



Chronic orofacial pain

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Abstract

While pain chronicity in general has been defined as pain lasting for more than 3 months, this definition is not useful in orofacial pain (OFP) and headache (HA). Instead, chronicity in OFP and HA is defined as pain occurring on more than 15 days per month and lasting for more than 4 h daily for at least the last 3 months. This definition excludes the periodic shortlasting pains that often recur in the face and head, but are not essentially chronic. Although the headache field has adopted this definition, chronic orofacial pain is still poorly defined. In this article, we discuss current thinking of chronicity in pain and examine the term 'chronic orofacial pain' (COFP). We discuss the entities that make up COFP and analyze the term's usefulness in clinical practice and epidemiology.

Keywords Headache · Persistent pain · Facial pain · Migraine · Myalgia · Neuropathic pain

Introduction

Chronic orofacial pain (COFP) has been variably defined to describe a group of regional disorders which are persistent in nature. In this manuscript, we will analyze the definition of COFP as it relates to the more established and widely accepted definitions of chronic headache and chronic pain in general. We make a clear case for adopting the criteria used to define 'chronicity' in headache to orofacial pain (OFP). Subsequently we examine common (OFP) disorders that may become chronic and discuss to what level the term COFP is of clinical importance and significance.

Chronic facial pain or headache?

Discussing facial pain is impossible without a parallel introduction to the overlap and intimate relationship with headache. Facial pain has generally been separated from headache based on anatomic definitions. Headache is defined as pain occurring only or mainly above the orbitomeatal

and/or nuchal ridge, whereas facial pain is defined as pain occurring mainly or exclusively under the orbitomeatal line, anterior to the pinnae and above the neck; (ICHD-3 2018; ICOP 2020) others include the forehead as part of the face (Piper 1995). However, the face and head are both innervated by the trigeminal nerve even if headache is largely via the first division and orofacial pain via the second and third trigeminal branches. Of itself, this provides a substrate for pain referral. Moreover, the face and head have a number of important structures adjacent to each other (eyes, ears, nose, paranasal sinuses, and oral cavity) further complicating pain referral patterns. The trigeminal nerve provides primary sensory innervation to all of these as well as the brain, brainstem, and the cavernous sinus further facilitating pain referral mechanisms at the peripheral and central levels (Tal et al. 2015).

Indeed, there is clinical overlap between chronic orofacial pain (COFP) and headache with 60% of patients seeking treatment for COFP reporting headaches (Dando et al. 2006). Moreover, there is a significant relationship in the general population between the frequencies of chronic facial, head, and cervical pain (Storm and Wanman 2006). The mechanism can be explained by the neuronal interplay between the trigeminal subnucleus caudalis and the upper cervical spinal cord (trigeminocervical complex), and neuroplastic changes that occur in response to injury and pain (Shinoda et al. 2019; Tal et al. 2015). In clinical practice, therefore, headache and facial pain are most often intimately

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related. The pain referral patterns are complex, but very commonly seen as the symptoms can overlap, hence this relationship can be bidirectional (Graff-Radford and Abbott 2016; Abouelhuda et al. 2017).

Based on this, we will be drawing on some headache research to examine the phenomenon of chronic orofacial pain (COFP). Orofacial pain is generally classified based on the symptomatology and suspected pathophysiology and a new classification has been recently published (ICOP 2020), see Table 1. Hence the clinical groupings such as musculoskeletal pain (within the temporomandibular disorders), neuropathic pain (post-traumatic and post-herpetic), and odontogenic pain due to a variety of dentoalveolar pathologies (Sharav and Benoliel 2015). OFP may be primary (or idiopathic) (Treede et al. 2019) or secondary when the pain is due to an identifiable pathological process (Benoliel et al. 2019).

The prevalence of pain in the orofacial region has been reported to be between 16.1 and 33.2% (Horst et al. 2015), (de Melo Junior et al. 2019). A realistic prevalence for OFP seems to be around 25%, of which about 10% is COFP (McMillan et al. 2006; Macfarlane et al. 2002a; Ng et al. 2002), and induces significantly reduced quality of life, sleep disturbances, and disability (Shueb et al. 2015; Benoliel et al. 2017; Haviv et al. 2017; Ridgeway et al. 2013; Almoznino et al. 2017). Painful temporomandibular disorders are quite prevalent with 4.6% of the population reporting these (6.3% in women, 2.8% in men) (Isong et al. 2008). This is in agreement with the 2009 National Health Interview Survey that found that 5% of adults reported pain in the face or jaw over a 3-month period. The incidence ratio of persistent facial pain was reported at 38.7 per 100,000 person years, is more common in women and increased with age (Koopman et al. 2009). Syndromes identified included trigeminal neuralgia and cluster headache, which were the most common forms. Paroxysmal hemicrania and glossopharyngeal neuralgia were among the rare syndromes. It

is clear that chronic orofacial pain is more prevalent than previously thought.

A clear definition of COFP is essential so as to allow a common base upon which to study disease burden, outcome, and comorbidities associated with orofacial pain in a standardized manner. These comorbidities may include other pain syndromes and psychosocial disturbances.

Chronic pain

Based on temporal patterns, OFP disorders may, rather simplistically, also be further classified as ‘acute’ or ‘chronic’. Although the term seems self-explanatory, what indeed is ‘chronicity’ in pain and specifically in OFP and headache? In general, chronic pain is widely defined as present for more than 3 months (Olesen et al. 2004, 2007). The definition of chronicity for pain has endured the test of time and the IASP task force on chronic pain recently defined it as “persistent or recurrent pain lasting longer than 3 months” (Treede et al. 2015). Although simple, the definition according to pain duration is clear, unambiguous, and easily applicable. The definition does not prevent the additional collection of relevant and important information and comorbid conditions such as psychosocial factors, depression, pain-related distress, and functional impairment. In studies, chronic pain, irrespective of diagnosis, demonstrates high prevalence of serious psychiatric and medical comorbidities (Ratcliffe et al. 2008; Altindag et al. 2008; Nicholson and Verma 2004; Wilson et al. 2002; Korszun 2002).

In the field of headache and OFP, a simple definition based on disease duration is incompatible with the temporal characteristics. When strictly adhering to such a definition, primary orofacial pain and headache disorders are chronic by definition, since many occur for the life of an individual patient. The particular temporal characteristics of OFP and HA require a different approach to define chronicity.

The headache community defined chronicity for head pain as headache that occurred (untreated) on at least 50% of the days for at least 3 months and lasted at least 4 h per day (ICHD-3 2018). The criterion of a 4-h duration per day was used to exclude the paroxysmal headache disorders (e.g. episodic cluster headache) but has since been shortened to 2 h for uniformity across disorders. These headache disorders are more of an unremitting paroxysmal disorder than a bona fide chronic pain condition. In this manner, chronic headache and OFP disorders can be separated from episodic disorders based on their time pattern.

Chronic daily headache (CDH) is the term coined in the headache literature to bring together these disorders based on their temporal pattern. Similarly, COFP is an umbrella term, primarily useful for epidemiology and the study of the effect of chronicity on quality of life issues. CDH as a diagnosis is sometimes seen clinically and in the headache

Table 1 International Classification of Orofacial Pain (ICOP)

Chapters describing diagnostic criteria for:
1. Orofacial pain attributed to disorders of dentoalveolar and anatomically related structures
2. Myofascial orofacial pain ^a
3. Temporomandibular joint (TMJ) pain ^a
4. Orofacial pain attributed to lesion or disease of the cranial nerves ^a
5. Orofacial pains resembling presentations of primary headaches ^a
6. Idiopathic orofacial pain ^a
Chapter with recommendations on further assessment
7. Psychosocial assessment of patients with orofacial pain

From International Classification of Orofacial Pain (ICOP) 2020

^aGroups that may include subtypes with a chronic temporal pattern as defined in the text

literature (Silberstein et al. 1996), but without knowing the precise diagnosis, the term is clinically of little use in establishing management strategies. CDH is relatively common in the population with a worldwide prevalence of about 2.5–5%. The vast majority suffers from chronic tension-type headache (global prevalence of 2–3%) or chronic migraine (1.3–2.5%) (Jensen 2003; Russell 2005). Secondary CDH is most usually due to medication overuse (Castillo et al. 1999; Zwart et al. 2003), but also includes headache secondary to COFP entities such as temporomandibular disorders (Graff-Radford 2005).

Primary CDHs are mostly a temporal transformation of their episodic counterparts (Olesen et al. 2004) and may be defined as short or long lasting (> 4 h per attack) Silberstein and Lipton 2000 include chronic migraine, chronic trigeminal autonomic cephalgias, chronic tension-type headache, and new daily persistent headache.

Defining chronic orofacial pain

The question is how do we define chronic orofacial pain? The issue has been debated in the literature. Attempts at defining chronic (orofacial) pain using additional criteria from common comorbid conditions, such as depression, have not been adopted due their inherent complexity. Inclusion criteria employed in studies on COFP differ; pain of 1 day over the last month, daily or near daily pain for the last 3 months (Aggarwal et al. 2007; McMillan et al. 2006; Chung et al. 2004; Macfarlane et al. 2002b; Sharav et al. 1987; Lipton et al. 1993; Locker and Grushka 1987; Riley and Gilbert 2001). Moreover, features such as attack frequency and duration are often unclear (Aggarwal et al. 2007; Chung et al. 2004; McMillan et al. 2006). This lack of uniformity in defining COFP has been emphasized so that comparing data across studies is consequently problematic (Macfarlane et al. 2004; Benoliel et al. 2010, 2009).

In the past, an attempt has been made to conceptually unify persistent or COFP syndromes under one pathophysiological concept. This proposes that based on chronicity and other shared features, the diagnostic entities included in COFP are clinically and therapeutically more similar than they are different (Woda and Pionchon 1999, 2000). Unfortunately, the precise definition of ‘chronicity’ for the different OFP disorders was poorly defined and inconsistent. Moreover, this concept, although interesting in its approach, has not received wide acceptance (Fricton 1999; Okeson 1999).

