The Role of Psychosocial Factors in Temporomandibular Disorders

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The temporomandibular disorders (TMDs) comprise a constellation of symptoms affecting the joints and muscles involved in jaw movement. Patients complain of orofacial pain, limited jaw opening, and clicking or popping sounds. Although pain is generally the defining characteristic of TMD, patients often report marked degrees of stress and interference in daily life. This article reviews recent studies on epidemiology, sex differences, pediatric TMD, classification systems, comparisons to other chronic pain disorders of uncertain etiology, psychological assessment, depression, central modulation and hypervigilance, sleep disturbances, stress, and the management of TMD by conservative physical interventions and cognitive behavioral therapy. Both the assessment and the management of TMD requires a multidisciplinary perspective with strong emphasis on psychosocial variables.

Introduction

Common conceptions of clinical pain tend to emphasize such benign disorders as headache or back pain or to focus on pain associated with cancer. It surprises many individuals to learn that TMDs are the most common chronic orofacial condition and that they affect a very sizeable proportion of the population.

Although numerous names have appeared in the literature, TMD is the term recommended by the American Dental Association and is preferred by many researchers because it does not make assumptions about the etiology or pathology of the disorder [1••]. Dental researchers speak of TMDs in the plural, because they encompass several clusters of symptoms affecting the temporomandibular joint, the masticatory muscles, or both. These include spontaneous pain in the area of the ear, the temporomandibular joint, or the muscles of mastication, limitations in the range of jaw movement, and clicking and popping noises in the temporomandibular joint during jaw function. As well, pain is often elicited by mandibular function or palpation of the muscles involved in chewing. Among all the symptoms, pain is the one that is most commonly reported by patients presenting to TMD clinics [2], and relief of pain is the most common reason for patients to seek treatment [3].

Patients with TMD are particularly interesting from a psychosocial perspective. Fascinating questions arise regarding the cause of the disorders, evaluation of pain and disability, patient management, predictions of outcome, the relationship between TMD and depression, and the role of cognitive factors in the presentation and course of TMD.

Research findings suggest that a distinction should be made between patients who suffer from the more common painful spasm in the muscles of mastication (often labeled "myofascial pain dysfunction" or "myogenic facial pain") and those who have internal derangement of the temporomandibular joint (TMJ). There is a third, and smaller, group labeled atypical facial pain, whose complaints deal with vague and wandering pain in the jaw region. Patients suffering from TMD due to internal derangement or osteoarthritis of the temporomandibular joint showed relatively low levels of pain and psychological distress [4]. Those in the first and third categories are more likely to show elevations in psychometric scales for hypochondriasis and depression [5], although, as will be noted later, such findings must be treated with caution.

Epidemiology

Signs and symptoms of TMD, including clicking sounds and crepitation, are not unusual in the general population [6]. Epidemiologic research suggests that the prevalence of TMD-related pain is approximately 12% [7,8•,9]. However, reported rates of the disorder have been shown to vary greatly depending on the population examined and the questions used to assess the presence and chronicity of the pain experienced [10].

Dworkin *et al.* [3] conducted an epidemiologic study among an age-stratified sample (18 to 75 years) of enrollees in a major health maintenance organization. They compared individuals who had actively sought treatment for their TMD with randomly selected persons from the same community who, only upon questioning, reported TMD signs and symptoms. About 12% of their community sample reported "facial ache or pain in the jaw muscles, the joint in front of the ear, or inside the ear (other than infections)"

in the previous 6 months. For the most part, their pain during jaw excursions and muscle and joint palpation was less than that of the clinical sample, and their vertical range of jaw motion was greater, but both TMD groups were markedly more impaired with regard to pain and movement than a group of controls with no facial pain complaints.

Goulet *et al.* [11] conducted a telephone survey of nearly 900 French-speaking residents of Quebec in order to assess the prevalence of self-reported jaw pain in a randomized stratified sample. Some degree of jaw pain was reported by about 30% of the population. The prevalence of cases reporting frequent episodes was about 7% (of whom close to 70% described their pain as moderate to severe). Overall, their data suggested that about 5% of the general population suffer clinically significant TMD-related jaw pain. De Kanter *et al.* [12], in a survey of nearly 7000 Dutch adults, found that about 20% of the participants had indications of TMD. For 5% of the sample, these symptoms were severe; nonetheless, only 1.4% of these individuals had sought professional help.

