New perspectives on painful temporomandibular disorders

Antoon De Laat

Pain and dysfunction of the masticatory system have challenged the dental profession for decades. Recently, a better understanding of the pathophysiological mechanisms paralleled the increase of basic and clinical research focusing on pain in general. Consequently, so-called diagnostic techniques and treatment procedures, based upon hypothetical, sometimes dogmatic, etiological mechanisms, are being increasingly questioned, and the ill-supported thoughts are gradually being replaced by insights resulting from scientific research. The ongoing communication between basic scientists, researchers or practitioners focusing on musculoskeletal pain, and the dental profession, has led to an improved quality of research on pain and dysfunction of the masticatory muscles and the temporomandibular joint (TMJ). This paper will try to review this progress, comment on the clinical implications and give some suggestions for future research.

During the 1970s, a number of epidemiological studies illustrated the high prevalence and incidence of signs and symptoms grouped under the heading Temporomandibular (or Craniomandibular) Disorders. The comparison of clinical studies and the interpretation of treatment procedures and results, has been hampered by the lack of standardized diagnostic criteria for (the different subgroups of) temporomandibular disorders (TMD).

Classification of temporomandibular disorders

Several classifications were suggested based upon the orthopedic literature, biopsychosocial models, rheumatological classifications, as well as on thorough review of the existing literature by expert committees (for review see 1). The taxonomy used, however, was criticized on e.g. the descriptive nature, the lack of validation, poor specificity, or impossibility of having multiple diagnoses. Recently, a set of Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were formulated (1) based on operational definition of the terms used, epidemiological data, specification of the examination methods and established reliability of the measurements. As in most classifications of pain syndromes, a dual axis system was applied, allowing a physical diagnosis to be coordinated with operationalized assessment of psychological distress and psychosocial dysfunction. The validation and clinical testing of these RDC/TMD is currently in progress in several centers. According to Axis I of the RDC/TMD, three subgroups are defined: muscle disorders, disk displacements and a group covering arthralgia, arthritis and arthrosis (Table 1).

Muscle spasm, myositis and contracture, as well as the

Table 1. Research diagnostic criteria, axis I: clinical conditions (1)

Group I: Muscle disorders:
- Myofascial pain
- Myofascial pain with limited mouth opening

Group II: Disk displacements
- Disk displacement with reduction
- Disk displacement without reduction with limited mouth opening
- Disk displacement without reduction without limited mouth opening

Group III: Arthralgia, arthritis, arthrosis
- Arthralgia
- Osteoarthritis of the TMJ.
- Osteoarthrosis of the TMJ.

polyarthritides and acute traumatic injury are rare and sometimes ill-defined, and consequently were deliberately omitted from the classification. The development of such a classification is a continuous process and will make progress concurrent with a better understanding of the cause(s) and natural progression of these disorders.

Masticatory muscle pain

Muscle pain (myalgia) is considered the most common source of pain in clinic populations of patients with chronic pain (2), as well as in an asymptomatic general population (3). The use of the terms »myofascial pain syndrome (MPS)«, »trigger points« (4) (as compared to tender points) and some suggested diagnostic criteria (e.g. twitch response, taut band) are still being debated. Recent research (5) could not duplicate the presence of histological changes at the site of the trigger points, and the spread of the pain sensation after local injection of hypertonic saline in muscles only partially paralleled the referred pain patterns described earlier (4,6). It appears very difficult to discriminate MPS from fibromyalgia, which is defined as widespread pain with tenderness at 11 out of 18 specific points located all over the body except in the masticatory system (7). The overlap between fibromyalgia and TMD is poorly documented: 18 – 35.5% of fibromyalgia patients reported jaw pain (8), while a recent study indicated that more widespread body pain and other symptoms of fibromyalgia were infrequent in TMD populations (9). More systematic studies are needed to understand the nature of both conditions.