The case for adopting CDH criteria

The study of the epidemiology, clinical characteristics, treatment outcomes, and associated comorbidities of ‘chronic’ pain syndromes requires precise definitions of its temporal features.

We studied the applicability of CDH criteria to COFP and found them to be very useful (Benoliel et al. 2010). Further studies are needed to examine the 4-h cut off point, but in general, we found this approach produced a more detailed resolution of pain patterns in persistent OFP (Benoliel et al. 2010). The criteria are applicable to the study of COFP and should be adopted in epidemiologic and clinical trials, bringing orofacial pain in line with headache.

The ‘International Classification of Orofacial Pain’ (ICOP)

ICOP is a multiprofessional, international initiative to establish a comprehensive classification of orofacial pain and has recently been published (ICOP 2020). This classification is in line with ICHD-3 and ICD-11, and defines common OFP diagnoses such as dentoalveolar pain, masticatory myofascial pain, and facial presentations of primary headaches, which are not directly described or recognized by the ICHD (Table 1). We have previously stressed the lack of inclusion of OFP in ICHD-3 (Benoliel et al. 2008) and ICOP may provide a bridge between the headache and OFP professions.

Importantly, ICOP adopts the temporal definitions of chronicity in OFP as that for headaches. These definitions can be subsequently field tested further to establish the specific relevance to the study of COFP (Benoliel et al. 2010).

General features of COFP

When we applied CDH criteria to OFP, we encountered interesting findings (Benoliel et al. 2010). Attesting to the complexity often involved in the diagnosis of orofacial pain syndromes (Zebenholzer et al. 2005, 2006; Benoliel et al. 1994, 2008), patients arrival for diagnosis and treatment about 2–3 years after the onset of pain irrespective of diagnosis or temporal patterns. These figures are similarly reported in the literature for primary headaches and orofacial pain (Bahra and Goadsby 2004; van Vliet et al. 2003; Bowsher 2000; de Siqueira et al. 2004; Main et al. 1992; Mitchell 1980; Taha et al. 1995; Benoliel et al. 2009, 2016; Haviv et al. 2014, 2017).

When applying CDH definitions, COFP patients were usually female, with a longer reported time to diagnosis and more frequently reported waking due to pain. The most

common diagnosis was one of the myalgias as defined by the Research Diagnostic Criteria for TMDs (RDC-TMD). Other characteristics were not significantly different from those in episodic-type OFP. Moreover, COFP was not distinctive in pain severity or other demographic features. Most parameters usually associated with the diagnostic process (laterality, severity, muscle tenderness, and waking) were associated with specific diagnosis rather than temporal patterns when employing appropriate statistical methodology.

This stresses the importance of relating to the term COFP as an umbrella term or diagnosis based on a purely temporal definition. It is similar to CDH which includes chronic tension-type headache, chronic migraine, and other disorders. For tailored management, further classification into specific diagnoses is needed.

Review of relevant-specific COFP disorders

A detailed, inclusive review of all specific COFP disorders is beyond the scope of this article. We, therefore, aim to provide an overview with carefully selected citations that will allow readers to expand their knowledge as well as subclassify the various specific diagnoses that can fall under COFP.

Orofacial pain attributed to disorders of dentoalveolar and anatomically related structures

Theoretically, chronic dentoalveolar pain may result from a disorder involving the teeth or associated tissues (pulpal, alveolar bone, periodontal, and gingival). Causative factors would include untreated caries or trauma to a tooth or associated tissues.

Untreated dental decay has been reported as the most common reason for toothache, which can impact routine daily activities. Toothache is a common problem and, depending on geographic location, may be highly prevalent (Kakoei et al. 2013). However, it is unclear what proportion of reported toothache is truly chronic and more data are needed (Kassebaum et al. 2017). From currently available data, duration of constant toothache is present for 27.6 days up to seeking care (Kassebaum et al. 2017). A similar study estimated 55.2 days of tooth pain prior to presenting for treatment to an emergency dental clinic (Whyman et al. 1996). As the above epidemiology suggests that truly chronic dental pain (i.e. lasting > 3 months or meeting CDH criteria) may be extremely rare and caution should be exercised when diagnosing such cases (Benoliel et al. 2019).

Inevitably, the conclusion is that chronic dentoalveolar pain due to related pathology is undocumented, or extremely

rare. Therefore, in the absence of clear etiologic findings following thorough clinical and radiographic examination, pain referral from regional structures, or an atypical presentation or referral pattern from primary or other headache should be considered, see below (Gross and Eliashar 2015; Sharav et al. 2017; Benoliel et al. 2008; Gaul et al. 2008; Benoliel et al. 2015).

Chronic mucosal pain has been extensively reported to be associated with burning mouth syndrome. However, it is still unclear whether pain originating from common oral mucosal lesions can truly be chronic (Abdalla-Aslan et al. 2016).

Temporo-mandibular disorders

The umbrella term- temporo-mandibular disorders (TMD) have been used to describe painful and non-painful disorders affecting the masticatory muscles and/ or the temporo-mandibular joint. Pain is associated with the TMJ (arthralgia) or the muscles of mastication (myalgia) and is usually chronic with a significant effect on quality of life (Almoznino et al. 2015). Together, these are the most common type of COFP disorders, affecting 4–12% of the population and severe symptoms are reported by 10% of subjects (Macfarlane et al. 2002a; Nilsson et al. 2005). Moreover only 3–11% seek treatment, with an estimated 7% of the general population demanding therapy for TMD (Goulet et al. 1995; Schiffman et al. 2014).

The diagnosis of myalgia and arthralgia is clinically based on response to palpation of muscles and TMJs. It is, therefore, important to note that masticatory muscle and TMJ tenderness are present in about 15% and 5%, respectively, of the population (Gesch et al. 2004). Moreover muscle tenderness may be ‘asymptomatic’ in a third of such cases. It is only when the patient reports pain that can be replicated by palpation that we can establish a diagnosis.

Clinically, it is common to see arthralgia and myalgia in the same patient (Almoznino et al. 2019, 2015; Benoliel et al. 2011a), they should be identified and treated as separate entities.

Myofascial–orofacial pain

The pathophysiology of myalgia is uncertain. Research suggests that it is likely to involve complex interactions between genetic, biological, and psychosocial parameters, hence the term ‘complex biopsychosocial disorder’ (Benoliel et al. 2011b; Slade et al. 2013, 2016; Smith et al. 2013). Myalgia has been subclassified into three categories, all of which may result in COFP. Localized myalgia presents with pain in a particular area of a muscle (local myalgia). Myalgia may also refer within (myofascial pain) or beyond muscle

boundaries (myofascial pain with referral) (Schiffman et al. 2014). Clinical presentation includes pain in the masticatory muscles which can be replicated on palpation, and resulting in dysfunction of the masticatory apparatus. Pain, is usually unilateral, but can be bilateral and is localized in and around the ear, angle/body of the jaw, and the temple region. Hypersensitive areas (aka active trigger points) can cause pain referral to distant sites such as the ear and teeth following palpation. The referral pattern depends on the location of the hypersensitive area and the intensity of pain. This commonly leads to misdiagnosis, leading to unnecessary treatment and increased health care utilization (Hobson et al. 2008).

The quality of pain is generally dull and aching with moderate intensity that increases on function. Clinically, the mouth opening may be reduced, with deviation of the mandible while opening the mouth. The muscles most commonly involved with MMP are the masseter, followed by the temporalis (Valentino et al. 2019), and these are the basis for clinical diagnosis (Schiffman et al. 2014).

Average pain duration ranges from 5.5 to 18 h (van Grootel et al. 2005; Benoliel et al. 2008). Typically, MMP is characterized by a chronic course with reported onset months to several years previously (Kino et al. 2005; Rammelsberg et al. 2003). Pain occurring on most days of the month is typical of MFP patients (Benoliel et al. 2008).

The sternocleidomastoid and upper trapezius muscles are often associated with MMP (Silveira et al. 2015). Indeed, MMP is highly correlated with pain of the cervical musculature, as previous studies have found that increased tenderness of the neck and body muscles predicted the incidence of TMD (Almoznino et al. 2019; da Costa et al. 2015). Indeed, patients with MMP had more widespread painful areas associated with chronic neck pain than patients with neck pain alone (Munoz-Garcia et al. 2017). Symptoms of TMD are also more prevalent in patients with fibromyalgia (Ayouni et al. 2019), which is a widespread chronic pain disorder. These data would suggest that MMP is part of a more generalized disorder with a variable clinical phenotype. Management of MMP is conservative involving the use of anti-inflammatory analgesics, physiotherapy, bite plates, centrally acting analgesics, intramuscular injections (aka trigger point injections), and cognitive behavioral therapy (Svensson et al. 2015).

Temporomandibular joint pain

Primary temporomandibular joint pain

TMJ arthralgia is characterized by pain originating from the TMJ that is affected by jaw movement, function, or parafunction, and can be replicated by palpation, joint loading,

or specific jaw movements (Schiffman et al. 2014). These signs usually indicate capsulitis or synovitis.

When discussing TMJ disorders, the term ‘internal derangement’ is often used as a diagnosis. However, internal derangement is a classification or descriptive term, not a diagnosis, and includes disc displacements and degeneration of the TMJ (Stegenga 2001; Nitzan et al. 2015). For a precise diagnosis, the structures and the mechanical problem must be clearly defined; for example, disc displacement with reduction or without reduction or intermittent locking (Nitzan et al. 2015). These may be accompanied by limited mouth opening and all may occur with and without pain (arthralgia). When there is damage to the condyle and/or eminence, we refer to this as joint degeneration or degenerative joint disease. This process is associated with clear tissue damage and disintegration leading to pathological changes of the joint components and is also referred to as ‘TMJ osteoarthritis’.