Sex differences

One consistent finding in the epidemiologic literature is the strong female representation in TMD [8•], as the problems are estimated to be approximately two to three times as common in women than in men [8•,13]. In the community study carried out by Dworkin *et al.* [3], 84% of those who had sought treatment and 75% of those who had not were women. TMD is most prevalent among women in their childbearing years [12,14]. Longitudinal studies of elderly populations have indicated that reports of the signs and symptoms associated with TMD tend to decrease with age for both men and women [15–17].

There are a number of potential explanations that may account for the over-representation of females in TMD patient samples. Women have been found to seek treatment for TMD four to seven times more than men [3], suggesting there may be sex role or psychosocial differences in the appropriateness of seeking assistance for pain problems [6]. Furthermore, sex differences have been demonstrated in the pain sensitivity of healthy men and women [18] and have been suggested as influencing one's susceptibility to joint and musculoskeletal problems [7].

Females have also been reported to demonstrate a tendency to monitor bodily symptoms significantly more than males [19]; however, Krogstad *et al.* [20] observed no gender differences in somatic complaints or anxiety in their sample of patients with TMD. Finally, endogenous female reproductive hormones have been implicated as potentially contributing to the etiology of the disorder. LeResche *et al.* [21] found that the odds of being a TMD case were approximately 30% higher among post-menopausal women receiving estrogen compared with those not exposed to hormone replacement therapy. Dao *et al.* [22] also noted that the predominance of myofascial pain in women of childbearing age suggests that reproductive hormones may play a role in the pathophysiology of the disorder. They found that users of oral contraceptives showed a relatively constant level of myofascial pain, whereas those who were not users exhibited a cyclic variation in pain levels.

Children

Although almost all of the literature on TMDs involves adults, investigators have begun to direct attention to the problem in children. Alamoudi *et al.* [23], for example, examined more than 500 school children, aged 3 to 7 years in Saudi Arabia, reporting that nearly 17% presented with TMDs. There was a small but significant tendency for the signs and symptoms to be more prevalent among girls. An Italian study [24] examined 240 boys and girls aged 7 to 16 years. Although signs and symptoms of TMDs were fairly common, they were mild in most instances. Again, the disturbance was somewhat more prevalent among girls. The authors found that fewer than 4% of the children required orthodontic treatment, and that the TMDs were not linked to malocclusion per se.

An epidemiologic study recently conducted in Sweden indicated that 7% of 12- to 18-year-olds attending a public dental clinic met the Research Diagnostic Criteria for TMD [25]. A gender difference similar to that reported in adults was also found in this group of children and adolescents. The substantial prevalence among young children suggests that assessment of pediatric TMD is an important task, both to provide relief to its sufferers and to attempt to forestall long-lasting pain and disability.

Families

Previous researchers have speculated that TMD may be a disorder that is aggregated within families. For example, Hartrick *et al.* [26] reported that TMJ was diagnosed in a large proportion of daughters within mother/daughter dyads seeking treatment in a pain clinic. Furthermore, Morrow *et al.* [27] suggested that specific subtypes of TMDs may run in families, as they found that individuals presenting with anteriorly displaced discs reported TMD in their family members twice as often as patients without disc displacement. However, each of these studies had methodologic limitations, producing difficulties with interpretation of the findings [28].

A recent study conducted by Raphael *et al.* [28] examined the occurrence of facial pain and associated symptoms and disorders in the first degree relatives of females diagnosed with myofascial TMD and a group of demographically matched acquaintance controls. The results indicated the lifetime rates of facial pain, TMD symptoms, and a range of other musculoskeletal conditions did not differ significantly between the first degree relatives of cases and controls. Furthermore, the self-reported pain severity and functional impairment of the patients did not predict the odds of having a first degree relative with at least one TMD-related symptom. These findings led the authors to conclude that, "myofascial temporomandibular

disorder does not run in families, nor do symptoms associated with a broad range of TMDs."

Classification

A number of diagnostic systems have been presented for the classification of TMD (see [29] for a review). The lack of a standard set of diagnostic and classification criteria for TMD has impeded epidemiologic studies [6] and also presents interpretive difficulties when comparing studies which have used different sets of criteria.

A 1982 conference sponsored by the National Institute of Dental Research led to the development of the multiaxial Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), which assesses both physical and psychological characteristics [29,30•]. The first axis deals with physical factors, as assessed by facial and jaw measures and palpation, dividing individuals into one of three groups: muscle disorders, disc displacements, and other joint conditions. Axis II assesses pain-related disability and psychological status through a questionnaire, paying particular attention to pain, disability, depression, somatization, and limitations.

