FACIAL PAIN AND TEMPOROMANDIBULAR DISORDERS

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Abstract

The study was undertaken to determine the prevalence of facial pain and the association of facial pain with temporomandibular disorders (TMD) as well as with other factors, in a geographically defined population-based sample consisting of subjects born in 1966 in northern Finland, and in a case-control study including subjects with facial pain and their healthy controls. In addition, the influence of conservative stomatognathic and necessary prosthetic treatment on facial pain and TMD was evaluated in a sample of patients with facial pain.

In the age group of 31-32-year-olds, facial pain was reported by 12 % of men and 18 % of women. Reported facial pain was strongly associated with TMD symptoms, and a relation was also seen with other factors, i.e. certain occlusal factors, previous traumas, other pain conditions in the body, clinically assessed tenderness in the neck muscles, and psychological problems, such as depressiveness and alexithymia. Conservative treatment of TMD seemed to be effective in relieving facial pain in a one-year follow-up.

It can be concluded that facial pain is quite a common symptom with several both localized and generalized associated factors. Conservative stomatognathic treatment is recommended in the case of TMD-related facial pain. The possibility of psychological problems should be taken into account, especially in complex and chronic cases. When no response to conservative stomatognathic treatment is achieved, a multidisciplinary team, including mental health professionals, will be needed in both diagnosis and treatment. This study provides support for the suggestion that in future individualizing treatment of the patients with facial pain should be based on patient characteristics, which may improve treatment efficacy.

Keywords: depression, temporomandibular joint disorders, alexithymia, facial pain

To Antti and Lauri

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Abbreviations

CI	confidence interval
Di	clinical dysfunction index
FM	fibromyalgia
IP	intercuspal position
LTR	laterotrusion
MTR	mediotrusion
NRS	numerical rating scale
OR	odds ratio
PTR	protrusion
RD	risk difference
RDC	research diagnostic criteria
RP	retruded position
SCL-25	Symptom Checklist-25
SCL-25 DS	Symptom Checklist-25 depression subscale
SD	standard deviation
TAS-20	Toronto Alexithymia Scale-20
TMD	temporomandibular disorders
TMJ	temporomandibular joint
VAS	visual analogue scale

List of original publications

This thesis is based on the following articles, which are referred to in the text by Roman numerals:

I Rauhala K, Oikarinen KS, Järvelin M & Raustia AM (2000) Facial pain and temporomandibular disorders: an epidemiological study of the Northern Finland 1966 Birth Cohort. J Craniomand Pract 18: 40-46.

II Sipilä K, Zitting P, Siira P, Laukkanen P, Järvelin MR, Oikarinen KS & Raustia AM (2002) Temporomandibular disorders, occlusion and neck pain in subjects with facial pain- a case control study. J Craniomand Pract (revised manuscript submitted).

III Sipilä K, Veijola J, Jokelainen J, Järvelin MR, Oikarinen KS, Raustia AM & Joukamaa M (2001) Association between facial pain, temporomandibular disorders and depression: an epidemiological study of the Northern Finland 1966 Birth Cohort. J Craniomand Pract 19: 183-187.

IV Sipilä K, Veijola J, Jokelainen J, Järvelin MR, Oikarinen KS, Raustia AM & Joukamaa M (2001) Association of symptoms of temporomandibular disorders and orofacial pain with alexithymia: an epidemiological study of the Northern Finland 1966 Birth Cohort. J Craniomand Pract 19: 246-251.

V Rauhala K, Oikarinen KS & Raustia AM (1999) Role of temporomandibular disorders (TMD) on facial pain. Occlusion, muscle and TMJ pain. J Craniomand Pract 17: 254-261.

Contents

1 Introduction

Pain is a subjective and a complex phenomenon, causing significant discomfort, suffering and psychosocial morbidity (Okeson 1996). The International Association for the Study of Pain (IASP 1986) defines pain as ”an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage”. The facial region has special characteristics with biological, emotional, and psychological meaning to the person (Feinmann 1999). Partly due to the fact that the etiology and pathogenesis of several facial pain conditions are still poorly understood, their diagnosis and management is often difficult. Especially when pain is unresponsive to conventional treatment, despite the well-intended efforts of many pain specialists, there is a tendency for categorized thinking by the clinicians, so that biologically trained specialists may view all problems as biologically determined, whereas mental health professionals may be guilty of psychopathologizing almost all clinical problems (Grzesiak 1991). The same problem may be encountered in the case of facial pain. Therefore, it is important to understand the factors associated with facial pain, in order to direct the treatment toward the major cause of the problem. Facial pain that originates from the musculoskeletal structures of the masticatory system is included in a category of pain complaints known as temporomandibular disorders (TMD) which may have a multifactorial etiology (Okeson 1996). Thus, it it important to relate the facial pain to dysfunction of the masticatory system in order to determine the relationship to TMD, and also other possible factors related to the pain.

2 Review of the literature

2.1 Epidemiology of facial pain

Chronic facial pain is comparable with other pain conditions in the body, accounting for between 20 % and 25 % of chronic pain conditions (NIDR 1990). A six-month prevalence of facial pain has been reported by 1 % (Lipton *et al.* 1993) to 3 % (Riley & Gilbert 2001) of the population. In the study of Locker & Grushka (1987) some pain or discomfort in the jaws, oral mucosa, or face had been experienced by less than 10 %, in the last four weeks. Bonica (1980) estimated that five to seven million Americans suffer from chronic pain in the face and mouth, and between 25-45 % are affected at some time of life (Lipton *et al.* 1993, Von Korff 1996).

Most population-based studies have shown that women report more facial pain than men (Von Korff *et al.* 1988, Lipton *et al.* 1993, Goulet *et al.* 1995, Riley *et al.* 1998a, 2001, Dao & LeResche 2000), with rates approximately twice as high among women, compared with men (Lipton *et al.* 1993, Goulet *et al.* 1995). In the clinic populations the rates for women are even higher (Bush *et al.* 1993, Feinmann 1996). On the other hand, other studies have found no sex difference in the prevalences of orofacial pain (Locker & Grushka 1987, Andersson *et al.* 1993, MacEntee *et al.* 1993, Bassols *et al.* 1999).

Several studies have also shown variability in the prevalence across age groups. The age distribution of the facial pain population differs from that of the most usual pain conditions. In contrast to chest and back pain, for example, facial pain has been suggested to be less prevalent among older persons than younger ones (Locker & Grushka 1987, Von Korff *et al.* 1988). Conversely, Lipton *et al.* (1993) found the prevalence of facial pain to remain relatively constant across the age groups, while in a study of Riley & Gilbert (2001) no difference in prevalence was observed between the age groups of 45-64 years and older.

2.2 Measurement of pain

Perception of pain involves intensity, quality, duration, and location of the pain. Because of the subjective phenomenology of pain, self-reported data play a critical role in pain assessment (Jensen *et al.* 1998). The most common dimension of pain assessed has been pain intensity or the perceived severity of felt pain. Historically, a visual analogue scale (VAS) has proved to be a valid index of experimental, clinical and chronic pain (Huskinsson 1982, Price *et al.* 1983). On the VAS, respondents indicate their pain intensity by making a mark on a 10 cm long line that includes descriptors of the extremes of pain intensity (e.g., ”no pain” to ”pain as bad as it could be”) labeling each end of the line. Because the line consists of an infinite number of points, very small changes in pain intensity could theoretically be noted. In contrast, verbal rating scales (VRSs) and numerical rating scales (NRSs) have a limited number of pain levels from which to choose. With VRSs, the subject is asked to choose the word that best describes the intensity of pain from a list of descriptors (e.g., ”no pain”, ”some pain”, ”significant pain”, ”extreme pain”), and NRSs consist of a finite list of numbers (e.g., 0-10) (Downie 1978, Jensen *et al.* 1998).

The first systematic attempt to incorporate verbal descriptors in pain assessment was the McQill Pain Questionnaire (MPQ) (Melzack 1975), currently the most widely used instrument in pain research and practice. The MPQ is a self-report instrument that consists of 20 sets of qualitative and quantitative verbal descriptors designed to measure the sensory, affective, evaluative and miscellaneous dimensions of pain.

2.3 Etiology of facial pain

Facial pain can be associated with pathologic conditions or disorders related to somatic and neurologic structures (Okeson 1996). These pain disorders may originate from intracranial lesions, such as neoplasms, aneurysms, or abscesses. Pain can also be characterized as primary headaches, which may be neurovascular, in the case of migraine pain, or tension-type. Several neurogenic pain disorders, of which the most common may be trigeminal neuralgia, also occur in the facial area. Pain may also arise from the associated structures of the head, such as ears, eyes, nose, paranasal sinuses, throat, lymph nodes, salivary glands, and the neck. On the other hand, facial pain can originate in the oral area and associated structures, including pain from the dental pulp, periodontium, mucogingival tissues, and the tongue. Additionally, temporomandibular disorders are a common cause of facial pain. Besides somatic pain, psychological factors can either contribute to pain or actually cause the pain disorder (Okeson 1996).