Secondary temporomandibular joint pain

Temporomandibular joint pain attributed to arthritis

Systemic autoimmune arthritides such as rheumatoid and psoriatic arthritides can affect the TMJ. Changes to the bony structures are seen early on in the disease process, where there is destruction of the bone and cartilage of the joint compartment. This in turn leads to limitation of function. Therefore, it is important to diagnose these conditions early, so that treatment can be rendered in a timely manner and further damage to the joint structures can be minimized (Cordeiro et al. 2016). The radiographic signs are similar to those found in DJD, though the progression is faster and there is involvement of both the TMJ's. Clinically, there may be an anterior open bite due to the rapid destruction of both the condylar heads, leading to autorotation of the mandible. The patients will also complain of pain on other joints in their body. For diagnosis, laboratory studies have to be performed, which may show increased inflammatory markers and rheumatoid factor.

The management of arthralgia is usually conservative with the use of anti-inflammatory analgesics, physiotherapy, bite plates, and arthrocentesis (Nitzan et al. 2015).

Finally, the chronicity of arthralgia has been less investigated than myalgia, possibly due to a lack of clear guidelines. In our study, truly chronic arthralgia was found in a small number of patients attending for treatment (Benoliel et al. 2010). The publication of ICOP will allow temporal patterns to be studied more thoroughly.

Degenerative joint disease (DJD)

The DC-TMD and ICOP classify osteoarthritis and osteoarthritis as subclasses of degenerative joint disease (Schiffman et al. 2014; ICOP 2020). Under the DCTMD, osteoarthritis (OA) is symptomatic, while osteoarthritis shares all the same signs and symptoms of joint damage and dysfunction but with no pain. The presence of ongoing pain is suggested to reflect inflammation and is reflected in the terminology (Alstergren et al. 2018). Indeed, degenerative joint disease or OA has historically been considered a non-inflammatory disorder. However, accumulating evidence indicates the presence of inflammation involving the synovium (Oehler et al. 2002). Sustained intra-articular inflammation induces degeneration of TMJ structures (Wang et al. 2012). There is now clear evidence that synovitis is associated with pain and dysfunction and that it promotes cartilage destruction in osteoarthritic joints (Scanzello et al. 2011; Walsh et al. 2007).

The signs of DJD are seen very commonly on radiographs, but do not always correlate with clinical tenderness (Arayasantiparb et al. 2019). Surface erosion with osteophyte formation, subcortical cysts, and sclerosis are some of the common radiographic signs of DJD (Kaimal et al. 2018). Crepitation is heard in the joint during auscultation.

So, while there are a number of TMJ disorders or derangements, not all are painful. Pain (arthralgia) occurs with accompanying inflammation of the capsule and/or synovial membrane lining the joint (Ibi 2019).

Orofacial pain attributed to lesion or disease of the cranial nerves

Neuropathic pain has been recently re-defined as “pain arising as a direct consequence of any lesion or disease affecting the somatosensory system” (Haanpaa et al. 2011). NP may result from neuronal injury, active or past systemic or local diseases (Elad et al. 2015). The most common neuropathic pain conditions affecting the orofacial area are trigeminal neuralgia and painful post-traumatic trigeminal neuropathy.

Trigeminal neuralgia

Trigeminal neuralgia is an episodic, short lasting (< 2 min), severe pain condition affecting one or more branches of the fifth cranial nerve (ICHD-3 2018). The most common presentation affects the second and third branch of the trigeminal nerve concomitantly (~ 35%), the same branches are affected individually in about equal prevalence (~ 16%). Trigeminal neuralgia has recently been reclassified into ‘classical’ (with

neurovascular compression), ‘idiopathic’ (with no neurovascular compression), and ‘symptomatic’ when caused by a known disease or space-occupying lesion (ICHD-3 2018). The pain of trigeminal neuralgia can be either exclusively paroxysmal or accompanied by concomitant continuous pain.

Diagnosis is made based on the clinical presentation, which includes the presence of trigger zones in over 50% of patients with trigeminal neuralgia (Maarbjerg et al. 2014). This explains why innocuous stimuli trigger the intense pain of trigeminal neuralgia. A refractory period where after a paroxysm of pain attacks cannot be triggered is another distinguishing feature. TN may remit but usually for only a few weeks and invariable returns. The course is chronic with daily or nearly daily pain occurring, some with a constant background pain.

Whether TN worsens over time is unclear. Previous studies suggest that TN is a progressive disease with a poor prognosis (Zakrzewska and Lopez 2004). About 90% of TN cases reported increased attack frequency and severity (Bowsher 2000; Zakrzewska and Patsalos 2002). Furthermore, initial response to carbamazepine is around 70%, but by 5–16 years the response rate is around 20% with 44% of patients requiring drug combinations or alternative medication (Taylor et al. 1981). Long-term follow-up of oxcarbazepine-treated CTN cases demonstrated a high failure rate necessitating surgery (Zakrzewska and Patsalos 2002). However, recent data indicate that according to current diagnostic criteria the treatment response and long-term prognosis of CTN are very good (Di Stefano et al. 2014). Clear treatment protocols have been established (Bendtsen et al. 2019).

Painful post-traumatic trigeminal neuropathy

Trigeminal neuropathy is a chronic neuropathic orofacial pain condition caused by trauma to the peripheral branches of the trigeminal nerve (Benoliel et al. 2012; ICHD-3 2018). Persistent pain can occur after simple dental procedures affecting smaller peripheral branches such as in 3–7% of patients undergoing endodontic procedures (Nasri-Heir et al. 2015) and 0.3–0.8% of patients undergoing dental implant placement (Vazquez-Delgado et al. 2018) or due to major trauma such as fractures, which can affect larger nerve bundles (Joachim et al. 2019; Benoliel et al. 2005). Altered sensation may occur commonly after third molar extractions in about 0.35–8.4% of patients, although chronic pain is extremely rare (Sarikov and Juodzbalys 2014).

The pain is located to the dermatome of the affected nerve, though as the condition becomes chronic, the pain may spread to adjacent dermatomes due to the development of central sensitization and alteration in pain modulation (Nasri-Heir et al.

2015). Patients who develop painful neuropathies present with a wide array of clinical symptoms ranging from negative symptoms such as analgesia to positive symptoms such as hyperalgesia (Vazquez-Delgado et al. 2018; Benoliel et al. 2012; Svensson et al. 2011). The pain is generally described as burning, continuous, moderate in intensity with occasional paroxysms that are more severe in intensity (Renton et al. 2012; Pigg et al. 2013; Baad-Hansen et al. 2008; Renton and Yilmaz 2011). The condition is extremely recalcitrant to therapy (Haviv et al. 2014). Nevertheless, accepted pharmacotherapeutic protocols (Attal et al. 2010; Dworkin et al. 2010; Finnerup et al. 2010) are recommended and topical therapies (Nasri-Heir et al. 2013; Haribabu et al. 2013) may alleviate pain.

Orofacial pains resembling presentations of primary headaches

Unexplained pain in the orofacial region may be an atypical presentation of a primary headache. ICHD group primary headache is divided into four groups; migraines, tension-type headache, trigeminal autonomic cephalgias, and a heterogeneous group termed ‘other primary headaches’. There have been no clear reports on an orofacial tension-type headache, although the discussion on the similarities and differences with masticatory myofascial pain (Svensson et al. 2015) point to some interesting research avenues. Similarly, no clear orofacial equivalents have been reported for ‘other primary headache’.

However, there are several reports of migraine-like or trigemino-autonomic (TAC)-like pains in the orofacial region. The differential diagnosis of such disorders includes a number of entities. A facial or orofacial equivalent to migraine without aura (MWOA), has been reported as ‘lower half’ (Penarrocha et al. 2004), ‘facial’ (Daudia and Jones 2002) or ‘orofacial’ (Gaul et al. 2007) migraine. Regarding this type of migraine, ICHD-3 states that “a subset of otherwise typical patients has facial location of pain, which is called ‘facial migraine’ in the literature; there is no evidence that these patients form a separate subgroup of migraine patients” (ICHD-3 2018). Amongst TACs, an atypically located cluster headache termed ‘lower’ CH (Cademartiri et al. 2002) and ‘orofacial’ CH (Gaul et al. 2008) has been most commonly noted. Maxillary and mandibular expressions of SUNCT/SUNA have also been recognized (Cohen et al. 2006; Goadsby et al. 2010). In their chronic form, all the above should be considered in the differential diagnosis. The importance is clear—primary orofacial pain needs no dental intervention. Nevertheless the facial, dentoalveolar, and maxillary sinus location of pain in these entities often cause misdiagnosis and subsequent mistreatment (Czerninsky et al. 1999; Eross et al. 2007; Foroughipour et al. 2011; Kari and DeGaudio 2008; Klapper et al. 2000; Perry et al.

2004; Schreiber et al. 2004; Senbil et al. 2008; Rossi et al. 2009; Van Alboom et al. 2009; Viana et al. 2013). ICOP deals with these entities and provides a solid base for future research.

Neurovascular orofacial pain

Studying a large group of patients with migraine-like or TAC-like pains in the orofacial region, we were able to use ICHD criteria to diagnose the majority into an orofacial component of a primary headache while a number remained ‘undiagnosable’ (Benoliel et al. 2008; Haviv et al. 2019 (in press)), fitting neither the criteria for migraine or TACs. We named the disorder in these patients “neurovascular orofacial pain” (NVOP).

The features that justify the establishment of NVOP as a distinct entity have been discussed in detail by our group, including the proposition of diagnostic criteria with positive and negative predictive values (Benoliel et al. 2008). The most prominent is oral and/or facial pain location [Benoliel et al. 2008; Haviv et al. 2019 (in press)]. Pain can be accompanied local autonomic signs, specifically tearing, nasal congestion, a feeling of cheek swelling or fullness (Benoliel et al. 1997) and migrainous phenomena such as pho/phono-phobia and nausea (Czerninsky et al. 1999; Benoliel et al. 1997; Obermann et al. 2007; Penarrocha et al. 2004). Pain is bilateral in up to a third of patients with NVOP [Haviv et al. 2019 (in press)]. Initially, unilateral pain was an inclusion criteria for our patient selection studies (Benoliel et al. 1997; Obermann et al. 2007; Penarrocha et al. 2004) leading to biased results and limiting the size of the NVOP group. In later studies, bilateral pain was included [Benoliel et al. 2008; Haviv et al. 2019 (in press)]. NVOP can present as paroxysmal, continuous, or combined temporal patterns. Based on these, 45% of NVOP patients would be considered COFP. Of clinical importance is the common finding of dentoalveolar-accompanying NVOP pain with unique characteristics that mimic dental pathology. These signs and symptoms include spontaneous or evoked dentoalveolar pain (e.g. cold allodynia), explaining patient reports of superimposed short pain attacks (Benoliel et al. 1997; Obermann et al. 2007; Penarrocha et al. 2004; Gaul et al. 2007). Usually there is no dental pathology to explain the pain and we hypothesize that this is part of the clinical phenotype. Additionally it has been a consistent finding that NVOP patients report a relatively late age of onset [Benoliel et al. 2008; Haviv et al. 2019 (in press)]. This fairly new diagnostic entity has been included in ICOP.