The RDC/TMD have demonstrated reliability and validity in adult and pediatric populations [31,32]. Generally, research supports the use of a dual axis diagnostic approach that incorporates both physical and psychological functioning [30•,33]. However, Steed [34,35] has recently suggested that measures of stress and psychological distress predict initial perceived symptom levels but not treatment outcome in patients with TMD.

An unresolved issue is whether patients presenting with pain associated with TMJ differ from those whose pain is associated with the muscles involved in mastication. Generally, recent studies have reported that categorizing patients with TMD into muscle-related and joint-related groups indicates psychological differences in patient profiles, as patients reporting myofascial pain are more sensitive to pain and demonstrate increased psychological distress [36–39]. Evaluations of treatment outcome indicate that individuals presenting with joint problems are more likely to report decreases in pain and other TMD symptoms than individuals presenting with primary symptoms involving the muscles [39,40].

Michelotti *et al.* [41] conducted a study in which a short form of the revised Minnesota Multiphasic Personality Inventory (MMPI-2) was administered to 30 patients presenting with myofascial pain and 20 patients who demonstrated pathology of TMJ. Overall, 62% of patients achieved scores within the psychopathologic range on at least one of the clinical scales. When the myofascial pain and TMJ groups were compared with one another, 73% of the myofascial patients and 45% of those in the TMJ group were classified as pathologic, on the basis of achieving a score of greater than two standard deviations above the norm on at least one clinical scale. Although the authors of this study interpreted these findings as evidence for the lack of psychological differences between the TMD patient subgroups, there was a trend ($P = 0.07$) toward a higher prevalence of psychopathology in the myofascial group relative to those with TMJ problems. This finding is particularly important when the small sample sizes of the groups are considered and indicates that further investigation must be undertaken before we can relate psychological features of TMDs and their physical pathology.

Comparison of TMD and Other Chronic Pain Groups

The lack of evidence for organic dysfunctions in the pathophysiology and maintenance of TMD, as well as a number of other important disorders such as fibromyalgia, irritable bowel syndrome, and chronic fatigue syndrome have caused some [42•,43,44] to group these together as "functional somatic syndromes." Researchers have suggested that individuals with TMD display a number of characteristics that are similar to other chronic pain conditions [10]. Others have noted that "TMDs rarely occur as single entities but rather as multiple problems with overlapping symptoms" [45].

In fact, Wessely *et al.* [44] argue that the acceptance of TMD, fibromyalgia, irritable bowel syndrome, multiple chemical sensitivity, and so on as distinct syndromes should be challenged, contending that the patients so labeled actually have much in common. They suggest that appropriate treatment calls for a physician or dentist with a broad-based approach, perhaps aided by liaison with psychiatrists or psychologists.

Dao *et al.* [46] suggested that facial pain may be part of the clinical manifestation of fibromyalgia. Recent studies that have assessed the comorbidity of facial pain and fibromyalgia support this hypothesis. Klineberg *et al.* [47], who found that 70% of the fibromyalgia patients they studied reported orofacial pain, suggested that generalized or localized pain may be variations of a similar problem. Cimino *et al.* [48] discovered that both patients with TMD and fibromyalgia tended to report articular noises, headache, and pain during mandibular function and both groups had muscle pain upon palpation. As well, both were restricted, compared with normal controls, in the range of active and passive mouth opening. However, it appears that generalized pain disorders are more debilitating than localized pain, as patients with fibromyalgia use stronger words to describe the affective dimension of their pain and report experiencing a greater number of neurologic and gastrointestinal symptoms [46].

Hedenberg-Magnusson *et al.* [49] compared muscle pain/tenderness, TMJ sounds, intramuscular temperature, and bite force among healthy individuals and patients presenting with fibromyalgia or localized myalgia of the temporomandibular system. Self-reported levels of pain produced from the temporomandibular system during the previous week and tenderness produced by palpation of

the masseter muscle were significantly higher in both the fibromyalgia and TMD groups relative to the healthy controls, but did not differ between the patient groups themselves. Perhaps surprisingly, the number of TMJ clicking sounds, painful body areas, and tender mandibular muscular regions were significantly higher in the fibromyalgia group compared with patients with TMD. Furthermore, patients with fibromyalgia demonstrated significantly lower pain thresholds and tolerance levels to pressure algometry on the face, providing support for the notion that differences exist in the way that individuals with each of these disorders perceive externally presented pressure pain.