2.4 Temporomandibular disorders (TMD)

2.4.1 Definition

According to the American Academy of Orofacial Pain (Okeson 1996), temporomandibular disorders (TMD) are defined as "a collective term embracing a number of clinical problems that involve the masticatory muscles, the temporomandibular joint and associated structures, or both". They are considered to be a subclassification of musculoskeletal disorders (Okeson 1996), and typically run a recurrent or chronic course, with a substantial fluctuation of TMD signs and symptoms over time (Könönen *et al.* 1996, Wänman 1996, Kuttila *et al.* 1997, Magnusson *et al.* 2000). Common signs and symptoms of TMD are clicking noises in the temporomandibular joint (TMJ), limited jaw opening capacity, deviations in the movement patterns of the mandible and masticatory muscle and/or TMJ pain in the face (Dworkin & LeResche 1992).

2.4.2 Diagnostic classifications

Although a sign alone can indicate a clinical condition, it also may refer to a subclinical event or may just be a normal variation (Stohler 1997). Over the years, many classification schemes for TMD have been offered (Okeson 1997). Helkimo´s indices were the first to be developed mainly for epidemiologic purposes in the diagnosis of TMD (Helkimo 1974a) and are still frequently used (Carlsson & LeResche 1995). Helkimo´s anamnestic index (AiI) comprises three degrees which are symptomless (Ai0), mild symptoms (AiI), and severe symptoms (AiII) of TMD. The clinical dysfunction index (Di) is based on the evaluation of five clinical signs: impaired range of movement, impaired function of the TMJ, muscle pain, TMJ pain, and pain on movement of the mandible. The Di index comprises four degrees which are signless (Di0), mild dysfunction (DiI), moderate dysfunction (DiII), and severe dysfunction (DiIII).

Recently, distinctions have been made between subgroups of TMD patients. The subclassification of TMD consists of two primary diagnostic categories: arthrogenous and myogenous. These classifications are not always clear, and there can be a considerable overlap or progression from one so-called syndrome to another (Kuttila *et al.* 1998). In 1990, the American Academy of Orofacial Pain (AAOP) established the first well-defined diagnostic classification for TMD, which was revised in 1993 (McNeill 1993). Further, the AAOP published an updated diagnostic classification in 1996 (Okeson 1996). The myogenous classification is often further subdivided into muscular hyperarousal due to stress and muscular abnormality associated with parafunctional oral habits (e.g., bruxism), and the arthrogenous category is subdivided on the basis of specific structural abnormalities (e.g. internal derangement of the temporomandibular joint or degenerative disease).

The research diagnostic criteria (RDC) developed by Dworkin and LeResche (1992), established a dual diagnosis that recognizes not only the physical conditions (axis I),

including muscle disorders, disc displacements and other types of joint conditions that may contribute to the pain disorder, but also the psychosocial issues (axis II) that contribute to the suffering, pain behavior, and disability associated with the patient's pain experience. This dual-axis classification approach has recently been incorporated in a diagnostic scheme not only for TMD but for all orofacial pain disorders (Okeson 1996). The RDC have been shown to be reliable for diagnosing TMD in U.S. and Swedish populations (Wahlund *et al.* 1998). In a recent study, however, the RDC have been shown to provide insufficient reliability for the determination of arthrogenous TMD (Emschoff & Rudisch 2001).

2.4.3 Epidemiology

2.4.3.1 Prevalence of signs and symptoms

TMD are among the most common orofacial pain conditions of nondental origin (Lipton *et al.* 1993). The reported prevalence of TMD differs between studies, probably because of variations in methodology and definitions of TMD (DeKanter *et al.* 1993, Goulet *et al.* 1995). The prevalences of TMD symptoms and signs are apparently also high in non-patient populations (Dworkin *et al.* 1990a, Agerberg & Inkapööl 1990). Further, TMD signs have been estimated to occur approximately twice as commonly as symptoms, the prevalence of symptoms varying from 5 % to 33 %, and the prevalence of signs from 1 % to 75 % (Schiffman & Friction 1988, DeKanter *et al.* 1993, Carlsson & LeResche 1995).

The most common symptom of TMD is clicking of the TMJ, the prevalence levels varying from 8 to 50 % (Wänman & Agerberg 1990, Duckro *et al.* 1990, Glass *et al.* 1993, Wabeke & Spruijt 1994, Goulet *et al.*1995, Könönen *et al.* 1996, Magnusson *et al.* 2000). In contrast, mouth opening limitations are relatively rare, occurring in 5 % or less of the population (Huber & Hall 1990, DeKanter *et al.* 1993).

Pain in the face and the TMJs is a common symptom of TMD, and supposed to be the most important reason for seeking treatment for TMD (Von Korff *et al.* 1988, Dworkin *et al.* 1990a). In adult population, the prevalence of TMD-related pain has been reported to vary between 5 and 15 % (Locker & Slade 1988, Von Korff *et al.* 1988, Dworkin *et al.* 1990, Lipton *et al.* 1993, Goulet *et al.* 1995, LeResche 1997a, Riley & Gilbert 2001). It has been suggested that TMD pain occurs with about the same prevalence as abdominal pain and chest pain, but is less common than back pain and headache (Von Korff *et al.* 1988).

List & Dworkin (1996) have evaluated that approximately three out of four of TMD patients have myogenous TMD. However, different levels have been found in a study of De Leeuw *et al.* (1994b) and Kuttila *et al.* (1998), where approximately equal proprotions of myogenous vs. arthrogenous subgroups were noted among subjects with TMD.

2.4.3.2 Treatment need

Despite the large percentages of the population having signs and symptoms of TMD, it has been estimated that only 2 % or less of the general population seeks treatment for a TMD symptom (De Kanter *et al.* 1992, Goulet *et al.* 1995). However, the levels of the treatment need are suggested to be higher, varying from 5 % to 16 % (Agerberg & Inkapööl 1990, Dworkin *et al.* 1990, Salonen *et al.* 1990, Magnusson *et al.* 1993, Kuttila *et al.* 1998).

Little is known about the significance of TMD diagnostic subgroups, i.e., with myogenous or arthrogenous symptoms, in the treatment need for TMD. It has been suggested that patients with myogenous TMD have a more acute need for treatment than arthrogenous patients (De Leeuw *et al.* 1994a, Kuttila *et al.* 1998), as well as a less favorable prognosis (Scholte *et al.* 1993).

2.4.3.3 Gender differences

Although earlier population studies found the prevalence of symptoms and signs of TMD to be similar in men and women (Helkimo 1974b, 1976), later studies have reported a higher prevalence among women (Locker & Slade 1988, Tervonen & Knuuttila 1988, Agerberg & Inkapööl 1990, DeKanter 1990, Dworkin *et al.* 1990, Salonen *et al.* 1990, DeKanter *et al.* 1993, Glass *et al.* 1993, Lipton *et al.* 1993, Magnusson *et al.* 1993, De Leeuw *et al.* 1994a, Goulet *et al.* 1995, Magnusson *et al.* 2000).

Several studies having representative general populations indicate that women experience more TMD-related pain than men, usually at a ratio of two to one (Locker & Slade 1988, Von Korff *et al.* 1988, Dworkin *et al.* 1990, Lipton *et al.* 1993, Goulet *et al.* 1995, LeResche 1997, Kamisaka *et al.* 2000, Riley & Gilbert 2001). The most prominent sex differences have been found at the age of 20-40 years (Agerberg & Inkapööl 1990, Salonen & Hellden 1990, Glass *et al.* 1993, Lipton *et al.* 1993, Magnusson *et al.* 1993, Levitt & McKinney 1994). The predominance of women is even higher in surveys of people seeking treatment for TMD pain (Dworkin *et al.* 1990, Goulet *et al.* 1995), at a ratio of 4:1 or 5:1 (Locker & Slade 1988, Bush *et al.* 1993, Dworkin & LeResche 1993, Levitt & McKinney 1994, McNeill 1997). Further, it has been shown that women need treatment for their TMD problems two to three times as often as men (Agerberg & Inkapööl 1990, Kuttila *et al.* 1998).

2.4.3.4 TMD and age

Many studies have shown that the highest prevalence of TMD occurs among adults under 45 years of age, with decreasing levels at an earlier age (Locker & Slade 1988, Von Korff *et al.* 1988, Dworkin 1990, Agerberg & Inkapööl 1990, Duckro *et al.* 1990, Glass *et al.* 1993, Lipton *et al.* 1993, Goulet *et al.* 1995, LeResche 1997). Further, the majority of the TMD

patients are found to be between 15 and 45 years old (Carlsson 1999). Therefore, the adult population is of special interest as far as TMD is concerned, and studies regarding the prevalence of TMD and related factors should be directed especially at this stage of age. In contrast, others have shown an increasing prevalence with advancing age (Aberberg & Bergenholtz 1989). Additionally, Salonen & Hellden (1990) have found that reported symptoms of TMD decrease with age, while clinical signs increase.