Idiopathic orofacial pain

Burning mouth syndrome

Burning mouth syndrome (BMS) is a rare intraoral pain condition that is poorly understood and often misdiagnosed (Salerno et al. 2016). BMS is common in peri and post-menopausal women and occurs in the absence of any organic findings, when it is often termed primary BMS. It is important to rule out local or systemic causes of burning such as candida infections, uncontrolled diabetes (Verhulst et al. 2019), avitaminoses, iron deficiency, and thyroid disease (Talattof et al. 2019). Medications that patients take commonly may cause oral burning as a common side effect. In the presence of such potentially causative factors, the disorder is termed as secondary BMS. Appropriate diagnostic tests are often required to establish the diagnosis.

Patients predominantly have minimal burning on waking but as the day progresses, the burning sensation increases in intensity, reaching peak levels during the evening hours. The most frequent location is the anterior two-thirds of the tongue, though in some patients, the burning may be present in the palate or gingiva, sometimes even the lips may be involved. Eating spicy foods may aggravate the burning sensation. BMS patients suffer from poor sleep quality and increased prevalence of anxiety and depression, although cause and effect has not been clearly established (Adamo et al. 2018; Davies et al. 2016).

The pathophysiology is still poorly understood. It is suggested that three groups may occur all of which link BMS to neuropathic pain (Jaaskelainen 2012; Kolkka-Palomaa et al. 2015). The largest subgroup (50–65%) display intraoral peripheral small-diameter fiber neuropathy. The second subgroup (20–25%) requires careful neurophysiologic examination to identify them, but is clinically indistinguishable from the other two subgroups. Subclinical lingual, mandibular, or trigeminal system pathology is revealed with these tests. The third subgroup (20–40%) displays characteristics of central pain that is hypothesized to involve hypofunction of dopaminergic neurons in the basal ganglia (Jaaskelainen 2012). A hypothetical relationship to the function (or dysfunction) of neuronal pathways relating to the sense of taste has been investigated and has evidence backing this hypothesis (Eliav et al. 2007; Formaker and Frank 2000; Grushka et al. 2003; Just et al. 2010; Kim et al. 2019; Kolkka-Palomaa et al. 2015). Management should be evidence based and often requires multiple, complimentary, and concomitant therapies (e.g. medication and behavioral therapy) (de Souza et al. 2018; Feller et al. 2017; McMillan et al. 2016).

Persistent idiopathic facial pain (PIFP)

The diagnostic criteria for PIFP include the presence of daily or near daily pain that is initially confined but may subsequently spread (ICHD-3 2018; ICOP 2020). Pain cannot be attributed to any pathological process for a diagnosis of PIFP. Clearly this is a loose and ambiguous definition and may allow the misclassification of a large number of chronic facial pain disorders. As such, it is often regarded as a ‘waste basket’ diagnosis and one of exclusion. However, it is important for clinicians to clearly distinguish PIFP from disorders that may mimic it such as trigeminal neuralgia with persistent background pain, painful traumatic trigeminal neuropathies, myofascial pain, and others (Sotorra-Figuerola et al. 2016). Accurate diagnosis is key to successful therapy and prevents potentially serious consequences. The prevalent theory is that PIFP is a disproportionate reaction to a mild injury, but the exact pathophysiology is still unclear. In a deviation from ICHD-3, the definition of PIFP in ICOP allows mild sensory changes to be present. The aim is to allow further research into the pathophysiology of PIFP and its relationship to PTTN. This change is justified based on hypoesthesia in studies using quantitative sensory testing (QST) (Siqueira et al. 2013; Baad-Hansen et al. 2013; Forssell et al. 2007).

Pain in PIFP is usually deep, poorly localized, radiating, and mostly unilateral although up to 40% of cases may describe bilateral pain (Maarbjerg et al. 2016). PIFP is commonly described as aching, burning, throbbing, and often stabbing (Siqueira et al. 2013; Lang et al. 2005; Baad-Hansen et al. 2013; Forssell et al. 2007; Maarbjerg et al. 2016; Pfaffenrath et al. 1993). Severity, usually mild to severe (rated 7 on an 11-point VAS), may be aggravated by emotional stress (Maarbjerg et al. 2016).

Most PIFP patients report persistent, long lasting (years) daily pain (Maarbjerg et al. 2016) that tends to spread, in a non-dermatomal pattern, with time. Typically, pain characteristics, location, and associated features change over time. Rarely, some PIFP patients report pain free or remission periods (Maarbjerg et al. 2016). Often, PIFP may coexist with other chronic orofacial pain or headache syndromes (Maarbjerg et al. 2016).

Conclusions

COFP should be regarded as an umbrella term covering individual and specific disorders that have a common chronic temporal pattern. It is certainly a useful tool to examine disease burden. In a clinical setting, however, establishing a diagnosis of COFP would have no therapeutic indication: each subcategory of COFP requires precise diagnosis and

tailored management protocols. The adoption of criteria used for headache chronicity (Benoliel et al. 2019) is recommended and indeed are followed in the recent publication of ICOP (ICOP 2020).

Compliance with ethical standards

Conflict of interest Dr. Ananthan declares no conflicts of interest. Dr. Benoliel is remunerated by Quintessence Publishing for serving as editor in chief.

References

- Abdalla-Aslan R, Benoliel R, Sharav Y, Czerninski R (2016) Characterization of pain originating from oral mucosal lesions. *Oral Surg Oral Med Oral Pathol Oral Radiol* 121(3):255–261. <https://doi.org/10.1016/j.oooo.2015.11.006>
- Abouelhuda AM, Kim HS, Kim SY, Kim YK (2017) Association between headache and temporomandibular disorder. *J Korean Assoc Oral Maxillofac Surg* 43(6):363–367. <https://doi.org/10.5125/jkaoms.2017.43.6.363>
- Adamo D, Sardella A, Varoni E, Lajolo C, Biasotto M, Ottaviani G, Vescovi P, Simonazzi T, Pentenero M, Ardore M, Spadari F, Bombeccari G, Montebugnoli L, Gissi DB, Campisi G, Panzarella V, Carbone M, Valpreda L, Giuliani M, Aria M, Lo Muzio L, Mignogna MD (2018) The association between burning mouth syndrome and sleep disturbance: a case-control multicentre study. *Oral Dis* 24(4):638–649. <https://doi.org/10.1111/odi.12807>
- Aggarwal VR, McBeth J, Zakrzewska JM, Lunt M, Macfarlane GJ (2007) Are reports of mechanical dysfunction in chronic orofacial pain related to somatisation. A population based study. *Eur J Pain*. <https://doi.org/10.1016/j.ejpain.2007.08.002>
- Almoznino G, Benoliel R, Sharav Y, Haviv Y (2017) Sleep disorders and chronic craniofacial pain: Characteristics and management possibilities. *Sleep Med Rev* 33:39–50. <https://doi.org/10.1016/j.smrv.2016.04.005>
- Almoznino G, Zini A, Zakuto A, Sharav Y, Haviv Y, Hadad A, Chweidan H, Yarom N, Benoliel R (2015) Oral health-related quality of life in patients with temporomandibular disorders. *J Oral Facial Pain Headache* 29(3):231–241. <https://doi.org/10.11607/ofph.1413>
- Almoznino G, Zini A, Zakuto A, Zlutky H, Bekker S, Shay B, Haviv Y, Sharav Y, Benoliel R (2019) Muscle tenderness score in temporomandibular disorders patients: a case-control study. *J Oral Rehabil* 46(3):209–218. <https://doi.org/10.1111/joor.12743>
- Alstergren P, Pigg M, Kopp S (2018) Clinical diagnosis of temporomandibular joint arthritis. *J Oral Rehabil* 45(4):269–281. <https://doi.org/10.1111/joor.12611>
- Altindag O, Gur A, Altindag A (2008) The relationship between clinical parameters and depression level in patients with myofascial pain syndrome. *Pain Med* 9(2):161–165. <https://doi.org/10.1111/j.1526-4637.2007.00342.x>
- Arayasantiparb R, Mitrirattanakul S, Kunasrapun P, Chutimataewin H, Netnoparat P, Sae-Heng W (2019) Association of radiographic and clinical findings in patients with temporomandibular joints osseous alteration. *Clin Oral Investig*. <https://doi.org/10.1007/s00784-019-02945-6>
- Attal N, Cruccu G, Baron R, Haanpaa M, Hansson P, Jensen TS, Nurmiikko T, European Federation of Neurological S (2010) EFNS guidelines on the pharmacological treatment of neuropathic pain: 2010 revision. *Eur J Neurol* 17(9):1113–e1188. <https://doi.org/10.1111/j.1468-1331.2010.02999.x>
- Ayouni I, Chebbi R, Hela Z, Dhidah M (2019) Comorbidity between fibromyalgia and temporomandibular disorders: a systematic review. *Oral Surg Oral Med Oral Pathol Oral Radiol* 128(1):33–42. <https://doi.org/10.1016/j.oooo.2019.02.023>
- Baad-Hansen L, Leijon G, Svensson P, List T (2008) Comparison of clinical findings and psychosocial factors in patients with atypical odontalgia and temporomandibular disorders. *J Orofac Pain* 22(1):7–14
- Baad-Hansen L, Abrahamsen R, Zachariae R, List T, Svensson P (2013) Somatosensory sensitivity in patients with persistent idiopathic orofacial pain is associated with pain relief from hypnosis and relaxation. *Clin J Pain* 29(6):518–526. <https://doi.org/10.1097/AJP.0b013e318268e4e7>
- Bahra A, Goadsby PJ (2004) Diagnostic delays and mis-management in cluster headache. *Acta Neurol Scand* 109(3):175–179
- Bendtsen L, Zakrzewska JM, Abbott J, Braschinsky M, Di Stefano G, Donnet A, Eide PK, Leal PRL, Maarbjeerg S, May A, Nurmiikko T, Obermann M, Jensen TS, Cruccu G (2019) European Academy of Neurology guideline on trigeminal neuralgia. *Eur J Neurol* 26(6):831–849. <https://doi.org/10.1111/ene.13950>
- Benoliel R, Eliav E, Elishoov H, Sharav Y (1994) Diagnosis and treatment of persistent pain after trauma to the head and neck. *J Oral Maxillofac Surg* 52(11):1138–1147 (**discussion 1147-1138**)
- Benoliel R, Elishoov H, Sharav Y (1997) Orofacial pain with vascular-type features. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 84(5):506–512
- Benoliel R, Birenboim R, Regev E, Eliav E (2005) Neurosensory changes in the infraorbital nerve following zygomatic fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 99(6):657–665
- Benoliel R, Birman N, Eliav E, Sharav Y (2008) The International classification of headache disorders: accurate diagnosis of orofacial pain? *Cephalalgia* 28(7):752–762. <https://doi.org/10.1111/j.1468-2982.2008.01586.x>
- Benoliel R, Eliav E, Sharav Y (2009) Self reports of pain-related awakenings in persistent orofacial pain patients. *J Orofac Pain* 23(4) (**in press**)
- Benoliel R, Eliav E, Sharav Y (2010) Classification of chronic orofacial pain: applicability of chronic headache criteria. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 110(6):729–737. <https://doi.org/10.1016/j.tripleo.2010.07.009>
- Benoliel R, Sela G, Teich S, Sharav Y (2011a) Painful temporomandibular disorders and headaches in 359 dental and medical students. *Quintessence Int* 42(1):73–78
- Benoliel R, Svensson P, Heir GM, Sirois D, Zakrzewska J, Oke-Nwosu J, Torres SR, Greenberg MS, Klasser GD, Katz J, Eliav E (2011b) Persistent orofacial muscle pain. *Oral Dis* 17(Suppl 1):23–41. <https://doi.org/10.1111/j.1601-0825.2011.01790.x>
- Benoliel R, Zadik Y, Eliav E, Sharav Y (2012) Peripheral painful traumatic trigeminal neuropathy: clinical features in 91 cases and proposal of novel diagnostic criteria. *J Orofac Pain* 26(1):49–58
- Benoliel R, Heir G, Eliav E (2015) Neuropathic orofacial pain. In: Sharav Y, Benoliel R (eds) *Orofacial pain & headache*, 2nd edn. Quintessence, Chicago, pp 407–474
- Benoliel R, Zini A, Khan J, Almoznino G, Sharav Y, Haviv Y (2016) Trigeminal neuralgia (part II): factors affecting early pharmacotherapeutic outcome. *Cephalalgia* 36(8):747–759. <https://doi.org/10.1177/0333102415611406>
- Benoliel R, Zini A, Zakuto A, Slutzky H, Haviv Y, Sharav Y, Almoznino G (2017) Subjective sleep quality in temporomandibular disorder patients and association with disease characteristics and oral health-related quality of life. *J Oral Facial Pain Headache* 31(4):313–322. <https://doi.org/10.11607/ofph.1824>