McKinney *et al.* [50] compared the behavioral and psychological characteristics of a group of patients with TMD with individuals presenting with a chronic pain problem that was not TMD related. All participants completed the Chronic Pain Battery, a multidimensional instrument specifically designed to gather medical, psychological, behavioral, social, and pain data. Results indicated that the TMD and non-TMD chronic pain groups did not differ significantly on patient characteristics such as most pain intensity, worst level of suffering, medication usage, anxiety, depression, hostility, illness behavior reinforcement, and social problems. Patients with TMD reported fewer vegetative signs of depression and indicated that they used health care services significantly less often than the non-TMD pain group. Finally, although the TMD group reported higher chronic stress than individuals in the non-TMD group, they demonstrated significantly less impairment in activity level, higher perceived pain tolerance, and more hope about treatment. These findings led McKinney *et al.* [50] to conclude that, in general, TMD and other groups of patients with chronic pain are psychologically and behaviorally similar; however, individuals presenting with TMD appear to perceive their disorder differently, resulting in less impairment than other groups of patients with chronic pain.

Personality and Coping

Problems associated with the temporomandibular region are related to a complex and heterogeneous constellation of disorders. Although the etiology of TMDs is considered to be multifaceted, controversy remains concerning the relative importance of the individual factors involved in its expression [38].

Psychological assessment

Psychological factors are generally recognized as important variables in the maintenance of chronic orofacial pain [41]. Studies have indicated that patients with TMD demonstrate increased somatization, stress, anxiety, and depression relative to healthy individuals [38,50], and a consistent relationship has been demonstrated among anxiety, general somatic complaints, and TMD-related pain [51]. These relationships are especially compelling in individuals presenting with significant psychiatric difficulties, as they complained of more pain associated with temporomandibular pain dysfunction syndrome, and reported more depression, anxiety, and physical symptoms than patients without a mental disorder [52].

A number of self-report instruments have been used to assess the psychological status of patients with TMD. Of these measures, the MMPI is arguably the psychometric instrument that is used most often with patients with chronic pain [41]. Studies using this measure to assess personality characteristics of patients with TMD have demonstrated that alterations in the clinical scales composing the neurotic triad (hypochondriasis, depression, hysteria) of the MMPI were related to "perceptions of severe pain, affective disturbances, and maladaptive patterns of psychosocial functioning" [1••]. Still, it is important to interpret the results of psychological profiles with care, because personality measures such as the MMPI include items that are likely to be endorsed by individuals with physical difficulties (such as, "I am not as active as I used to be"), which elevates scales of hypochondriasis or hysteria [53,54].

The use of personality tests to assess the psychological profiles of patients with TMD is a fascinating and controversial matter, because the "chicken or egg" issue makes interpretation of the results very difficult. Numerous studies find that even for patients with TMD of myogenic origin, their level of psychological impairment is not different from patients with other forms of pain. Schnurr *et al.* [55] compared patients with TMD with those being treated for acute pain in athletic injury or physiotherapy clinics. Whereas the patients with TMD did score somewhat higher on measures of depression and hypochondriasis than healthy controls, they did not differ from those with short-lasting painful conditions. Moreover, among those who responded positively to conservative treatment, much of the psychological distress diminished. A subsequent study by the same authors [56] surveyed these patients 5 months later and found that more than 40% reported a substantial reduction in pain intensity. Based upon a coping scale administered at the onset of the treatment program, individuals who improved the most were those who did not blame themselves for their condition and who were better able to divert attention away from the problem.

Turk [31,57] has proposed that patients with TMD ought to be classified along two dimensions—physical and psychological. This dual-diagnostic approach suggests that physical interventions should be accompanied by treatments that target relevant psychosocial characteristics. Dahlstrom *et al.* [58], using a Swedish sample, found that patients with TMD who were high in pain and distress (the "dysfunctional" profile) were more likely to be those who had orofacial pain of obscure origin or pain considered to be solely myofascial. Those patients diagnosed with disc displacement and who had undergone a successful discectomy (in which the disc of the TMJ is removed and permanently replaced by a silicone sheet) tended to have low pain and psychological distress, whereas those awaiting

such surgery were least likely to cope adaptively. These findings are complex, but one interpretation is that both the patients whose TMD is associated with myofascial factors and those with joint disturbances are likely to suffer from pain and psychological distress. Those in the second category may be helped by surgical intervention. Those in the myofascial category, where surgery is inappropriate, are more likely to need psychological support to help alleviate their pain and distress.