2.4.4 Etiology

2.4.4.1 General aspects

Numerous efforts have been made in order to resolve the etiology of TMD. De Boever (1979) reported five different etiologic theories of TMD, i.e. mechanical displacement theory, neuromuscular theory, psychophysiological theory, muscular theory and psychological theory. At present, TMD are considered not as a single entity but as comprising several diseases of varying etiology and pathology, and controversy still exists because of limited knowledge regarding the etiology and natural history of the course of TMD (Dworkin & LeResche 1992, McNeill 1993). General factors, such as impaired health, general joint and muscle diseases, psychological and psychosocial factors, and local influences such as occlusal disturbances, parafunctional activities, i.e. bruxism, and traumas, can affect the condition of the stomatognathic system (Okeson 1996). At present, the role of different factors in TMD is still unclear. In addition to studies with most commonly used patient samples, where biases such as access to providers and care-seeking behavior may have an effect on the results, additional population-based studies are needed to clarify the heterogenous factors related to TMD.

2.4.4.2 Occlusal factors

More than 60 years ago, Costen (1934) proposed that chronic musculoskeletal facial pain is caused by the loss of molar teeth. Although occlusion continued to be regarded as one of the major influences on TMD, and treatment of the occlusion as the most important strategy in treatment of TMD (De Boever *et al.* 2000a), the significance of the role of occlusion in the etiology is still unclear, creating a demand for further longitudinal studies.

Several reviews and studies have not found any strong support for an occlusal etiology of TMD, at least not as a unique or dominant factor (Tervonen & Knuuttila 1988, Egermark-Eriksson *et al.* 1990, McNeill 1993, Pullinger *et al.* 1993, McNamara *et al.* 1995, Okeson 1996, Clark *et al.* 1997, Kitai *et al.* 1997, Watanabe *et al.* 1998, de Boever *et al.* 2000a, Pullinger & Seligman 2000). It has been stated, however, that the low correlation between occlusal factors and TMD found may be partly due to problems in the study designs conventionally applied (Kirveskari & Alanen 1993). Some studies,

however, have shown the role of occlusion in TMD to be more important than is generally accepted (Raustia *et al.* 1995a,b, Kirveskari 1998). For example, anterior open bite, crossbite, deep bite, distal occlusion, missing posterior teeth, large slide from the retruded to the intercuspal position as well as occlusal interferences have been suspected to be risk factors for TMD (Egermark-Eriksson *et al.* 1990, Kirveskari *et al.* 1992, Pullinger *et al.* 1993, Seligman & Pullinger 1996).

2.4.4.3 Bruxism

Bruxism is a psychophysiological disorder that can be defined as diurnal or nocturnal tooth contact parafunctional activity, such as clenching and grinding (Mohl *et al.* 1988). Sleep bruxism has been defined by the American Sleep Disorders Association (ASDA) in its International Classification as a "stereotyped movement disorder characterized by grinding or clenching of the teeth during sleep" (Thorpy 1990). The prevalence of bruxism in the general population ranges from 8 to 21 % when assessed by a questionnaire, and from 48 to 58 % when clinical oral examination is employed (Seligman *et al.* 1988). There are studies in which bruxism and other parafunctional habits are associated with head and facial pain (Dao *et al.* 1994a, Molina *et al.* 1997, Glaros *et al.* 1998).

The etiology of bruxism is unclear. Bruxism has been suggested to be a multifactorial psychosomatic phenomenon (Olkinuora 1972). Bruxers are suggested to have increased levels of stress and tension, disturbed sleep, and depression (Dao *et al.* 1994a). At present, bruxism is considered a phenomenon of centrally mediated neurologic activity related to sleep disorders (Lobbezoo & Lavigne 1997), and it has also been suggested to be a link between autonomic regulation of circulation and rhythmic activation of masticatory muscles, especially when associated with body movements during sleep (Sjöholm 1995).

2.4.4.4 Traumas

It has been shown that many patients with TMD have a history of head or cervical trauma. Patients who have undergone surgical treatment of TMD have reported extrinsic traumas, i.e. car accidents and blows in the face etc., preceding their TMD symptoms (Raustia 1994). It has also been found that patients with trauma history present with signs and symptoms of TMD (De Boever & Keersmakers 1996, Friedman & Weisberg 2000). The association between traumas and TMD has also been shown epidemiologically (Seligman & Pullinger 1996, Kamisaka *et al.* 2000). In contrast, a population-based study of Locker & Slade (1988) found no association between trauma and signs or symptoms of TMD. Additionally, a critical review by Ferrari & Leonard (1998) revealed no substantial theory of mechanical TMJ injury to be connected with TMD.

2.4.4.5 TMD and generalized pain

Several studies with patient samples have found a significant overlap between TMD and pain conditions in other parts of the body (Allebring & Hagerstam 1993, Hagberg *et al.* 1994, Turp *et al.* 1998). Especially patients with masticatory muscle problems have complaints beyond the masticatory system, mostly in the head, neck and back areas (Hagberg *et al.* 1994). In addition, high rates of comorbidity between myogenous facial pain and fibromyalgia have been noted in several studies (Marbach 1995a, Plesh *et al.* 1996, Hedenberg-Magnusson *et al.* 1999). In addition to these studies with patient samples, however, population-based studies are needed to describe the association between TMD and other pain conditions

It has been stated that women are more likely to have multiple symptoms than men (Bassols 1999), and that muscular TMDs can be part of a generalized pain syndrome more commonly among women than among men (Korszun *et al.* 1998). This generalized pain condition has been suggested to associate with psychological disturbances, especially with depression and somatization (Raphael *et al.* 2000).

2.4.4.6 Psychological factors

The perception of pain is highly dependent upon psychological state (Price 1988). The importance of psychological factors has also been emphasized in TMD (Kight *et al.* 1999, Rollman & Gillespie 2000). They are thought to have a role in the cause or maintenance of TMD (Rugh 1992), and may predispose the condition to chronicity (Gatchel *et al.* 1996). On the other hand, it has been stated that psychological disturbances may be a direct consequence of pain-related life events in TMD patients (Rugh 1992, Murray *et al.* 1996).

Subcategorization of the patients into diagnostic subgroups of TMD suggests that myogenous patients may have more psychological difficulties than patients with arthrogenous TMD (McCreary *et al.* 1991, Jaspers *et al.* 1993, Scholte *et al.* 1993, Levitt & McKinney 1994, Lobbezoo-Scholte *et al.* 1995, Spruijt & Wabeke 1995).

Somatization. Somatization is defined as a tendency to experience and communicate somatic distress in response to psychosocial stress and to seek medical help for it (Lipowski 1988). Somatoform disorder is a condition in which the patient reports somatic complaints, yet no physical evidence of organic disease is present (American Psychiatric Association, 1994). Somatization has been connected with frequent use of health services (Jyväsjärvi 2001), and about 20 % of frequent attenders have been classified as chronically somatizing patients (Karlsson *et al.* 1997). Somatizing patients have a negative perception of their health (Katon *et al.* 1991), and often have psychosocial difficulties (Mechanic 1992), substantial distress (Noyes *et al.* 1995), and show enhanced sensitivity to normal physical sensations (Blackwell & DeMorgan 1996). In addition, they are characterized by abnormal illness behavior (Noyes *et al.* 1995).

TMD patients have been found to have increased scores in somatization (Wilson *et al.* 1994, McGregor *et al.* 1996). It has been suggested that especially patients with masticatory muscle pain may be more prone to report symptoms as compared to normal

controls (Wilson *et al.* 1991) and are likely to be more sensitive to painful stimuli (Reid *et al.* 1994), although this is argued by the data of Carlson *et al.* (1998).

Depression. Depression is a disorder that can be defined as a collection of symptoms such as depressed mood, loss of interest or pleasure, weight loss or weight gain, insomnia or hypersomnia, feelings of worthlessness, and diminished ability to think or concentrate, etc. (American Psychiatric Association 1987). According to the DSM-III-R criteria (American Psychiatric Association 1987), a major depression episode includes a minimum of five symptoms that have lasted for a period of at least two weeks. Major depression can be diagnosed on the basis of structured clinical interview. However, reliable and valid self-report questionnaires will yield a numeral rating of depressive symptoms (Beck *et al.* 1961, Derogatis 1973, Radloff 1977, Zigmond & Snaith 1983). Cut-off points have been applied to these questionnaires to provide an indication of the extent of depression.

Epidemiological studies have shown that depression is the most common mental disorder in man. The point prevalence of a clinically significant depressive disorder is 4 % among men and 8 % among women, whereas depressive symptoms are much more common (Lehtinen and Joukamaa 1994). Depression affects at least 20 percent of women and 10 percent of men during their lifetimes (Kessler *et al.* 1994).