- Benoliel R, Svensson P, Evers S, Wang SJ, Barke A, Korwisi B, Rief W, Treede RD, Pain ITftCoC (2019) The IASP classification of chronic pain for ICD-11: chronic secondary headache or orofacial pain. *Pain* 160(1):60–68. <https://doi.org/10.1097/j.pain.0000000000001435>
- Bowsher D (2000) Trigeminal neuralgia: a symptomatic study of 126 successive patients with and without previous interventions. *Pain Clin* 12(2):93–98
- Cademartiri C, Torelli P, Cologno D, Manzoni GC (2002) Upper and lower cluster headache: clinical and pathogenetic observations in 608 patients. *Headache* 42(7):630–637
- Castillo J, Munoz P, Guitera V, Pascual J (1999) Epidemiology of chronic daily headache in the general population. *Headache* 39(3):190–196
- Chung JW, Kim JH, Kim HD, Kho HS, Kim YK, Chung SC (2004) Chronic orofacial pain among Korean elders: prevalence, and impact using the graded chronic pain scale. *Pain* 112(1–2):164–170
- Cohen AS, Matharu MS, Goadsby PJ (2006) Short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing (SUNCT) or cranial autonomic features (SUNA)—a prospective clinical study of SUNCT and SUNA. *Brain* 129(Pt 10):2746–2760. <https://doi.org/10.1093/brain/awl202>
- Cordeiro PC, Guimaraes JP, de Souza VA, Dias IM, Silva JN, Devito KL, Bonato LL (2016) Temporomandibular joint involvement in rheumatoid arthritis patients: association between clinical and tomographic data. *Acta Odontol Latinoam* 29(3):123–129
- Czerninsky R, Benoliel R, Sharav Y (1999) Odontalgia in vascular orofacial pain. *J Orofac Pain* 13(3):196–200
- da Costa DR, de Lima Ferreira AP, Pereira TA, Porporatti AL, Conti PC, Costa YM, Bonjardim LR (2015) Neck disability is associated with masticatory myofascial pain and regional muscle sensitivity. *Arch Oral Biol* 60(5):745–752. <https://doi.org/10.1016/j.archoralbio.2015.02.009>
- Dando WE, Branch MA, Maye JP (2006) Headache disability in orofacial pain patients. *Headache* 46(2):322–326
- Daudia AT, Jones NS (2002) Facial migraine in a rhinological setting. *Clin Otolaryngol Allied Sci* 27(6):521–525
- Davies SJ, Underhill HC, Abdel-Karim A, Christmas DM, Bolea-Alamanac BM, Potokar J, Herrod J, Prime SS (2016) Individual oral symptoms in burning mouth syndrome may be associated differentially with depression and anxiety. *Acta Odontol Scand* 74(2):155–160. <https://doi.org/10.3109/00016357.2015.1100324>
- de Melo Junior PC, Aroucha J, Arnaud M, Lima MGS, Gomes SGF, Ximenes R, Rosenblatt A, Caldas AF Jr (2019) Prevalence of TMD and level of chronic pain in a group of Brazilian adolescents. *PLoS ONE* 14(2):e0205874. <https://doi.org/10.1371/journal.pone.0205874>
- de Siqueira SR, Nobrega JC, Valle LB, Teixeira MJ, de Siqueira JT (2004) Idiopathic trigeminal neuralgia: clinical aspects and dental procedures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 98(3):311–315
- de Souza IF, Marmora BC, Rados PV, Visioli F (2018) Treatment modalities for burning mouth syndrome: a systematic review. *Clin Oral Investig* 22(5):1893–1905. <https://doi.org/10.1007/s00784-018-2454-6>
- Di Stefano G, La Cesa S, Truini A, Cruccu G (2014) Natural history and outcome of 200 outpatients with classical trigeminal neuralgia treated with carbamazepine or oxcarbazepine in a tertiary centre for neuropathic pain. *J Headache Pain* 15:34. <https://doi.org/10.1186/1129-2377-15-34>
- Dworkin RH, O'Connor AB, Audette J, Baron R, Gourlay GK, Haanpaa ML, Kent JL, Krane EJ, Lebel AA, Levy RM, Mackey SC, Mayer J, Miaskowski C, Raja SN, Rice AS, Schmader KE, Stacey B, Stanos S, Treede RD, Turk DC, Walco GA, Wells CD (2010) Recommendations for the pharmacological management of neuropathic pain: an overview and literature update. *Mayo Clin Proc* 85(3 Suppl):S3–14. <https://doi.org/10.4065/mcp.2009.0649>
- Elad S, Sroussi H, Epstein J (2015) Secondary orofacial pain and headache: systemic diseases, tumors, and trauma. In: Sharav Y, Benoliel R (eds) *Orofacial pain & headache*, 2nd edn. Quintessence, Chicago, pp 487–540
- Eliav E, Kamran B, Schaham R, Czerninski R, Gracely RH, Benoliel R (2007) Evidence of chorda tympani dysfunction in patients with burning mouth syndrome. *J Am Dent Assoc* 138(5):628–633. <https://doi.org/10.14219/jada.archive.2007.0234>
- Eross E, Dodick D, Eross M (2007) The sinus, allergy and migraine study (SAMS). *Headache* 47(2):213–224. <https://doi.org/10.1111/j.1526-4610.2006.00688.x>
- Feller L, Fourie J, Bouckaert M, Khammissa RAG, Ballyram R, Lemmer J (2017) Burning mouth syndrome: aetiopathogenesis and principles of management. *Pain Res Manag* 2017:1926269. <https://doi.org/10.1155/2017/1926269>
- Finnerup NB, Sindrup SH, Jensen TS (2010) The evidence for pharmacological treatment of neuropathic pain. *Pain* 150(3):573–581. <https://doi.org/10.1016/j.pain.2010.06.019>
- Formaker BK, Frank ME (2000) Taste function in patients with oral burning. *Chem Sens* 25(5):575–581. <https://doi.org/10.1093/chemse/25.5.575>
- Foroughipour M, Sharifian SM, Shoeibi A, Ebdali Barabad N, Bakhshae M (2011) Causes of headache in patients with a primary diagnosis of sinus headache. *Eur Arch Otorhinolaryngol* 268(11):1593–1596. <https://doi.org/10.1007/s00405-011-1643-6>
- Forssell H, Tenovuo O, Silvonemi P, Jaaskelainen SK (2007) Differences and similarities between atypical facial pain and trigeminal neuropathic pain. *Neurology* 69(14):1451–1459. <https://doi.org/10.1212/01.wnl.0000277274.83301.c0>
- Frequently asked questions (2007) The British Pain Society. https://www.britishpainsociety.org/media_faq.htm. Accessed Oct 2007
- Fricton JR (1999) Critical commentary 1; A unified concept of idiopathic orofacial pain: clinical features. *J Orofac Pain* 13(3):185–189
- Gaul C, Sandor PS, Galli U, Palla S, Ettlin DA (2007) Orofacial migraine. *Cephalalgia* 27(8):950–952
- Gaul C, Gantenbein AR, Buettner UW, Ettlin DA, Sandor PS (2008) Orofacial cluster headache. *Cephalalgia* 28(8):903–905. <https://doi.org/10.1111/j.1468-2982.2008.01576.x>
- Gesch D, Bernhardt O, Alte D, Schwahn C, Kocher T, John U, Hensel E (2004) Prevalence of signs and symptoms of temporomandibular disorders in an urban and rural German population: results of a population-based Study of Health in Pomerania. *Quintessence Int* 35(2):143–150
- Goadsby PJ, Cittadini E, Cohen AS (2010) Trigeminal autonomic cephalalgias: paroxysmal hemicrania, SUNCT/SUNA, and hemicrania continua. *Semin Neurol* 30(2):186–191. <https://doi.org/10.1055/s-0030-1249227>
- Goulet JP, Lavigne GJ, Lund JP (1995) Jaw pain prevalence among French-speaking Canadians in Quebec and related symptoms of temporomandibular disorders. *J Dent Res* 74(11):1738–1744
- Graff-Radford SB (2005) Temporomandibular disorders and headache. In: Goadsby PJ, Silberstein SD, Dodick D (eds) *Chronic daily headaches for clinicians*. BC Decker Inc, Hamilton, pp 199–207
- Graff-Radford SB, Abbott JJ (2016) Temporomandibular disorders and headache. *Oral Maxillofac Surg Clin N Am* 28(3):335–349. <https://doi.org/10.1016/j.coms.2016.03.004>
- Gross M, Eliashar R (2015) Otolaryngologic aspects of orofacial pain. In: Sharav Y, Benoliel R (eds) *Orofacial pain & headache*, 2nd edn. Quintessence, Chicago
- Grushka M, Epstein JB, Gorsky M (2003) Burning mouth syndrome and other oral sensory disorders: a unifying hypothesis. *Pain Res Manag* 8(3):133–135. <https://doi.org/10.1155/2003/654735>