Depression

Clearly, although there is a link between TMD pain and depression, there is still enormous ambiguity about its directionality. There are those who favor the view that the depression occurs because of the pain disorder, others who believe that TMD results from depression ("masked depression"), whereas others suggest that both depression and pain may arise from a more central deficiency. Dworkin *et al.* [13] found that individuals with a single pain condition, such as TMD, did not demonstrate a greater incidence of major depression than persons with no present pain condition, but those with a number of pain conditions were at higher risk of depression. Korszun *et al.* [59] found that more than a quarter of their facial pain clinic patients suffered from major depression and that another quarter met the criteria for minor depression. List and Dworkin [60] indicated that nearly 20% of their patients with TMD reported high scores on a depression index. These data mandate that screening and treatment for depression should be an integral part of the evaluation and management of patients with facial pain.

Gallagher *et al.* [61] used the data of 106 white, middle to upper middle class females involved in a longitudinal study to ascertain the rate of comorbidity between temporomandibular pain and depression. Participants were diagnosed with TMD if they demonstrated tenderness in the masticatory muscles and noises in the temporomandibular joint or a limited range of motion in the mandible, which were not the result of organic damage. Lifetime history of depression was determined by reviewing the medical chart of each participant. Using this procedure, sufficient information was available to classify 62% of the women; of these individuals, 45% were classified as "likely to be or have been depressed." In order to confirm whether the treating clinician's diagnostic impressions were correct, the Structured Clinical Interview for DSM (SCID) was used with a subsample of patients with TMD, showing that nearly all of the individuals whom the clinician thought to be at risk for depression met diagnostic criteria for at least one major depressive episode. The extrapolated data for the entire sample indicated that 41% of the patients with TMD had a lifetime history of major depression. The high prevalence of major depression suggests that it may be a risk factor for the development of TMD, or conversely, may occur as a result of it.

A recent detailed study by Dohrenwend *et al.* [62••] provided strong support for the hypothesis that the experience of chronic pain contributes to the elevated rates of depression in patients with myofascial face pain. Participants included 107 women diagnosed with myofascial face pain, 118 acquaintance controls, and one randomly selected first degree relative of each individual in the patient and control groups. All participants were interviewed using the SCID, and patient and control probands were subdivided on the basis of whether or not they had a personal history of major depressive disorder (MDD). The major analyses examined the lifetime history of MDD or depression spectrum disorders within family members of the patients with myofascial pain and control participants. The occurrence of these disorders was elevated only in first degree relatives of controls with early onset (before the age of 30 and thus more likely to be familial) MDD. Among the patients with both TMD and major depression, the TMD preceded the depression for about 40%, followed the depression for 44%, and occurred concurrently for the remainder. The data appear to indicate that although depression is an important consideration in myofascial pain, it does not appear to result from genetic predisposition. Rather, Dohrenwend *et al.* [62••] favor the pain-as-causal-stressor hypothesis, which postulates that the stress of living with chronic pain causes the psychological suffering with which it is often linked.

Contributing Factors

Central modulation

Numerous studies have demonstrated that patients with TMD display lower pain threshold and tolerance levels than pain-free controls [49,63–67]. Maixner *et al.* [64,68] have proposed that alterations in pain regulatory systems in patients with TMD may limit the capacity of their endogenous pain-control systems to respond adaptively to both clinical and experimentally induced pain. Similar suggestions have been made for fibromyalgia and other disorders [69]. Lautenbacher and Rollman [70], for example, found that patients with fibromyalgia do not display the normal pattern of descending inhibitory control of noxious signals.

Plesh *et al.* [71] and Hedenberg-Magnusson *et al.* [72], among others, noted that many patients with fibromyalgia have TMD symptoms. The similarities between the pain and distress of these conditions, the finding [73] that many patients with TMD, although ostensibly suffering from a regional disorder, report pain at multiple body sites, and the evidence for increased pain responsiveness in both fibromyalgia and TMD suggest a need for longitudinal studies of patients with TMD in order to see whether pain conditions that are not improved show evidence of spread to more distant body regions and conversion from TMD to a more widespread or generalized disorder.