The generation and processing of muscle pain

Animal studies have recently provided a better understanding of how noxious information is registered and transmitted to the central nervous system (CNS). Data on the physiological properties of nociceptors, both in the jaw muscles and the TMJ, is scarce (10) in contrast with the body of knowledge on the spinal afferents involved in muscle and joint nociception in limbs (11). Integration of these data in the trigeminal system indicate that heavy mechanical or chemical agents excite predominantly free endings, served by small-diameter afferents (Group III and IV), which, like the limb muscles, are subject to peripheral sensitization and are involved in neurogenic inflammation (12). These afferents project to various sites of the trigeminal (V) sensory complex, but especially to the subnucleus caudalis, also called the medullary dorsal horn. Both using direct projection and multisynaptic pathways, the information is sent to the thalamus (the ventrobasal and posterior complex (13)). Virtually no information exists concerning the projection from thalamus to cortex as regards the orofacial area.

Etiology of muscle pain

Several etiological hypotheses from the past have recently been challenged and refuted:

First, the correct interpretation that simple correlations do not implicate cause/effect relationships (14) has led to many studies indicating that occlusal and articular parameters should only be attributed a minor (if any) etiologic role in the development of muscular pain and other signs and symptoms of TMD (15).

Second, the existence of a »vicious cycle« hypothetizing that pain causes muscle hyperactivity, which in turn causes more pain (16), has been challenged due to a number of points: (1) critical evaluation of the literature (17) and recent data indicate that parafunctional habits are a very common event usually not resulting in TMD symptoms (18), (2) bruxers with pain have been shown to exhibit less episodes of bruxism per hour than bruxers without pain (19), and (3) heavy exercise results in short-term pain but does not trigger the »vicious cycle« and merely produces a training effect (20). In addition, TMD patients do not show an increased postural electro-myographic (EMG) activity of jaw muscles (17) or signs of central motoneuronal hyperexcitability (21). Thus, muscle pain merely results in decreased maximum voluntary contraction and bite force (17) in humans, as well as smaller and slower neuronal discharges in rabbits (22).

These findings all fit in a pain-adaptation model, including a diminished work capacity against load and a reduction of speed and range of motion (17,22).

In line with this discussion, the attention has been turned away from the local factors mentioned above and focused more on systemic factors. Muscle tenderness might be related to prolonged central sensory hyperexcitability and changes in central processing resulting from a peripheral injury (23). A recent blind and controlled study correlated painful temporomandibular disorders with segmental limitations of the cervical spine (especially in the C0-C3 region) and cervical muscle myalgia (24). Surprisingly, the apparent discriminator between patients and controls appeared during a skin folding test, reported as »painfull« by most of the patients and none of the controls. This might reflect a overall increase in sensitivity towards an otherwise non-painful stimulus.

Similarly, it is striking that only recently several groups have started to look into the influence of possible etiologic role of female hormones (25), in spite of females outnumbering up to ten times the males in patient populations.

Diagnosis of muscle pain

In view of the absence of metabolic or immunologic markers, and in correspondence with the data on muscular activity

(17), which make the use of EMG recordings useless at the present time, the clinical diagnosis of masticatory myalgia is made by algometry. Manual palpation (26) and several kinds of algometers allow a consistent and significant difference between groups with and without muscle pain. It should be noted, however, that higher counts of tender points are seen after pressure algometry when compared to digital palpation (27), which might result in confusion for diagnoses in which the number of tender points is conclusive (1,7). Pressure algometry has been proven as a reliable tool (28), with reproducible measurements over a period of time, but with high inter-individual variability (29).

TMJ disk displacements and related pain

Since the early seventies (30), a renewed interest on the association between TMJ disk displacements and signs and symptoms of TMD led to an increased focus on disk position and treatments aimed at reestablishing »normal« relationships between disk and condyle. A clinical distinction has been made between a (usually anteromedial) displacement of the disk *with* reduction (clicking joint) and *without* reduction (closed lock). The latter situation could result in the presence or absence of limitation of mouth opening (1).