- Haanpaa M, Attal N, Backonja M, Baron R, Bennett M, Bouhassira D, Cruccu G, Hansson P, Haythornthwaite JA, Iannetti GD, Jensen TS, Kauppila T, Nurmikko TJ, Rice AS, Rowbotham M, Serra J, Sommer C, Smith BH, Treede RD (2011) NeuPSIG guidelines on neuropathic pain assessment. *Pain* 152(1):14–27. <https://doi.org/10.1016/j.pain.2010.07.031>
- Haribabu PK, Eliav E, Heir GM (2013) Topical medications for the effective management of neuropathic orofacial pain. *J Am Dent Assoc* 144(6):612–614. <https://doi.org/10.14219/jada.archive.2013.0172>
- Haviv Y, Zadik Y, Sharav Y, Benoliel R (2014) Painful traumatic trigeminal neuropathy: an open study on the pharmacotherapeutic response to stepped treatment. *J Oral Facial Pain Headache* 28(1):52–60. <https://doi.org/10.11607/jop.1154>
- Haviv Y, Zini A, Etzioni Y, Klitinich V, Dobriyan A, Sharav Y, Benoliel R, Almoznino G (2017) The impact of chronic orofacial pain on daily life: the vulnerable patient and disruptive pain. *Oral Surg Oral Med Oral Pathol Oral Radiol* 123(1):58–66. <https://doi.org/10.1016/j.oooo.2016.08.016>
- Haviv Y, Zini A, Keshet N, Almoznino G, Benoliel R, Sharav Y (2019) (in press) Features of neurovascular orofacial pain compared to painful posttraumatic trigeminal neuropathy. *J Oral Facial Pain Headache*
- Hobson KA, Huang GJ, Covell DA Jr (2008) Patterns of dental care utilization among patients with temporomandibular disorders. *J Orofac Pain* 22(2):108–114
- Horst OV, Cunha-Cruz J, Zhou L, Manning W, Mancl L, DeRouen TA (2015) Prevalence of pain in the orofacial regions in patients visiting general dentists in the Northwest Practice-based REsearch Collaborative in Evidence-based DENTistry research network. *J Am Dent Assoc* 146(10):721–728. <https://doi.org/10.1016/j.adaj.2015.04.001>
- Ibi M (2019) Inflammation and temporomandibular joint derangement. *Biol Pharm Bull* 42(4):538–542. <https://doi.org/10.1248/bpb.b18-00442>
- ICHD-3 (2018) Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. *Cephalalgia* 38(1):1–211. <https://doi.org/10.1177/0333102417738202>
- ICOP (2020) International Classification of Orofacial Pain, 1st edition (ICOP). *Cephalalgia* 40(2):129–221
- Isong U, Gansky SA, Plesh O (2008) Temporomandibular joint and muscle disorder-type pain in U.S. adults: the National Health Interview Survey. *J Orofac Pain* 22(4):317–322
- Jaaskelainen SK (2012) Pathophysiology of primary burning mouth syndrome. *Clin Neurophysiol* 123(1):71–77. <https://doi.org/10.1016/j.clinph.2011.07.054>
- Jensen R (2003) Diagnosis, epidemiology, and impact of tension-type headache. *Curr Pain Headache Rep* 7(6):455–459
- Joachim M, Tabib R, Laviv A, Pikoovsky A, Zadik Y, Zeltser R (2019) Trigeminal neuropathy after mandibular fractures: epidemiology and neurophysiologic diagnosis. *J Craniofac Surg* 30(4):1113–1117. <https://doi.org/10.1097/SCS.00000000000005215>
- Just T, Steiner S, Pau HW (2010) Oral pain perception and taste in burning mouth syndrome. *J Oral Pathol Med* 39(1):22–27. <https://doi.org/10.1111/j.1600-0714.2009.00824.x>
- Kaimal S, Ahmad M, Kang W, Nixdorf D, Schiffman EL (2018) Diagnostic accuracy of panoramic radiography and MRI for detecting signs of TMJ degenerative joint disease. *Gen Dent* 66(4):34–40
- Kakoei S, Parirokh M, Nakhaee N, Jamshidshirazi F, Rad M, Kakoei S (2013) Prevalence of toothache and associated factors: a population-based study in southeast Iran. *Iran Endod J* 8(3):123–128
- Kari E, DelGaudio JM (2008) Treatment of sinus headache as migraine: the diagnostic utility of triptans. *Laryngoscope* 118(12):2235–2239. <https://doi.org/10.1097/MLG.0b013e318182f81d>
- Kassebaum NJ, Smith AGC, Bernabe E, Fleming TD, Reynolds AE, Vos T, Murray CJL, Marcenes W, Collaborators GBDOH (2017) Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990–2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. *J Dent Res* 96(4):380–387. <https://doi.org/10.1177/0022034517693566>
- Kim MJ, Kim J, Kho HS (2019) Comparison of clinical characteristics between burning mouth syndrome patients with bilateral and unilateral symptoms. *Int J Oral Maxillofac Surg*. <https://doi.org/10.1016/j.ijom.2019.06.013>
- Kino K, Sugisaki M, Haketa T, Amemori Y, Ishikawa T, Shibuya T, Sato F, Amagasa T, Shibuya T, Tanabe H, Yoda T, Sakamoto I, Omura K, Miyaoka H (2005) The comparison between pains, difficulties in function, and associating factors of patients in subtypes of temporomandibular disorders. *J Oral Rehabil* 32(5):315–325
- Klapper JA, Klapper A, Voss T (2000) The misdiagnosis of cluster headache: a nonclinic, population-based. *Internet Surv Headache* 40(9):730–735
- Kolkka-Palomaa M, Jaaskelainen SK, Laine MA, Teerijoki-Oksa T, Sandell M, Forssell H (2015) Pathophysiology of primary burning mouth syndrome with special focus on taste dysfunction: a review. *Oral Dis* 21(8):937–948. <https://doi.org/10.1111/odi.12345>
- Koopman JS, Dieleman JP, Huygen FJ, de Mos M, Martin CG, Sturkenboom MC (2009) Incidence of facial pain in the general population. *Pain* 147(1–3):122–127. <https://doi.org/10.1016/j.pain.2009.08.023>
- Korszun A (2002) Facial pain, depression and stress - connections and directions. *J Oral Pathol Med* 31(10):615–619
- Lang E, Kaltenhauser M, Seidler S, Mattenklodt P, Neundorfer B (2005) Persistent idiopathic facial pain exists independent of somatosensory input from the painful region: findings from quantitative sensory functions and somatotopy of the primary somatosensory cortex. *Pain* 118(1–2):80–91. <https://doi.org/10.1016/j.pain.2005.07.014>
- Lipton JA, Ship JA, Larach-Robinson D (1993) Estimated prevalence and distribution of reported orofacial pain in the United States. *J Am Dent Assoc* 124(10):115–121
- Locker D, Grushka M (1987) Prevalence of oral and facial pain and discomfort: preliminary results of a mail survey. *Community Dent Oral Epidemiol* 15(3):169–172
- Maarbjerg S, Gozalov A, Olesen J, Bendtsen L (2014) Trigeminal neuralgia—a prospective systematic study of clinical characteristics in 158 patients. *Headache* 54(10):1574–1582. <https://doi.org/10.1111/head.12441>
- Maarbjerg S, Wolfram F, Heinskou TB, Rochat P, Gozalov A, Brennum J, Olesen J, Bendtsen L (2016) Persistent idiopathic facial pain—a prospective systematic study of clinical characteristics and neuroanatomical findings at 3.0 Tesla MRI. *Cephalalgia*. <https://doi.org/10.1177/0333102416675618>
- Macfarlane TV, Blinkhorn AS, Davies RM, Kincey J, Worthington HV (2002a) Oro-facial pain in the community: prevalence and associated impact. *Community Dent Oral Epidemiol* 30(1):52–60
- Macfarlane TV, Blinkhorn AS, Davies RM, Ryan P, Worthington HV, Macfarlane GJ (2002b) Orofacial pain: just another chronic pain? Results from a population-based survey. *Pain* 99(3):453–458
- Macfarlane TV, Blinkhorn AS, Craven R, Zakrzewska JM, Atkin P, Escudier MP, Rooney CA, Aggarwal V, Macfarlane GJ (2004) Can one predict the likely specific orofacial pain syndrome from a self-completed questionnaire? *Pain* 111(3):270–277
- Main JH, Jordan RC, Barewal R (1992) Facial neuralgias: a clinical review of 34 cases. *J Can Dent Assoc* 58(9):752–755