There is evidence of greater prevalence of depressive symptoms in subjects with chronic pain in community (VonKorff *et al.* 1988, Dworkin *et al.* 1990b) and patient samples (Magni 1987, Lautenbacher 1999) than in controls. Numerous studies have also shown a high rate of depression in patients with facial pain and TMD (McCreary *et al.* 1991, Gallagher *et al.* 1991, Gatchel *et al.* 1996, Korszun *et al.* 1996, Carlson *et al.* 1998, Madland *et al.* 2000), while the number of population-based studies concerning the connection between depression and TMD (Von Korff *et al.* 1988, Dworkin *et al.* 1990b, Vimpari *et al.* 1995) is lower than the number of studies with patient samples. In contrast, McGregor (1996) found no differences between depression rates in orofacial pain patients and normal controls.

Personality features. Several studies have found no evidence of any separate personality profile to be connected with TMD (Parker *et al.* 1993, Marbach 1995b, Feinmann 1996), while others have shown that facial pain correlates with some personality characteristics similar to those of other chronic pain patients (Michelotti *et al.* 1998, Mongini *et al.* 2000). Dworkin (1995) identified patients with chronic pain and noted distinct personality styles among them. The first personality style was characterized by excessive avoidance in dealing with everyday responsibilities, including management of pain. In contrast, the individual whose personality style was marked by "approach excess" typically overrelies on external sources, such as medical providers, friends and family, to manage his or her life, including the pain.

Alexithymia. The concept of alexithymia was first introduced by Sifneos in 1972 to describe psychological characteristics of patients with psychosomatic diseases (Sifneos 1972, 1973). Alexithymia (from the Greek *a* for lack, *lexis* for word, and *thymos* for feeling) means literally “no words for feelings”. It denotes a deficit in the ability to differentiate emotional states from physical ones and to identify and describe one’s feelings, as well as a preference for externally oriented, utilitarian thinking rather than fantasy or introspection (Taylor *et al.* 1991).

There have been many attempts to develop standard measures of alexithymia. Currently, the most commonly used and best validated measure is the Toronto Alexithymia Scale (TAS) and its modified 20-item version, the TAS-20 (Bagby *et al.* 1994a,b). In Finnish population, the prevalence of alexithymia has been reported to be 10 % among women and 17 % among men (Salminen *et al.* 1999).

Many different theories have been presented concerning the etiology of alexithymia, dealing e.g. with traumatic stress (Krystal & Krystal 1988), psychological deficit (Taylor *et al.* 1991), dysfunctional communication between hemispheres (TenHouten *et al.* 1987, Zeitlin *et al.* 1989), cultural aspects (Kirmayer 1987), genetic origin (Heiberg & Heiberg 1978), disturbance of the mechanism of pain experience involving the limbic system and the endogenous opiates (Flannery 1978), and central catecholamines (Giannini 1996). Alexithymia has also been linked with childhood family environment (Kench & Irwin 2000). Further, in addition to primary alexithymia, the term secondary alexithymia has also been conceptualized, resulting from psychological traumatic events (Freyberger 1977). With the development of neuroimaging techniques, alexithymia has been found to be associated with certain neurobiologic processes in the central nervous system (Karlsson *et al.* 2000).

Numerous reports have been published linking alexithymia with various somatic and psychosomatic diseases (Taylor *et al.* 1991, Kauhanen *et al.* 1993, Cohen *et al.* 1994). It has been found that alexithymia associates positively with somatization (Taylor 1997). Further, a connection between chronic pain and alexithymia has been observed in several studies with patient samples (Cox *et al.* 1994, Lumley *et al.* 1997a, Okasha *et al.* 1999). However, there are no studies with modern methods, using the Toronto Alexithymia Scale, concerning the association between facial pain and alexithymia.

2.4.5 Management

2.4.5.1 General aspects

Treatment of TMD mostly aims at managing pain (Dworkin & LeResche 1992). These therapies include occlusal, behavioral, physical, and pharmacological treatments (Okeson *et al.* 1996).

There has been controversy regarding the need of actively treating patients with TMD. It has been suggested that treatment only including analgesics and stress reduction counseling is adequate for treating TMD (Randolph *et al.* 1990). Several studies, however, suggest that conservative, noninvasive methods are successful in the treatment of TMD (McNeill 1997, Wexler & Kinney 1999). A study of Gaudet & Brown (2000), using a large and representative sample of patients with TMD, found that treated patients reported significant symptom improvement, while untreated patients reported unchanged symptom level, in a follow-up of six months. Therefore, they do not support the hypothesis that TMD are self-limiting and improve spontaneously.

2.4.5.2 Occlusal splints

Interocclusal orthopedic appliances, also referred to as occlusal splints, have been used in the treatment of TMD, including TMJ and masticatory muscle disorders (Okeson 1996). Previous studies have demonstrated that the use of intraoral appliances can produce rapid improvement of pain for TMD patients (Turk *et al.* 1993). In contrast, controlled clinical trials conclude that appliances are not effective (Dao *et al.* 1994b, Marbach & Raphael 1996). Marbach & Raphael (1997) have suggested that the positive effect of appliances in uncontrolled studies may be due to the methodological artefacts, based on the fluctuating course of TMD, the spontaneous improvement with time, and the placebo effect, and do not recommend the use of appliances for facial pain.

Based on the systematic review of randomized controlled trials on splint therapy from 1966 to 1999, Forssell *et al.* (1999) concluded that "the use of occlusal splints may be beneficial in the treatment of TMD, but the evidence is scarce". The two methodologically strongest studies on occlusal splints using an identical experimental design ended in different conclusions. Ekberg *et al.* (1998) reported that stabilization splints were superior to palatal splints, whereas no difference between the two splints was found in the study by Dao *et al.* (1994b). Ekberg *et al.* (1998) suggested that the difference between these two studies could be due to the different origins of the TMD pain, i.e. arthrogenous or myogenous. According to the review of Major & Nebbe (1997), occlusal splints are effective in reducing headaches and muscle pain, but may be of limited value in reducing joint pain.

2.4.5.3 Occlusal adjustment

Controlled clinical trials suggest an effect for the occlusal adjustment on TMD (Forssell *et al.* 1986*)*, on chronic headaches (Forssell *et al.* 1985, Vallon *et al.* 1995) as well as on neck and shoulder pain (Karppinen *et al.* 1999), and also on prevention on TMD (Karjalainen *et al.* 1997). However, the use of occlusal adjustment as a treatment for TMD has been questioned because of the lack of evidence regarding the effect (Forssell *et al.* 1999, Tsukiyama *et al.* 2001), the reported good short-term results of reversible therapies, the probability of spontaneous recovery, and the risk of possible adverse effects (Forssell *et al.* 1999). In two recent systematic reviews (Antczak-Bouckoms 1995, Forssell *et al.* 1999), the quality of the clinical trials concerning occlusal adjustment has been shown to be fairly low. At present, it has been recommended that occlusal adjustment should not be used, at least as a prophylactic method (McNeill 1997, De Boever *et al.* 2000a).

2.4.5.4 Prosthetic treatment

Loss of molar support has traditionally been considered to be an important etiological factor for TMD (De Boever 1979). However, several studies have found no significant relationship between certain characteristics of dentures and the presence or severity of symptoms of TMD (Okimoto *et al.* 1996, De Boever 2000b), although Tervonen & Knuuttila (1988) found that complete denture wearers had more signs and symptoms of TMD than those with natural dentition.

There are only few studies on treatment outcome in TMD following prosthetic treatment. In most clinical studies, a combination of treatment modalities has been used, where prosthetic treatment is carried out after conservative treatment of TMD and on prosthetic indications (De Boever 2000b). The study of Magnusson (1982) reported a reduction of TMD signs and symptoms, including recurrent headache, in denture wearers after treatment with new, complete dentures, whereas in another investigation, renewal of the complete dentures did not seem to change the symptoms of TMD significantly (Raustia *et al.* 1997a). It has been stated that the vertical dimension of occlusion is an important factor in provoking pain and dysfunction (Monteith 1984). However, this question remains open, and a recent review has demonstrated that the vertical dimension of occlusion can be raised without negative consequences, both in the natural dentition and in the renewal of complete dentures (Palla 1997).

2.4.5.5 Surgical treatment

Surgery is indicated only in specific articular disorders, usually in cases that do not respond to conservative treatment, and when the patient's quality of life has been significantly affected (Okeson 1996, McNeill 1997, Dolwick 1997). Surgical management may vary from closed surgical procedures, such as arthrocentesis and arthroscopy, to more complex open joint operations, such as arthrotomy, disk repositioning, diskectomy and condylotomy (Dolwick 1997). Evaluations of the effect of surgical treatment on reducing the signs and symptoms of TMD have been encouraging (Montgomery *et al.* 1992, Peltola *et al.* 2000), and the importance of stomatognathic and/or prosthetic follow-up treatment has been highlighted (Raustia *et al.* 1997b, 1998).