The underlying motivation for early diagnosis and treatment of disk displacements was the assumption that the anterior position of the disk was directly related to the occurrence of pain, limitation of mandibular movement (in case of non-reducing disk displacements), as well as to the development of osteoarthrosis. Recently, however, the importance of disk position and disk displacement, the relationship between degenerative joint disease and the interpretation of (as well as the need for) elaborated diagnostic techniques and treatment have been revisited.

Epidemiological findings and natural course

Although the lack of standardization regarding definition and diagnosis of joint sounds complicated the comparison between studies, agreement exists that the symptom is very common in the general population (30-50%). Recently, longitudinal data obtained in adolescents (31) and adult patients (32) indicate that TMJ clicking only rarely develops into joint locking, and that the symptom might be a bad predictor of such locking. Furthermore, TMJ clicking seems to be a cyclic and poorly predictable symptom, which as such does not warrant treatment (33).

TMJ disk displacement and pain

Movements of the jaw in patients with disk displacement lead to increased pain, which suggests that traction or pressure on the ligaments and retrodiskal tissues are the main cause of the pain (34). Most patients, however, do not report pain concomitant with clicking and even locking of the TMJ, which questions this direct relationship. A possible explanation might be offered by focusing on (micro or macro) trauma as the main etiology for disk displacements: if the internal derangement develops *slowly*, the neighbouring tissues will gradually adapt to the altered biomechanics without pain, while in case of *sudden* or massive trauma, pain will occur. With regard to treatment of the pain, longitudinal studies have indicated that non-invasive procedures yield long-lasting results in most patients, regardless of disk position (35).

TMJ disk displacement and osteoarthrosis

The interaction between internal derangement and the development of degenerative changes is still unclear. Both in primary and secondary osteoarthrosis, a mechanical, biochemical, inflammatory or immunologic insult disturbs the equilibrium between form and function maintained by continuous remodeling, and as a result cartilage breakdown occurs (36). Disk displacements might be considered both an etiologic (co-)factor because of the possible overload of condylar cartilage, and a sign of osteoarthrosis, where the altered sliding properties of the cartilage or deterioration of the synovial fluid give rise to friction, wear and possibly disk displacement (36).

Diagnosis of TMJ disk displacement

Disk displacement with and without reduction are *clinical* diagnoses. Clicking of the TMJ can be traced using manual palpation or stethoscopy with fair to good intra- and interobserver reliability. Electronic devices have proven to give higher reliability, but are not necessary in clinical settings. For non-reducing disks, the diagnosis is sometimes complicated in patients with joint laxity, where the limitation of mouth opening or the asymmetric lateral movements appear less marked. MRI offers a reliable non-invasive tool without the hazard of radiation with which to study disk position in these patients (37). The use of this expensive technique should, however, be limited to doubtful cases.

Degenerative/inflammatory disorders

Animal models and developments in molecular biological research begin to illustrate the complex changes which occur at the level of the articular fibrocartilage, and the role of loading, matrix components, cytokines and neuropeptides (38).

Factors like female hormones, age, sympathetically mediated effects related to pain or psychological stress, trauma,

systemic illness, diet and smoking have been suggested to cause changes of the adaptive capacities of the TMJ. In both the inflammatory (e.g. rheumatoid arthritis) and degenerative disorders, local inflammatory processes lead to cartilage breakdown and damage of the joint. An important role in maintaining normal tissue turn-over has been attributed to proteases (and -inhibitors), cytokines, growth factors and arachidonic acid (39). The local peripheral nervous system appears not only to signal nociception, but also to take active part in the inflammatory process (neurogenic inflammation, 12). The sympathetic fibres release substance P, calcitonin gene-related peptide (CGRP), neurokinin A and neuropeptide Y. These substances mediate and modulate the inflammatory disease and the concomitant pain, and their presence is highly correlated to the amount of pain and destruction. These markers have been found in the synovial fluid of TMJ arthritic patients (40). Care should be taken, however, not to confuse between real markers of disease and products possibly resulting from the inflammatory process itself.