- McMillan AS, Wong MC, Zheng J, Lam CL (2006) Prevalence of orofacial pain and treatment seeking in Hong Kong Chinese. *J Orofac Pain* 20(3):218–225
- McMillan R, Forssell H, Buchanan JA, Glenney AM, Weldon JC, Zakrzewska JM (2016) Interventions for treating burning mouth syndrome. *Cochrane Database Syst Rev* 11:CD002779. <https://doi.org/10.1002/14651858.CD002779.pub3>
- Mitchell RG (1980) Pre-trigeminal neuralgia. *Br Dent J* 149(6):167–170
- Munoz-Garcia D, Lopez-de-Uralde-Villanueva I, Beltran-Alacreu H, La Touche R, Fernandez-Carnero J (2017) Patients with concomitant chronic neck pain and myofascial pain in masticatory muscles have more widespread pain and distal hyperalgesia than patients with only chronic neck pain. *Pain Med* 18(3):526–537. <https://doi.org/10.1093/pm/pnw274>
- Nasri-Heir C, Khan J, Heir GM (2013) Topical medications as treatment of neuropathic orofacial pain. *Dent Clin North Am* 57(3):541–553. <https://doi.org/10.1016/j.cden.2013.04.011>
- Nasri-Heir C, Khan J, Benoliel R, Feng C, Yarnitsky D, Kuo F, Hirschberg C, Hartwell G, Huang CY, Heir G, Korczeniewska O, Diehl SR, Eliav E (2015) Altered pain modulation in patients with persistent postendodontic pain. *Pain* 156(10):2032–2041. <https://doi.org/10.1097/j.pain.0000000000000265>
- Ng KF, Tsui SL, Chan WS (2002) Prevalence of common chronic pain in Hong Kong adults. *Clin J Pain* 18(5):275–281
- Nicholson B, Verma S (2004) Comorbidities in chronic neuropathic pain. *Pain Med* 5(Suppl 1):S9–S27
- Nilsson IM, List T, Drangsholt M (2005) Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. *J Orofac Pain* 19(2):144–150
- Nitzan D, Heir G, Dolwick MF, Benoliel R (2015) Pain and dysfunction of the temporomandibular joint. In: Sharav Y, Benoliel R (eds) *Orofacial pain & headache*, 2nd edn. Quintessence, Chicago
- Obermann M, Mueller D, Yoon MS, Pageler L, Diener H, Katsarava Z (2007) Migraine with isolated facial pain: a diagnostic challenge. *Cephalalgia* 27(11):1278–1282. <https://doi.org/10.1111/j.1468-2982.2007.01413.x>
- Oehler S, Neureiter D, Meyer-Scholten C, Aigner T (2002) Subtyping of osteoarthritic synovioarthropathy. *Clin Exp Rheumatol* 20(5):633–640
- Okeson J (1999) Critical commentary 1; A unified concept of idiopathic orofacial pain: clinical features. *J Orofac Pain* 13(3):189–191
- Olesen J, Boussier M-G, Diener HC, Dodick D, First M, Goadsby PJ, Gobel H, Lainez MJA, Lance JW, Lipton RB, Nappi G, Sakai F, Schoenberg BS, Silberstein SD, Steiner TJ (2004) The international classification of headache disorders, 2nd edition. *Cephalalgia* 24(suppl 1):24–150
- Penarrocha M, Bandres A, Penarrocha M, Bagan JV (2004) Lower-half facial migraine: a report of 11 cases. *J Oral Maxillofac Surg* 62(12):1453–1456
- Perry BF, Login IS, Kountakis SE (2004) Nonrhinologic headache in a tertiary rhinology practice. *Otolaryngol Head Neck Surg* 130(4):449–452
- Pfaffenrath V, Rath M, Pollmann W, Keeser W (1993) Atypical facial pain—application of the IHS criteria in a clinical sample. *Cephalalgia* 13(Suppl 12):84–88
- Pigg M, Svensson P, Drangsholt M, List T (2013) Seven-year follow-up of patients diagnosed with atypical odontalgia: a prospective study. *J Orofac Pain* 27(2):151–164. <https://doi.org/10.11607/jop.1033>
- Piper T (1995) *Stedman's medical dictionary*. Lippincott Williams & Wilkins, Baltimore
- Rammelsberg P, LeResche L, Dworkin S, Mancl L (2003) Longitudinal outcome of temporomandibular disorders: a 5-year epidemiologic study of muscle disorders defined by research diagnostic criteria for temporomandibular disorders. *J Orofac Pain* 17(1):9–20
- Ratcliffe GE, Enns MW, Belik SL, Sareen J (2008) Chronic pain conditions and suicidal ideation and suicide attempts: an epidemiologic perspective. *Clin J Pain* 24(3):204–210. <https://doi.org/10.1097/AJP.0b013e31815ca2a3>
- Renton T, Yilmaz Z (2011) Profiling of patients presenting with post-traumatic neuropathy of the trigeminal nerve. *J Orofac Pain* 25(4):333–344
- Renton T, Yilmaz Z, Gaballah K (2012) Evaluation of trigeminal nerve injuries in relation to third molar surgery in a prospective patient cohort. Recommendations for prevention. *Int J Oral Maxillofac Surg* 41(12):1509–1518. <https://doi.org/10.1016/j.ijom.2012.06.025>
- Ridgeway JL, Beebe TJ, Chute CG, Eton DT, Hart LA, Frost MH, Jensen D, Montori VM, Smith JG, Smith SA, Tan AD, Yost KJ, Ziegenfuss JY, Sloan JA (2013) A brief Patient-Reported Outcomes Quality of Life (PROQOL) instrument to improve patient care. *PLoS Med* 10(11):e1001548. <https://doi.org/10.1371/journal.pmed.1001548>
- Riley JL 3rd, Gilbert GH (2001) Orofacial pain symptoms: an interaction between age and sex. *Pain* 90(3):245–256
- Rossi P, Faroni J, Tassorelli C, Nappi G (2009) Diagnostic delay and suboptimal management in a referral population with hemiparesis continua. *Headache* 49(2):227–234. <https://doi.org/10.1111/j.1526-4610.2008.01260.x>
- Russell MB (2005) Tension-type headache in 40-year-olds: a Danish population-based sample of 4000. *J Headache Pain* 6(6):441–447
- Salerno C, Di Stasio D, Petrucci M, Lauritano D, Gentile E, Guida A, Maio C, Tammaro M, Serpico R, Lucchese A (2016) An overview of burning mouth syndrome. *Front Biosci (Elite Ed)* 8:213–218
- Sarikov R, Juodzbalys G (2014) Inferior alveolar nerve injury after mandibular third molar extraction: a literature review. *J Oral Maxillofac Res* 5(4):e1. <https://doi.org/10.5037/jomr.2014.5401>
- Scanzello CR, McKeon B, Swaim BH, DiCarlo E, Asomugha EU, Kanda V, Nair A, Lee DM, Richmond JC, Katz JN, Crow MK, Goldring SR (2011) Synovial inflammation in patients undergoing arthroscopic meniscectomy: molecular characterization and relationship to symptoms. *Arthritis Rheum* 63(2):391–400. <https://doi.org/10.1002/art.30137>
- Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, List T, Svensson P, Gonzalez Y, Lobbezoo F, Michelotti A, Brooks SL, Ceusters W, Drangsholt M, Ettlin D, Gaul C, Goldberg LJ, Haythornthwaite JA, Hollender L, Jensen R, John MT, De Laat A, de Leeuw R, Maixner W, van der Meulen M, Murray GM, Nixdorf DR, Palla S, Petersson A, Pionchon P, Smith B, Visscher CM, Zakrzewska J, Dworkin SF, International Rdc/Tmd Consortium Network IafDR, Orofacial Pain Special Interest Group IAftSoP (2014) Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the international RDC/TMD consortium network* and orofacial pain special interest group dagger. *J Oral Facial Pain Headache* 28(1):6–27. <https://doi.org/10.11607/jop.1151>
- Schreiber CP, Hutchinson S, Webster CJ, Ames M, Richardson MS, Powers C (2004) Prevalence of migraine in patients with a history of self-reported or physician-diagnosed "sinus" headache. *Arch Intern Med* 164(16):1769–1772. <https://doi.org/10.1001/archinte.164.16.1769>
- Senbil N, Gurer YK, Uner C, Barut Y (2008) Sinusitis in children and adolescents with chronic or recurrent headache: a case-control study. *J Headache Pain* 9(1):33–36. <https://doi.org/10.1007/s10194-008-0007-0>