Hypervigilance

Investigators have suggested that some patients with chronic pain display heightened levels of attention to internal painful sensations, and therefore, are hyper-reactive to externally presented stimuli as well. As a result of this perceptual habit, patients with pain are expected to display lower threshold and tolerance levels to pain produced in the laboratory [74,75]. Inherent in the concept of hypervigilance is the notion that psychosocial factors exert an integral role in the predisposition and perpetuation of altered pain perception. Specifically, in addition to demonstrating increased sensitivity to internal and external stimuli, individuals who are hypervigilant are hypothesized to monitor bodily events, attribute their bodily symptoms to physical rather than psychological or psychosocial causes, and exhibit a coping style involving catastrophizing [76,77].

Riley *et al.* [78] suggested that individuals with a history of abuse may demonstrate an increased tendency to monitor, amplify, and overreact to somatic symptoms. Recent studies [78,79] indicate that close to half of female patients with facial pain report a history of physical or sexual abuse, leading one to speculate that these individuals may be extremely hypervigilant. However, when interpreting data concerning these types of emotional trauma, one must also consider that, although the figures for the TMD group are higher than that generally reported in control participants (*ie*, 33.3% in [79]), the numbers do not differ significantly. In any case, studies have shown that patients who are overly concerned about their bodily functioning may experience less pain relief from treatment programs involving occlusal appliances, physical therapy, and anti-inflammatory medications [80].

Sleep

The literature on the relationship between TMDs and sleep disturbances is surprisingly small. Certainly, fibromyalgia researchers have looked extensively at this link, establishing that patients often complain about nonrestorative sleep and demonstrating that sleep deprivation can lead to transient fibromyalgia-like symptoms [81]. For TMD, Fricton and Olsen [82] found that sleep difficulties, among other factors, predicted poor outcome in an interdisciplinary treatment program, but noted that the link between these factors and depression suggested that assessment and therapy for depression should be an important component of treatment programs.

DeNucci *et al.* [83] examined the hypothesis that nocturnal motor hyperactivity of the masticatory muscles may contribute to the nociceptive process. Twenty patients with TMD in a two-period, within-subject, crossover study received either a benzodiazepine hypnotic (triazolam) or a placebo for four nights with a washout period between trials. Although subjective report of sleep quality and amount of time in stage 2 sleep was significantly improved by the drug, no change was seen in pain to palpation, scales of sensory and affective components of pain, or pain diaries. As well, the triazolam did not change the levels of facial electromyographic activity recorded during sleep. It may be the case, however, that a longer trial is warranted, since Feige *et al.* [84] found alterations in EEG sleep activity across 4 weeks of triazolam administration.

Those studies that have looked at the sleep-TMD relationship have typically examined the importance of nocturnal bruxism or grinding (seen by some as a stress-related behavior). Lobbezoo and Lavigne [85] reviewed the controversy about whether bruxism leads to TMD symptoms or whether it is a TMD itself, indicating that the relationship is still unclear. Dao and Lavigne [86] concluded that evidence for a variety of theories proposing beneficial effects of oral splints that restrict tooth grinding is poor or inconsistent, but that patients tend to feel that the splints have led to positive changes. The two studies indicate the need for longitudinal studies of both TMD and bruxism to evaluate a possible cause-effect relationship, paying particular attention to the various sub-groups of temporomandibular disorders.

Stress

A recent study [73] indicated that 42% of patients presenting with chronic fatigue syndrome, fibromyalgia, or both disorders comorbidly, reported they had previously received a diagnosis of TMD. These individuals also reported a high prevalence of "stress-associated syndromes" such as irritable bowel syndrome, premenstrual syndrome, and interstitial cystitis, suggesting that these disorders may involve dysregulation of the hypothalamic-pituitary-adrenal axis [87].

These findings relate to the study completed by Jones *et al.* [88]. Patients with TMD underwent stressful public speaking and mental arithmetic tasks. Although they claimed to have experienced no more stress than a matched control group, they showed, on average, a marked increase in the secretion of cortisol in the saliva, indicating an endocrine stress response. Further analysis showed that the patients with TMD split into two subgroups, with the highly responsive group showing a peak cortisol level about three times greater than the low cortisol group or the controls. Even 20 minutes after the brief stress exposure, the high salivary cortisol patients secreted cortisol at twice their baseline rate.

The data may indicate that at least some patients with TMD have a biological predisposition for enhanced stress reactivity and suggest that early screening of responses to stressful conditions could identify individuals who might benefit from relaxation training, biofeedback, or instruction in adaptive coping, hopefully averting later myofascial problems. As well, the ease with which salivary cortisol can be collected and assessed with radioimmunoassay kits indicates that neuroendocrine measures should be added to dental and behavioral ones in TMD research.