2.4.5.6 Pharmacotherapy

Pharmacologic intervention in the management of TMD is usually considered adjunctive to other treatments (Dionne 1997). Based on a meta-analysis, of the literature published from 1980 to 1992, Antczak-Bouckoms (1995) concluded that it is not clear whether the drug therapies currently in use for TMD provide any benefit over placebo alone. However, palliative pharmacologic management of intractable pain is considered an indication when pain is poorly controlled by other treatments (Dionne 1997).

The indicated classes of pharmacologic agents include analgesics, anti-inflammatory agents, corticosteroids, anxiolytics, muscle relaxants and antidepressants. Non-opiate analgesics are effective for mild to moderate acute pain associated with TMD, and opioid narcotics are considered for short-term use in controlling acute severe pain (McNeill 1997). Additionally, tricyclic antidepressants appear to be effective in the control of chronic orofacial pain of non-inflammatory origin, independent of their effects on mood (Pettengill & Reisner-Keller 1997, Plesh *et al.* 2000), with daily doses smaller than those typically used in the treatment of depression (Pettengill & Reisner-Keller 1997).

2.4.5.7 Other treatments

Psychological findings have led to the development of TMD treatment protocols addressing psychological dimensions (Rudy *et al.* 1995). Recently, it has been suggested that facial pain sufferers would benefit from certain types of cognitive-behavioral treatment (Schwartz & Gramling 1997). Several studies have evaluated different methods, i.e. habit reversal, relaxation training, problem-solving or stress management, and brief cognitive restructuring, in addition to the standard stomatognathic treatment (Turk *et al.* 1993, Dworkin *et al.* 1994).

Further, several researchers prefer combined therapy in treating chronic TMD patients. Turk *et al.* (1993) support the importance of using both stomatognathic and psychological treatment for treating TMD successfully. In addition, Tversky *et al.* (1991) found combined therapy, i.e. a combination of occlusal splint and antidepressant therapy, to be more effective in pain relief, compared with single therapies consisting of either of these two therapies.

Some forms of physical therapy, including thermal therapy, acupuncture, laser therapy, electrical stimulation, manipulation and exercise, have been used in the treatment of TMD. Although there is little evidence about the long-lasting effect of these therapies on TMD signs and symptoms, it has recently been suggested that exercise programs to improve physical fitness are effective in pain and disability conditions of the musculoskeletal system (Feine *et al.* 1997).

2.4.5.8 Factors related to treatment outcome

It has been found that psychosocial factors affect the individual treatment outcome of TMD. It has been hypothesized that TMD are characterized more by the individual's inability to cope with the local etiological factor, e.g. tooth loss, than by these morphologic factors themselves (Turk & Rudy 1990). In a study of 100 patients with TMD pain that were conservatively treated, those reporting the largest reduction in pain intensity were the least inclined to blame themselves for their problems and the most able to divert attention away from their problems (Schnurr *et al.* 1991).

De Leeuw *et al.* (1994b) investigated whether various psychosocial characteristics are associated with treatment outcome in patients with TMD treated with a splint. Results

showed that patients with negative treatment outcome were older, and reported more severe symptoms and correlates of TMD, fewer stressors and more frequently considered health to be determined by external factors than the patients who were treated successfully. In a 6-month follow-up study of 37 TMD patients, Suvinen *et al.* (1997) confirmed coping strategies and illness behavior to be very important factors influencing treatment outcome, occlusal factors playing a minor role.

3 Aims of the study

The aims of this study were to evaluate

1. The prevalence and gender distribution of facial pain in a geographically defined sample of 31-32-year-old adults
2. The association of facial pain with TMD, occlusal factors, previous traumas and generalized pain in a sample of 31-32-year-old adults as well as in a group of subjects with facial pain and their healthy controls
3. The association of facial pain with depression and alexithymia in a sample of 31-32-year-old adults
4. Clinical findings of TMD, occlusion, and influence of conservative stomatognathic and/or prosthetic treatment of TMD on facial pain and signs and symptoms of TMD, in a sample of referred facial pain patients.

4 Material and methods

4.1 Population-based study

4.1.1 Background

The population-based study (Papers I-IV) is part of the Northern Finland 1966 Birth Cohort Project. The original sample was collected from a geographically defined area of the two northernmost provinces of Finland. Originally, it consisted of an unselected, general population-based birth cohort of 12,058 live births, whose expected date of delivery fell in 1966, representing 96.3 % of all such births (Rantakallio 1988). In 1997-98, when the subjects were 31-32 years old, a postal questionnaire was sent to those included in the cohort (n=11,541), and 8,461 of them responded and gave their written consent. Those living in northern Finland or in the capital area (n=8,463) were invited to a field study which consisted of a clinical examination (including measurement of blood pressure and physical workability of the subjects, allergy tests and collection of blood samples, etc., performed by a nurse), questionnaires and interviews. Of the subjects contacted, 5,993 participated in the field study and gave their written consent. 5,696 subjects, representing 67.3 % of those who were invited to the clinical examination, answered a computer-aided questionnaire. In addition, they were given a questionnaire on opinions and experiences to fill in at home, and it was later returned by mail. Of those, 5,113 responded and gave their written consent. The overall design of this population-based study is presented schematically in Figure 1.

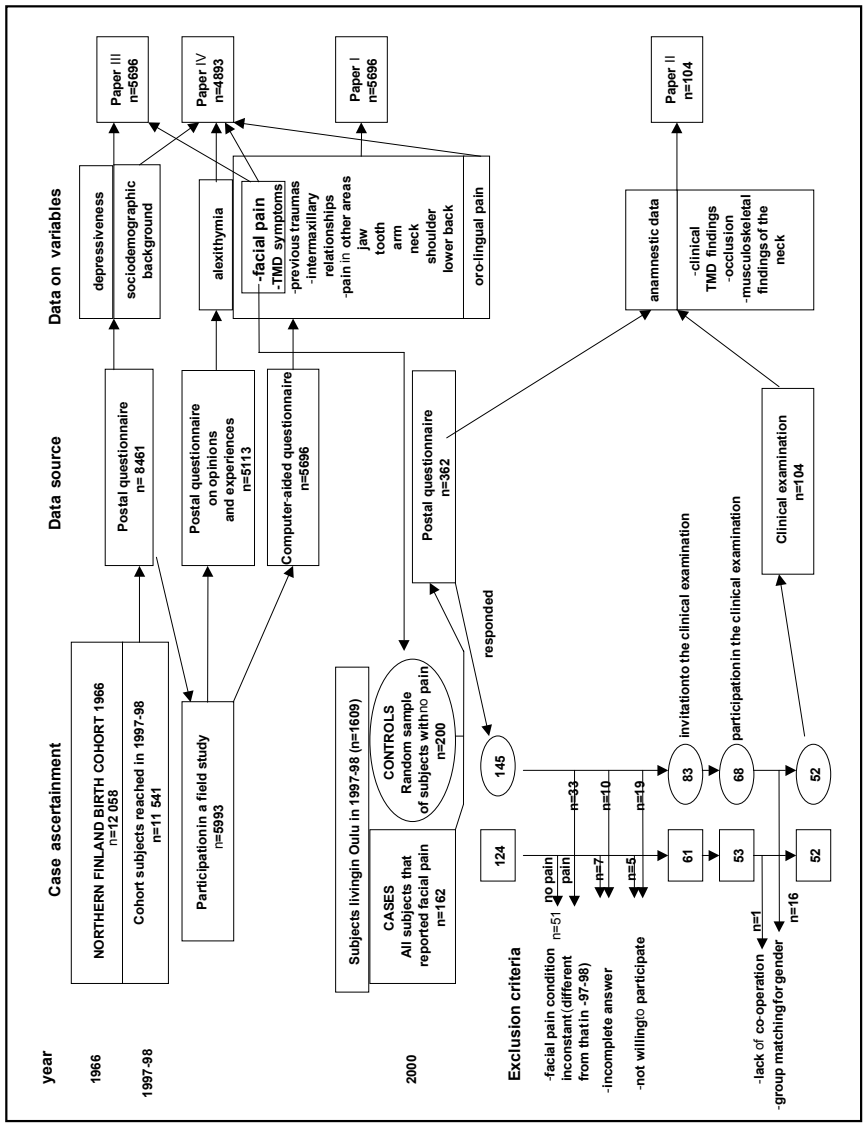

Fig.1. Study population and data collection from the Northern Finland Birth Cohort

4.1.2 Computer-aided questionnaire

Among other aspects concerning the health and well-being of the subjects, the questionnaire included data on TMD symptoms (facial pain, TMJ pain, joint sounds and difficulties in mouth opening), oro-lingual and dental pain, occlusal intermaxillary relationships and traumas in the face as well as other regional pain areas (Paper I). To those who did not show up at the questionnaire session, a postal questionnaire was sent containing the same questions.

