial Pain and Temporomandibular Disorders. New York: Raven Press, 1995, pp 415-463.
26. Forssell H, et al. Pain 1999; 83(3):549-560.
27. Koh H, Robinson PG. Occlusal adjustment for treating and preventing temporomandibular joint disorders (Cochrane Review). In: The Cochrane Library. Chichester: John Wiley & Sons, 2003. Available via the Internet: www.cochrane.org/cochrane/revabstr/AB003812.htm.

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