The notion that stress may contribute to the myofascial pain of patients with TMD received strong support from a study conducted by Flor *et al.* [89]. They examined the

hypothesis that chronic musculoskeletal pain syndromes may develop from and be exacerbated by stressful events that target bodily regions that are predisposed to respond to stress. Flor *et al.* [89] had 20 patients with TMD, 20 patients with back pain, and 20 healthy controls visualize neutral or personally relevant stressful situations. Surface EMG electrodes were placed on widely dispersed body regions including the face and back. They found that patients exhibited stress-related reactivity that was specific to their pain disorder. Patients with TMD, during stressful imagery but not neutral imagery, increased muscle activity in the masseter muscles of the face, whereas patients with back pain increased activity in the muscles of the lower back. Given the changes that were elicited by imagined stressors, one can propose that real stressors would have caused an even larger change.

A more recent study [90] also showed that high-relevance imagery produced high self-reported distress and increased myoelectric activity. These studies tend to support the stress-hyperactivity hypothesis and suggest that treatments such as biofeedback, stress counseling, or cognitive behavioral therapy, which are directed at reducing muscle tension, could have a very beneficial effect for these patients.

Management

A complex problem such as TMD requires complex solutions. No single therapy, certainly not surgical intervention, is the key to helping patients who suffer from these disorders. Chronic pain management requires a multidisciplinary approach, including a strong emphasis on psychological treatment. Because the majority of patients with TMD suffer from pain of myofascial origin, conservative measures rather than invasive treatments are recommended [45,91].

Physiotherapy and biofeedback

Brooke *et al.* [92] treated a group of 194 patients with myofascial pain (almost all of whom complained of pain, often exacerbated by chewing or yawning, and most of whom also had a clicking jaw, difficulty in opening or closing the jaw, and muscle tenderness to palpation). The condition was explained fully to the patients and they were reassured that no organic disease was present. For some, who described themselves as undergoing a period of severe stress, a mild tranquilizer was prescribed. For those with a history of bruxism or an obvious occlusal abnormality, a splint was constructed. Almost all patients received 1 to 2 months of tri-weekly physiotherapy sessions involving ice and ultrasound to the region around the TMJ. When seen 16 to 44 months after their initial visit, close to 40% had no symptoms and another 40% had only occasional symptoms that did not require treatment. For the 20% who were still having symptoms, training in deep muscle relaxation and biofeedback provided marked improvement on both objective and subjective measures.

Electromyography has played an important role in understanding the pathophysiology of TMDs and in their clinical management. Crider and Glaros [93] recently reported the outcome of a meta-analysis of studies of EMG biofeedback treatment for TMD. Focusing on patient pain reports, the findings of clinical examinations and ratings of global improvement, they found that five of six controlled studies involving attempts to relax the facial muscles with EMG biofeedback treatments, showed significant reductions in at least one of the outcome variables. More than two thirds of patients who received EMG biofeedback were rated as symptom-free or significantly improved, compared to about one third of patients who improved after placebo interventions.

Flor and Birbaumer [94] compared the efficacy of biofeedback, cognitive-behavioral therapy, and conservative medical treatment in 78 randomly assigned patients with chronic pain (57 with chronic back pain and 21 with temporomandibular pain and dysfunction). Post-treatment improvement was observed for patients within each type of intervention; however, individuals who received biofeedback demonstrated the greatest progress. Furthermore, follow-up of participants 6 months and 2 years later indicated that significant improvements in pain severity, interference, distress, health care utilization, muscular response to stress, and the use of active coping self statements were maintained only by individuals who had received biofeedback.

Cognitive behavioral therapy

Patients with facial pain have been reported to demonstrate more maladaptive beliefs than healthy controls [95]. Therefore, it seems reasonable to assume that interventions aimed at reducing negative beliefs may improve the dysfunction experienced by these individuals. Cognitive behavioral therapy (CBT) is one such treatment that may be beneficial with patients with TMD.