The major part of the questionnaire concerned the following topics:

1. Have you had pain or ache in the face, in the mucosa of the mouth or the tongue, or in the teeth *during the last year*? no/ yes (now and then/ fairly often/ often or continuously)
2. Have you had symptoms in the area of jaw joint? (pain at jaw rest, pain on jaw movement, clickings, difficulties in mouth opening) no/ yes (sometimes/ continuously)
3. Do you have following deviations related to teeth and jaws? no/ yes
   – lower jaw located forward compared with the upper jaw
   – lower jaw clearly backward compared with the upper jaw
4. Have you *ever* had the following injuries in the face area? no/ yes (own opinion or noted by a doctor or a dentist)
   – fractures in the upper jaw
   – fractures in the lower jaw
   – other fractures in the face
   – injury in the jaw joint
   – other injury in the face
5. Have you had pain or ache *during the last year* in the following regions? no/yes (now and then/ fairly often/ often or continuously)
   – neck and occiput
   – shoulders
   – arms or elbows
   – lower back
   – jaws
   – teeth

4.1.3 Case-control study

A subsample of the cohort was formed based on the question concerning facial pain in the computer-aided questionnaire (Paper II). A new questionnaire was sent to the following subjects living in Oulu in 1997: 1) all subjects who had reported facial pain in the former questionnaire (n=162) (cases), and 2) to a randomly selected group of controls (n=200), group matched for gender, who had reported no facial pain in the former questionnaire. The amount of the controls was calculated in order to obtain an equal number of cases and controls, providing for a drop-out of 20 %, in controls. The new inquiry consisted of questions about facial pain, symptoms of TMD and other musculoskeletal symptoms in

the body. 124 (76.5 %) cases and 145 controls (72.5 %) responded. Those who reported willingness to participate in the clinical examination and gave the same answer concerning facial pain as in the earlier questionnaire (61 cases, 83 controls) were invited to a clinical stomatognathic and musculoskeletal examination. In total, 121 (53 cases, 68 controls) persons participated in the clinical examination. One of the cases was excluded from the study due to lack of co-operation. Due to a different gender distribution in the final study groups, the controls were randomized by the proportional allocation method. The final number of the subjects was 104, with 52 participants (10 men, 42 women) in both of the groups. (Fig.1, Paper II).

Anamnestic data on general health were collected. Both the clinicians (dentist and physiotherapist) and the subjects were unaware of the case-control status of the subjects. The examinations of the masticatory system was carried out by the same dentist (K.S.), and included radiographic (orthopantomogram) and stomatognathic examinations, consisting of the measurement of the ranges of movements of the mandible, deviations of movements, TMJ sounds, masticatory muscle pain, TMJ pain and pain during movement of the mandible. The degree of TMD was assessed with the clinical dysfunction (Di) index of Helkimo (1974a). On the basis of criteria corresponding to those described by the American Academy of Orofacial Pain (Dworkin and LeResche 1992) the subjects were classified into three subgroups depending on their type of disorder (De Leeuw *et al.* 1994a,c). The subjects were classified as mainly myogenous (myogenous TMD group) if they reported pain on palpation of one or more masticatory muscles, and had no tenderness on palpation of the TMJs or no clinical or radiographic evidence of organic changes in the TMJs. The subjects were classified as mainly arthrogenous (arthrogenous TMD group) if they had pain on palpation of the TMJs and/or radiographic evidence of organic changes in the TMJs. Subjects with signs both in muscles and TMJs were classified in the combined TMD group.

Occlusal interferences were recorded in various contact positions of the mandible using GHM (Hanel Co., Roeko, D-89122 Langenau, Germany) occlusal registration tape. The occlusal variables examined were as follows: a) protrusion interferences (PTR) were recorded at the incisal edge-to-edge position when asking the patient to move the mandible forward. PTR interferences were determined as tooth contacts posterior to canines in protrusion movement; b) laterotrusion (LTR) and c) mediotrusion (MTR) interferences were recorded at the position of lateral gliding up to 3 mm from intercuspal position (IP), when asking the patients to move the mandible to the side, corresponding approximately to an edge-to-edge position of working side teeth. LTR interferences were determined as contacts posterior from canines in LTR movement, and MTR interferences as contacts on the non-working side in LTR movement; and d) when recording retruded position (RP) interferences the mandible was manipulated into the retruded contact position by Dawson's method (Dawson 1989). RP interferences were determined as any unilateral contact in retruded contact position. Slide between RP and IP was recorded in millimeters with a periodontal probe, and the direction of lateral deviation of the mandible between RP and IP was recorded.

Neck pain was defined according to the distribution of pain during the last week in the neck-occiput area by means of a pain drawing from the body outline (back view) (Fig. 2, Paper II). A visual analogue scale (VAS) was used to assess the stiffness of the neck during the last week with anchor points at the left (no stiffness) and right-hand (full

stiffness) ends of a 100 mm horizontal line. All the musculoskeletal examinations were performed by the same physiotherapist (P.S.). The following fibromyalgia (FM) points, according to criteria described by the American College of Rheumatology (ACR) (Wolfe *et al.* 1990), were palpated in the neck area bilaterally in response to digital palpation, performed with an approximate force of 4 kg with an algometer: 1) occiput: at the occipital muscle insertions (FM 1), 2) low cervical: at anterior aspects of the transverse spaces at C5- C7 (FM 2), 3) trapezius: at the midpoint of the upper border (FM 3), and 4) supraspinatus: at the origins above the scapula spine near the medial border (FM 4) (Fig. 2, Paper II). Cervical spine mobility on six head movements (flexion, extension, lateral flexions and rotations) was examined with a Myrin Goniometer (Lic Rehab AB, Linköping, Sweden), measuring the flexion and extension movements with a weight pointer controlled by gravity and axial rotation with a compass (AAOS 1965, Ekstrand *et al.* 1982). The degree of the motion range between the neutral position, 0^{o}, (the subject sitting in a relaxed position and looking straight ahead) and maximum angular displacement of the head was recorded.

4.1.4 Postal questionnaires

4.1.4.1 Sociodemographic background

For the analyses, sociodemographic data, including marital status, education and self-rated general health, were obtained from the postal questionnaire. Marital status was dichotomized as single vs. married or cohabiting. Education was divided into two classes; high school graduate or no high school diploma, and self-rated general health into good (very good, good or moderate) or poor (poor or very poor).

4.1.4.2 Depressiveness

Those who returned the postal questionnaire and filled the questionnaire participated in study III (n=5,696). Information about depressiveness was obtained from the postal questionnaire. The most important indicator of depressiveness was the Symptom Checklist-25 (SCL-25) (Fink *et al.* 1995), which is a 25-item shortened version of an originally 90-item questionnaire designed by Derogatis *et al.* (1973). A depression subscale (DS), containing 13 questions, was used. Subjects recorded their own estimates of symptom severity by values from 1 (not at all) to 4 (very much). Responses were summed and divided by the numbers of the answers. A score over 1.75 indicated depression (Winokur *et al.* 1984, Nettelbladt *et al.* 1993). In addition, the postal questionnaire included the following question about diagnosed depression: Have you ever had depression, observed by a doctor? The answers were dichotomized as no/ yes.

4.1.4.3 Alexithymia

Those who returned the postal questionnaire on opinions and experiences and filled the questionnaire participated in study IV (n=4,893). To assess alexithymia, the Toronto Alexithymia Scale-20 (TAS-20) (Bagby *et al.* 1994a,b), included in the postal questionnaire on opinions and experiences, was used. The TAS-20 consists of 20 statements, each rated on a Likert-type scale from 1 (strongly disagree) to 5 (strongly agree) for a maximum score of 100. According to the recommendation by the developers of the TAS-20, a total score over 60 indicated alexithymia.

4.2 Clinical study on referred facial pain patients

The study on facial pain patients is described in Paper V. The material consisted of 25 patients (21 women, 4 men), mean age 45 years (SD 7,4, range 21-67 years), who had been referred to the Oral and Maxillofacial Department, Oulu University Hospital, chiefly by dentists, otolaryngologists, neurologists or general practitioners, on account of chronic facial pain. The anamnestic data were recorded and clinical examination of the masticatory system was carried out at all registrations by the author herself.

Clinical examination included measurement of the ranges of movements of the mandible, deviations of movements, TMJ sounds, masticatory muscle pain, TMJ pain and pain during movement of the mandible. The degree of TMD was assessed using the clinical dysfunction (Di) index of Helkimo (1974a). The intensity of facial pain was measured by a numerical rating scale (NRS), the patients being asked to evaluate the intensity of pain by assigning scores from 0, “no pain”, to 10 “the worst pain imaginable” (Downie *et al.* 1978). The subjects were classified into three subgroups depending on their type of disorder, as described in chapter 4.1.3.

Five (20 %) patients had complete dentition and 16 (64 %) had partial dentition. Four (16 %) patients were totally edentulous, having complete dentures in both jaws. Three (3/16) patients with partial dentition had a complete denture in the upper jaw and a partial denture in the lower jaw. At the first examination occlusal interferences were recorded, as described in chapter 4.1.3., and occlusion of the dentures was evaluated according to conventional methods used in prosthodontics (Basker *et al.* 1986).