Management of masticatory disorders

Research on the treatment of pain and dysfunction of the masticatory system is especially characterized by the lack of prospective studies, randomized clinical trials and clear criteria for both inclusion/exclusion of subjects and treatment outcome. Some principles with regard to management can be put forward:

The treatment goals are a decrease of pain, decreased loading of the masticatory system, and restored mandibular movements and oral function. In this respect, early treatment of significant signs and symptoms is advocated to prevent chronicity, which leads to more psychosocial (Axis II, ref. 1) factors and altered care-seeking behaviour (41). Since both physical and psychological contributing factors need to be considered, a multidisciplinary approach is advocated for both assessment and management of the disorders.

As mentioned earlier (31,32,35), there is increasing evidence that signs and symptoms of TMD are self-limiting and resolve without apparent side-effects. Consequently, the use of non-invasive, reversible treatment procedures should be promoted over surgical interventions. Conservative treatment has proven efficacy in relieving pain and dysfunction in 50 to over 90% of patient populations examined (42), also over longer periods of time (32).

Temporomandibular disk position seems less critical with regard to the development of pain (34), and accumulating evidence suggests that TMJ-clicking is not a determinant factor in the development of closed lock of the TMJ (31,32). The use of intra-oral appliances or surgical techniques aimed at repositioning the disc into its »best« position should therefore be reconsidered, and moreover have been reported to be only moderately successful in stabilizing the disk position or avoiding TMJ-clicking in the long term (for review see 43).

It is striking that comparable results are obtained with whichever treatment executed, which questions the value of intensive treatment in comparison with time or placebo effects. Only very few randomized clinical trails have been performed which indicate that biofeedback, antidepressant (amitriptilyne) or relaxing (clonazepam) medication, and acupuncture are more effective than placebo (see 44 for review). Conversely, no such studies could validate the reported clinical success of interocclusal appliances, NSAID's, muscle-relaxant medication and various physical treatment procedures (for review see 45). The real effect of arthroscopic lysis and lavage in comparison with non-invasive treatment is still under discussion (46).

In conclusion, and based on the (limited) data available, a conservative, non-invasive, reversible approach appears effective in most patients.

Dansk resumé

Nye synspunkter vedr. smertegivende temporomandibulære lidelser

Sammenhæng mellem smerte og dysfunktion i tyggeapparatet har i årtier repræsenteret en stor udfordring for odontologien. I den senere tid har basal og klinisk forskning specielt fokuseret på smerte, og denne forskning har bevirket en bedre forståelse af de patofysiologiske mekanismer ved smerte. Der kan sættes spørgsmålstegn ved en række diagnostiske teknikker og behandlingstyper, der ofte udelukkende har været baseret på dogmatisk fremstillede og hypotetiske ætiologiske mekanismer. Disse uunderstøttede ideer erstattes nu gradvist af ny indsigt opnået gennem videnskabelige undersøgelser. Diagnostik af de forskellige undergrupper af smerte- og funktionsforstyrrelser i tyggeapparatet sker primært på basis af den kliniske undersøgelse, da fx elektromyografi og andre tekniske hjælpemidler endnu ikke er tilstrækkelig valideret. Der må i dag anbefales en konservativ holdning til behandling, ikke mindst fordi patienternes udbytte af en stor og omfattende behandling af ikke-smertevoldende kæbeledsproblemer er diskutabel.

Der er i fremtiden et udtalt behov for kontrollerede og randomiserede kliniske undersøgelser af behandlingseffekten på de forskellige undergrupper af smerte- og funktionsforstyrrelser i tyggeapparatet.

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Author

Antoon De Laat, Professor, LDS, GHO
Cluster Oral Physiology, Dept. Oral and Maxillofacial Surgery, School of Dentistry, Catholic University of Leuven, Capucijnenvoer 7, B-3000 Leuven, Belgium