Turk *et al.* [96] compared the effectiveness of using a dental intervention (intraoral appliances) and a psychological therapy (biofeedback and stress management) in the treatment of 80 patients with TMD. At the conclusion of treatment, patients using the dental splints reported a significantly greater reduction in pain relative to individuals whose treatment involved psychological management. However, assessment at 6 months post-treatment indicated that the dental group experienced significant relapse, whereas those who had received psychological intervention maintained and continued to demonstrate improvement on measures of pain and depression. Interestingly, a follow-up study using a smaller TMD sample assessed the effects of combining dental and psychological treatments and found that this collective intervention was more successful in reducing patients' pain 6 months later than either of the treatments alone. The results emphasize the importance of combining both dental and psychological interventions in the treatment of TMD.

Dworkin *et al.* [97] assessed the usefulness of CBT in the treatment of TMD when it was provided prior to common dental treatment (occlusal splints, nonsteroidal anti-inflammatory medications, jaw motion exercises, parafunctional/dietary modifications, use of hot and cold packs). A total of 139 patients with TMD presenting with self-reported pain in the masticatory muscles, temporomandibular joint, or ear region participated in a clinical trial that compared usual treatment with or without two sessions of a cognitive behavioral group intervention. At 3- and 12-month follow-up, measures of maximum mandibular opening, depression, and somatization showed improvements in both groups, but the two did not differ. However, differences in reported pain between the treatment groups emerged at 12-month follow-up, as the CBT group continued to demonstrate improvements in characteristic pain, whereas those in the usual treatment alone group maintained the same level of improvement seen during the 3-month assessment period. Furthermore, relative to the usual treatment group, significantly more patients in the CBT group reported improvement in their condition and understanding about their disorder and self-management strategies. Moreover, CBT was a very popular intervention with patients, as 94% of the CBT sample indicated they were extremely satisfied with the program.

A companion study [98] found that passive coping strategies and perceived inability to control pain at 3 months after treatment predicted greater pain interference in daily activities at the 1-year assessment. However, one must consider that the two sessions of cognitive-behavioral intervention provided only brief therapy. The finding that passive coping and low perceptions of pain control are related to functional impairment provides intuitive support for the use of CBT in the treatment of TMD, because these are two factors that could be directly addressed by this intervention.

Conclusions

Although we do not yet definitively know the influence on pain and distress of each of the many factors discussed in this review, it seems reasonable to conclude that TMDs arise from multiple sources and involve complex interactions between psychosocial and biological variables. There is now enormous interest in orofacial pain, and remarkable progress has been made in recent years in understanding the factors that contribute to its pathogenesis, maintenance, and treatment.

If anything, the studies reviewed here indicate that there are no simple answers to questions regarding causality and management [1••,99••]. From the patient's perspective, many of these issues are academic ones. Practitioners have a responsibility to evaluate and treat pain and psychological distress. As Marbach [100] noted, "An understanding clinician can provide the sustained support required to prevent the cycle of ever more invasive treatments with their potential for harm." Often, if the pain is diminished, so, too, is the depression, anxiety, and illness behavior. At other times, therapy designed to reduce catastrophizing, increase adaptive coping, and diminish stress will lead to a marked reduction in temporomandibular pain and dysfunction. A dual treatment approach, which targets both pain and suffering, makes logical sense and has received strong empiric support [101•]. For example, all of the patients with myofascial TMD evaluated in a 7-year follow-up study who had received counseling combined with dental treatments improved compared with only 43% of the patients treated otherwise [102].

Still, there is a need for a great deal more research. Marbach and Raphael [103] noted that evidence-based care forces us to question many of the assumptions and approaches that have been mainstays of TMD treatment programs. They suggest that there is little evidence for the long-term effectiveness of oral appliances [104] and TMJ surgery. On the other hand, there is a pressing need for clinical trials of opioid analgesic agents in the treatment of chronic and recalcitrant musculoskeletal facial pain.

There are many other unanswered questions about predisposing factors for TMD and interventions that might inhibit the expression of the disorders, about the heterogeneity of the patients, about individualized treatments, and about the use of psychophysical, imaging, neurochemical, electrodiagnostic, and psychometric approaches in diagnosing subtle but critical distinctions in symptom presentation. Although affective disturbances seem, for the most part, a consequence of severe and unremitting facial pain, there seem to be individuals for whom affect is a predisposing factor. Likewise, it is tempting to conclude that diminished central inhibition or patterns of generalized hypervigilance precede the onset of TMD, but longitudinal studies of individuals with diminished inhibitory control and low tolerance are needed to see if they are at heightened risk for TMD and other chronic pain disorders.

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Recently published papers of particular interest are highlighted as:

- • Of special interest
- •• Of outstanding interest

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