The treatment of TMD included occlusal splint therapy, occlusal adjustment, muscular exercises and prosthetic treatment, if needed. All pathological conditions diagnosed clinically or roentgenologically in the teeth or jaws were also treated (Table 1, Paper V). Clinical examinations of the masticatory system and recording of the NRS score were also performed 1-2 weeks, three months and one year after treatment, and 22 subjects attended the one-year follow-up.

4.3 Statistical analyses

4.3.1 Studies on questionnaires

The prevalences of facial pain and other symptoms were calculated by gender. The relationships between facial pain, TMD symptoms as well as intermaxillary relationships, traumas and other pain symptoms were described by Odds ratios (OR) and their 95 % confidence intervals (CI). The prevalences among women were compared to those among men with risk differences (RD) and their 95 % CIs (Paper I) .

The prevalences of depression indicated by the SCL-25 DS and reported depression were compared between subjects with and without symptoms of TMD (Paper III), and the prevalence of alexithymia between subjects with and without orofacial pain and symptoms of TMD (Paper IV), stratified by gender. The total number varies between different variables because of missing data. The Chi-Square test was used to analyse the relations of the variables. The crude and adjusted (including marital status, education and self-rated health in Paper III, and marital status, self-rated health and depressiveness indicated with the SCL-25 DS in Paper IV) ORs and 95 % CIs were calculated in the model.

4.3.2 Case-control study

Odds ratios and 95 % CIs, matched by gender, were used to assess the associations of anamnestic data, Di of Helkimo, occlusal interferences and findings of the musculoskeletal examination with facial pain (Paper II). In addition, a conditional logit model was used to estimate the degree of influence of each variable on facial pain when the other variables were controlled. Different combinations of uncorrelated independent variables were analysed. After consideration, known confounding factors and statistically significant ($p<0.05$) dependent variables remained in the reported model.

4.3.3 Clinical study on referred facial pain patients

In Paper V, the medians of the total Di and NRS index were compared between different points of time (before treatment and 1-2 weeks, 3 months and 1 year after treatment), and the correlation between the number of occlusal interferences with the number of painful masticatory muscles was evaluated. The results were analysed using Friedman's two-way ANOVA, Spearman's rank correlation (r_s), Cochran's Q test, McNemar's test, Kruskal-Wallis test and Wilcoxon signed ranks test (Paper V). With binary variables measured at four different points of time Cochran's Q test was used and, if needed, pairwise comparisons of different timepoints were made by McNemar's test. With ordinal variables (such as NRS index) the Kruskal-Wallis test and Wilcoxon signed ranks test were used.

5 Results

5.1 Prevalence and gender distribution of facial pain

According to the data obtained from the computer-aided questionnaire, the prevalence of reported facial pain was 12.2 % among men and 17.9 % among women (Table 1 in Paper I). 84.3 % of the subjects reported facial pain "now and then", 13.3 % "fairly often", and 1.5 % "often or continuously". The prevalence levels among women were significantly higher than among men (RD 5.7, 95 % CI 3.9-7.6) (Table 1 in Paper I).

5.2 Facial pain and TMD

5.2.1 Facial pain and subjective symptoms of TMD

The most usual TMD symptom was clicking in the temporomandibular joint (21 % in men, 28 % in women). Eleven percent of the men and 13 % of the women reported TMJ pain at jaw rest, and also TMJ pain on jaw movement. 6 % of the men and 11 % of the women reported difficulties in mouth opening. Women reported clickings in the TMJs and difficulties in mouth opening significantly more often than men (RD 6.9, 95 % CI 4.7-9.1, RD 4.3, 95 % CI 2.9-5.7, respectively) (Table 1 in Paper I). According to the computer-aided questionnaire (Paper I), all the reported TMD symptoms had a relation to facial pain (Fig.1 in Paper I).

5.2.2 Facial pain and clinical findings of TMD

5.2.2.1 Case-control study

Fifty percent of the cases and 19 % of the controls showed moderate (DiII), and 21 % of the cases and 10 % of the controls severe (DiIII) signs of TMD. The association between TMD, including either DiII or DiIII class severity, and facial pain was significant (OR 6.1, 95 % CI 2.6-14.2) (Table 2 in Paper II). Thirty-seven (71 %) of the cases were classified in the myogenous, 2 (4 %) in the arthrogenous, 8 (15 %) in the combined, and 5 (10 %) in the non-classified subgroup of TMD (Table 1 in Paper II).

5.2.2.2 Clinical study on referred facial pain patients

Nine (36 %) of the facial pain patients had mild dysfunction (DiI) at the first examination, 11 (44 %) had moderate dysfunction (DiII) and 5 (20 %) had severe dysfunction (DiIII) (Paper V). Fifteen (60 %) patients were classified in the myogenous TMD group, one (4 %) in the arthrogenous TMD group and nine (36 %) in the combined TMD group. At the first examination the highest level in the NRS index was in the myogenous TMD group (median 6, range 4-9), while the values were 5 (range 2-6) and 5 in the combined TMD and arthrogenous TMD groups, respectively (Fig. 2 in Paper V).

5.3 Occlusion

According to the computer-aided questionnaire (Paper I), 1-2 % of the subjects reported ”lower jaw forward”, and about 5 % ”lower jaw clearly backward” (Table 1 in Paper I), of which the latter was related to facial pain in both genders (OR 1.8, 95 % CI 1.2-2.8 in men, OR 2.0, 95 % CI 1.4-2.8 in women) (Fig. 2 in Paper I).

In the case-control study (Paper II), the number of PTR interferences associated significantly with facial pain (OR 5.8, 95 % CI 1.8-18.8) (Table 3 in Paper II).

In the clinical study (Paper V), severe MTR interferences, i.e. contacts on both sides, correlated with pain on palpation of the right (r_S=-0.48, $p<0.05$) and left (r_S=-0.42, $p<0.05$) masseter muscles, and with pain on palpation in left medial pterygoid muscles (r_S=0.38, p=0.06).

5.4 Traumas

According to the computer-aided questionnaire (Paper I), the number of facial fractures (i.e., fractures in the upper or lower jaw, or other facial fractures) was 4 % among men and 1.5 % among women. The number of ”other facial traumas” was 14 % among men

and 6 % among women, and 3 % of the men and 4 % of the women reported trauma in the TMJ (Table 1 in Paper I). Among women, facial pain related to reported facial fractures (OR 2.9, 95 % CI 1.6-5.4), and in both genders to traumas in the face (OR 2.1, 95 % CI 1.6-2.7 in men, OR 2.3, 95 % CI 1.7-3.2 in women) or TMJs (OR 3.2, 95 % CI 2.0-5.2 in men, OR 4.4, 95 % CI 3.0-6.6 in women) (Fig. 3 in Paper I). In the case-control study (Paper II), no associations were found between facial pain and reported traumas.

5.5 Other pain symptoms and musculoskeletal findings

According to the computer-aided questionnaire, the prevalence of pain in other areas, i.e. teeth, jaw, neck, shoulder, arm and lower back, had a relation to facial pain (Fig. 4 in Paper I). In Paper II, the VAS on stiffness of the neck was higher in cases (mean 38.3 mm, SD 25.4 mm) than in controls (mean 24.4 mm, SD 24.4 mm), although the difference was not significant (Table 3 in Paper II). According to the pain drawings, neck pain was defined in 73 % of cases and 55 % of controls (p=0.06). Clinically, facial pain associated significantly with tenderness of the right FM 2 (OR 2.7, 95 % CI 1.2-6.2) and the left FM 2 (OR 2.8, 95 % CI 1.1-6.9) and the left FM 4 (OR 3.4, 95 % CI 1.2-9.6). In addition, the ranges of cervical movements were slightly lower in the case than in the control group, the differences being not significant (Table 3 in Paper II).

5.6 Effect of treatment of TMD on facial pain and clinical signs of TMD

In the patient sample (Paper V), the median of the total Di score before treatment was 6 (range 2-17). A significant decrease in Di was noted 1-2 weeks after treatment ($p<0.001$, Wilcoxon match-pairs test) (median 3, range 0-17) and the score remained at this level for three months ($p<0,01$) (median 3, range 0-13) and one year ($p<0.01$) (median 3, range 1-16) after treatment (Fig. 3, Paper V). The NRS index decreased significantly in the myogenous TMD group 1-2 weeks (median 6, range 0-6) ($p=0.001$ Wilcoxon signed ranks test), three months (median 1, range 0-6) ($p=0.001$) and one year (median 3, range 2-6) ($p<0.01$) after treatment compared with NRS index registered before treatment (median 6, range 4-9). In the other groups no significant changes were found (Fig. 2 in Paper V).

A significant decrease was noted in the amount of painful left-sided masseter ($p<0.05$, Cochran's Q test) and medial pterygoid ($p=0.05$) muscles during the time of follow-up. Clinical findings of the TMJs can be seen in Table 3, Paper V. At the first examination TMJ pain on palpation and pain during mandibular movements was more severe in the left than in the right TMJ. A slight decrease in TMJ sounds was found gradually in the right TMJ during the treatment. A slight increase in mandibular movements was also seen during the one-year follow-up (Table 4 in Paper V).