- Sharav Y, Benoliel R (2015) Acute orofacial pain. In: Sharav Y, Benoliel R (eds) Orofacial pain & headache, 2nd edn. Quintessence, Chicago
- Sharav Y, Singer E, Schmidt E, Dionne RA, Dubner R (1987) The analgesic effect of amitriptyline on chronic facial pain. *Pain* 31(2):199–209
- Sharav Y, Katsarava Z, Charles A (2017) Facial presentations of primary headache disorders. *Cephalalgia* 37(7):714–719. <https://doi.org/10.1177/0333102417705374>
- Shinoda M, Kubo A, Hayashi Y, Iwata K (2019) Peripheral and central mechanisms of persistent orofacial pain. *Front Neurosci* 13:1227. <https://doi.org/10.3389/fnins.2019.01227>
- Shueb SS, Nixdorf DR, John MT, Alonso BF, Durham J (2015) What is the impact of acute and chronic orofacial pain on quality of life? *J Dent* 43(10):1203–1210. <https://doi.org/10.1016/j.jdent.2015.06.001>
- Silberstein SD, Lipton RB (2000) Chronic daily headache. *Curr Opin Neurol* 13(3):277–283
- Silberstein SD, Lipton RB, Sliwinski M (1996) Classification of daily and near-daily headaches: field trial of revised IHS criteria. *Neurology* 47(4):871–875
- Silveira A, Gadotti IC, Armijo-Olivo S, Biasotto-Gonzalez DA, Magee D (2015) Jaw dysfunction is associated with neck disability and muscle tenderness in subjects with and without chronic temporomandibular disorders. *Biomed Res Int* 2015:512792. <https://doi.org/10.1155/2015/512792>
- Siqueira SR, Siviero M, Alvarez FK, Teixeira MJ, Siqueira JT (2013) Quantitative sensory testing in trigeminal neuropathic pain and persistent idiopathic facial pain. *Arq Neuropsiquiatr* 71(3):174–179
- Slade GD, Bair E, Greenspan JD, Dubner R, Fillingim RB, Diatchenko L, Maixner W, Knott C, Ohrbach R (2013) Signs and symptoms of first-onset TMD and sociodemographic predictors of its development: the OPPERA prospective cohort study. *J Pain* 14(12 Suppl):T20–32. <https://doi.org/10.1016/j.jpain.2013.07.014>
- Slade GD, Ohrbach R, Greenspan JD, Fillingim RB, Bair E, Sanders AE, Dubner R, Diatchenko L, Meloto CB, Smith S, Maixner W (2016) Painful temporomandibular disorder: decade of discovery from OPPERA studies. *J Dent Res* 95(10):1084–1092. <https://doi.org/10.1177/0022034516653743>
- Smith SB, Mir E, Bair E, Slade GD, Dubner R, Fillingim RB, Greenspan JD, Ohrbach R, Knott C, Weir B, Maixner W, Diatchenko L (2013) Genetic variants associated with development of TMD and its intermediate phenotypes: the genetic architecture of TMD in the OPPERA prospective cohort study. *J Pain* 14(12 Suppl):T91–101. <https://doi.org/10.1016/j.jpain.2013.09.004>
- Sotorra-Figuerola D, Sanchez-Torres A, Valmaseda-Castellon E, Gay-Escoda C (2016) Continuous neuropathic orofacial pain: a retrospective study of 23 cases. *J Clin Exp Dent* 8(2):e153–159. <https://doi.org/10.4317/jced.52560>
- Stegenga B (2001) Osteoarthritis of the temporomandibular joint organ and its relationship to disc displacement. *J Orofac Pain* 15(3):193–205
- Storm C, Wanman A (2006) Temporomandibular disorders, headaches, and cervical pain among females in a Sami population. *Acta Odontol Scand* 64(5):319–325. <https://doi.org/10.1080/00016350600801915>
- Svensson P, Baad-Hansen L, Pigg M, List T, Eliav E, Ettlind D, Michelotti A, Tsukiyama Y, Matsuka Y, Jaaskelainen SK, Essick G, Greenspan JD, Drangsholt M, Special Interest Group of Orofacial P (2011) Guidelines and recommendations for assessment of somatosensory function in oro-facial pain conditions—a taskforce report. *J Oral Rehabil* 38(5):366–394. <https://doi.org/10.1111/j.1365-2842.2010.02196.x>
- Svensson P, Sharav Y, Benoliel R (2015) Persistent orofacial muscle pain related to TMDs, headaches, and fibromyalgia. In: Sharav Y, Benoliel R (eds) Orofacial pain & headache, 2nd edn. Quintessence, Chicago
- Taha JM, Tew JM Jr, Buncher CR (1995) A prospective 15-year follow up of 154 consecutive patients with trigeminal neuralgia treated by percutaneous stereotactic radiofrequency thermal rhizotomy. *J Neurosurg* 83(6):989–993
- Tal M, Villanueva L, Devor M (2015) Anatomy and neurophysiology of orofacial pain. In: Sharav Y, Benoliel R (eds) Orofacial pain & headache, 2nd edn. Quintessence, Chicago, pp 31–77
- Talattof Z, Dabbaghmanesh MH, Parvizi Y, Esnaashari N, Azad A (2019) The association between burning mouth syndrome and level of thyroid hormones in hashimoto's thyroiditis in public hospitals in Shiraz, 2016. *J Dent (Shiraz)* 20(1):42–47
- Taylor JC, Brauer S, Espir ML (1981) Long-term treatment of trigeminal neuralgia with carbamazepine. *Postgrad Med J* 57(663):16–18
- Treede RD, Rief W, Barke A, Aziz Q, Bennett MI, Benoliel R, Cohen M, Evers S, Finnerup NB, First MB, Giamberardino MA, Kaasa S, Kosek E, Lavand'homme P, Nicholas M, Perrot S, Scholz J, Schug S, Smith BH, Svensson P, Vlaeyen JW, Wang SJ (2015) A classification of chronic pain for ICD-11. *Pain* 156(6):1003–1007. <https://doi.org/10.1097/j.pain.0000000000000160>
- Treede RD, Rief W, Barke A, Aziz Q, Bennett MI, Benoliel R, Cohen M, Evers S, Finnerup NB, First MB, Giamberardino MA, Kaasa S, Korwisi B, Kosek E, Lavand'homme P, Nicholas M, Perrot S, Scholz J, Schug S, Smith BH, Svensson P, Vlaeyen JWS, Wang SJ (2019) Chronic pain as a symptom or a disease: the IASP Classification of Chronic Pain for the International Classification of Diseases (ICD-11). *Pain* 160(1):19–27. <https://doi.org/10.1097/j.pain.0000000000001384>
- Valentino R, Cioffi I, Vollaro S, Cimino R, Baiano R, Michelotti A (2019) Jaw muscle activity patterns in women with chronic TMD myalgia during standardized clenching and chewing tasks. *Cranio*. <https://doi.org/10.1080/08869634.2019.1589703>
- Van Alboom E, Louis P, Van Zandijcke M, Crevits L, Vakaet A, Paemeleire K (2009) Diagnostic and therapeutic trajectory of cluster headache patients in Flanders. *Acta Neurol Belg* 109(1):10–17
- van Grootel RJ, van der Glas HW, Buchner R, de Leeuw JR, Passchier J (2005) Patterns of pain variation related to myogenous temporomandibular disorders. *Clin J Pain* 21(2):154–165
- van Vliet JA, Eekers PJ, Haan J, Ferrari MD (2003) Features involved in the diagnostic delay of cluster headache. *J Neurol Neurosurg Psychiatry* 74(8):1123–1125
- Vazquez-Delgado E, Viaplana-Gutierrez M, Figueiredo R, Renton T, Gay-Escoda C, Valmaseda-Castellon E (2018) Prevalence of neuropathic pain and sensory alterations after dental implant placement in a university-based oral surgery department: a retrospective cohort study. *Gerodontology* 35(2):117–122. <https://doi.org/10.1111/ger.12326>
- Verhulst MJL, Loos BG, Gerdes VEA, Teeuw WJ (2019) Evaluating all potential oral complications of diabetes mellitus. *Front Endocrinol (Lausanne)* 10:56. <https://doi.org/10.3389/fendo.2019.00056>
- Viana M, Tassorelli C, Allena M, Nappi G, Sjaastad O, Antonaci F (2013) Diagnostic and therapeutic errors in trigeminal autonomic cephalalgias and hemicrania continua: a systematic review. *J Headache Pain* 14(1):14. <https://doi.org/10.1186/1129-2377-14-14>
- Walsh DA, Bonnet CS, Turner EL, Wilson D, Situ M, McWilliams DF (2007) Angiogenesis in the synovium and at the osteochondral junction in osteoarthritis. *Osteoarthritis Cartil* 15(7):743–751. <https://doi.org/10.1016/j.joca.2007.01.020>

- Wang XD, Kou XX, Mao JJ, Gan YH, Zhou YH (2012) Sustained inflammation induces degeneration of the temporomandibular joint. *J Dent Res* 91(5):499–505. <https://doi.org/10.1177/0022034512441946>
- Whyman RA, Treasure ET, Ayers KM (1996) Dental disease levels and reasons for emergency clinic attendance in patients seeking relief of pain in Auckland. *N Z Dent J* 92(410):114–117
- Wilson KG, Eriksson MY, D'Eon JL, Mikail SF, Emery PC (2002) Major depression and insomnia in chronic pain. *Clin J Pain* 18(2):77–83
- Woda A, Pionchon P (1999) A unified concept of idiopathic orofacial pain: clinical features. *J Orofac Pain* 13(3):172–184 (**discussion 185–195**)
- Woda A, Pionchon P (2000) A unified concept of idiopathic orofacial pain: pathophysiologic features. *J Orofac Pain* 14(3):196–212
- Zakrzewska JM, Patsalos PN (2002) Long-term cohort study comparing medical (oxcarbazepine) and surgical management of intractable trigeminal neuralgia. *Pain* 95(3):259–266
- Zakrzewska JM, Lopez BC (2004) Trigeminal neuralgia. *Clin Evid* 12:1880–1890
- Zebeholzer K, Wober C, Vigl M, Wessely P, Wober-Bingol C (2005) Facial pain in a neurological tertiary care centre—evaluation of the International Classification of Headache Disorders. *Cephalalgia* 25(9):689–699. <https://doi.org/10.1111/j.1468-2982.2004.00936.x>
- Zebeholzer K, Wober C, Vigl M, Wessely P, Wober-Bingol C (2006) Facial pain and the second edition of the International Classification of Headache Disorders. *Headache* 46(2):259–263
- Zwart JA, Dyb G, Hagen K, Svebak S, Holmen J (2003) Analgesic use: a predictor of chronic pain and medication overuse headache: the Head-HUNT Study. *Neurology* 61(2):160–164

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