5.7 Facial pain, TMD symptoms and depression

In both genders, the proportion of depression, measured with the indicators used, was higher in subjects with symptoms of TMD compared with non-symptom subjects (Table I in Paper III).

The number of reported clickings associated significantly with SCL-25 DS among men (OR 1.4, 95 % CI 1.1-1.9) and women (OR 1.4, 95 % CI 1.1-1.7). The prevalence of depression indicated by SCL-25 DS was significantly higher in subjects with facial pain than in non-pain subjects among men (OR 1.9, 95 % CI 1.4-2.7) and women (OR 2.3, 95 % CI 1.8-2.9). Significant associations were found between SCL-25 DS and the symptom "pain at jaw rest" among men (OR 2.2, 95 % CI 1.6-3.0) and women (OR 1.9, 95 % CI 1.4-2.4), and in the "pain on jaw movement" among men (OR 2.0, 95 % CI 1.4-2.8) and women (OR 1.4, 95 % CI 1.1-1.9). "Difficulties in mouth opening" associated significantly with SCL-25 DS in both genders (OR 2.0, 95 % CI 1.3-3.1 among men, OR 1.6, 95 % CI 1.2-2.1 among women). After adjusting for marital status, education and self-rated general health, the associations remained significant, except in "pain on jaw movement" and "difficulties in mouth opening" among women (Table 1 in Paper III).

Reported clickings associated significantly with recognized depression among men (OR 1.6, 95 % CI 1.0-2.7). Women with facial pain reported significantly higher amounts of diagnosed depression than women without pain (OR 2.9, 95 % CI 2.0-4.1), and the same tendency was noted in "pain at jaw rest" (OR 2.1, 95 % CI 1.4-3.2) and "pain on jaw movement" (OR 1.9, 95 % CI 1.2-2.9). The corresponding levels among men were lower, the differences being significant in "pain at jaw rest" (OR 2.0, 95 % CI 1.2-3.6). After adjusting, the associations remained significant, except in "difficulties in mouth opening" among women (Table 1 in Paper III).

5.8 Orofacial pain, TMD symptoms and alexithymia

Among men, alexithymia associated significantly with facial pain (OR 1.8, 95 % CI 1.2-2.6), difficulties in mouth opening (OR 2.0, 95 % CI 1.3-3.2), oral and lingual pain (OR 1.7, 95 % CI 1.3-2.4) and dental pain (OR 1.8, 95 % CI 1.4-2.4) (Table I in Paper IV). In men with these symptoms, the proportion of alexithymia was 1.6-1.8 times higher than in men with no symptoms. After adjusting for depressiveness, marital status and self-rated health, difficulties in mouth opening, oral and lingual pain and dental pain associated significantly with alexithymia (Table 1 in Paper IV).

Among women, pain on jaw movement and dental pain had a significant association with alexithymia (OR 1.7, 95 % CI 1.1-2.6, OR 2.0, 95 % CI 1.4-2.9, respectively), and the relations remained significant after adjusting. Alexithymia in women with these symptoms was 1.7-1.9 times more common than in women with no symptoms (Table 1 in Paper IV).

6 Discussion

6.1 Methodological considerations

6.1.1 Subjects

When estimating prevalences, the best data sources are samples that represent the general population (Uhari & Nieminen 2000). The study reported here, concerning the prevalence of facial pain and TMD symptoms, included in the Northern Finland Birth Cohort 1966 (Paper I), consisted of a representative sample of 31-to-32-year-old adults. The age of the subjects is of special interest, since many investigations have shown that the majority of patients seeking treatment for TMD are between 20 and 50 years old (Carlsson 1999). The large size of the sample of the birth cohort minimized the effect of low power concerning the sample size. Further, the large, unselected, geographically representative, general population sample also minimized selection, referral, information, and recall bias.

The selection criteria of the cohort subjects into clinical examination (Paper II) were based on the same condition concerning facial pain in 1997 and in 2000, which is why the pain reported by the cases can be regarded as chronic, corresponding to a highly constant pain-free period of the controls. The purpose of these criteria was to exclude short-term, temporary pain conditions from the study, based on a statement that in tests for differences inside a population, comparisons should be made between the least symptomatic and the most ill (Alanen & Kirveskari 1990). However, due to the limitations of the large set of the general medical questionnaire (Paper I), the adjustment of the question concerning facial pain, provided from the pen-micro questionnaire, did not give any information about the chronicity or severity of the pain.

The weakness of the clinical part of the study (Paper V) was the small size of the sample. However, the follow-up time of one year restricted the size of the sample achieved, taking into consideration the chances of the clinical study in practice. The purpose of the study was to select patients who had facial pain as a main symptom, and were not typical TMD patients. However, the diagnosis of TMD was suspected by the doctors who referred the patients to the Oral and Maxillofacial Department of Oulu

University Hospital for diagnostic examination and treatment of TMD, which had a selective effect on the sample. Patients participating in the clinical study had suffered from a chronic pain condition, and most of them had gone through various examinations by different medical specialists before a referral to stomatognathic consultation. Another problem was the absence of the control group. Because of ethical reasons, however, the use of the control group, i.e. chronical facial pain patients with signs and symptoms of TMD who would be left untreated, was not possible. As pointed by Ferrari & Leonard (1998), the types of active treatment modalities often administered to TMD patients preclude the use of double-blind designs. Despite the limitations, however, the clinical study gives suggestions about the effect of conservative treatment of TMD, over a reasonably long period of time.

6.1.2 Methods

In the population-based study (Papers I-IV), attention was focused to consider the confounding factors as well as was possible. A number of studies have shown an interaction between TMD symptoms and gender and age (Agerberg & Inkapööl 1990, Salonen *et al.* 1990, Dworkin & LeResche 1993, Jensen *et al.* 1993, Lipton *et al.* 1993). The cohort sample in the present study was homogenous, concerning age. In the analyses (Papers I, III, IV), the influence of gender was controlled by stratification. When investigating the associations between psychological factors and facial pain (Papers III, IV), controlling of the confounding variables was based on the analysis in which the possible confounding factors were evaluated. The higher prevalence of facial pain among women compared to men found in Paper I (18 % vs. 12 %) was the reason for the randomization of the control group for gender in study II. The same gender distribution was considered to be more important than a possible decrement in statistical power.

Psychiatric structured self-report inquiries, i.e. the Symptom Checklist-25 (SCL-25) as an indicator of depressiveness (Paper III), and Toronto Alexithymia Scale-20 (TAS-20), indicating alexithymia (Paper IV), were used in the study. The Symptom Checklist-25 depression subscale is a method that has been used in all Nordic countries in a large population study (Lehtinen *et al.* 1995). The Toronto Alexithymia Scale (TAS)-20 is the most widely used and obviously the most carefully validated (Bagby *et al.* 1994a,b). Further, the use of Helkimo's indices (Papers II and V) indicating severity of TMD is a method frequently used in epidemiologic studies, and provided the possibility to compare the results with those of other studies.

Besides prevalences of facial pain and TMD symptoms, the epidemiological part of the study (Papers I, III-IV) investigated the associations of facial pain with different variables, i.e. TMD, other pain conditions and psychological factors. Although problems may arise from information bias (subjectivity) when using questionnaires, this possible bias should not be selective. Because of the cross-sectional study design, these associations were described without the possibility to test the chronological order of the suspected cause and effect, and therefore no conclusions about the causality between the variables could be made.

When using questionnaires, several considerations may result in information bias. The reported prevalences should be proportionate to the wording of the questions and the suggested descriptors, which are always open to individual interpretation (Goulet *et al.* 1995). Memory of pain has also been shown to be poor (Jamison *et al.* 1989), and the variability in the intensity of TMD pain over time (Raphael & Marbach 1992) may contribute to the variation in reported prevalence estimates. In the present study, the question concerned facial pain during the period of the preceding year, while those concerning TMD symptoms comprised no time period. After comparisons of the frequencies between the positive answers concerning facial pain, all positive answers (i.e. "now and then", "fairly often" and "often or continuously") were combined as "yes".

Before the clinical examinations of the study (Papers II, V), the examiner (K.S.) went through a calibration at the University of Oulu together with another experienced clinician (A.M.R.) to increase the validity and reliability of observations. In the present study all stomatognathic examinations were performed by the same dentist, and the musculoskeletal examinations by the same therapist, but intraexaminer variations were not measured due to the practical difficulty of arranging repeated visits. It can also be pointed out that the unawareness of both the subjects and the clinicians of the case-control status decreased the possibility of information bias (Paper II).

6.2 Prevalence of facial pain and TMD symptoms

In the age group of 31-32-year-olds, facial pain was reported by 12 % of men and 18 % of women, and TMJ pain (i.e. pain at jaw rest or on jaw movement) by 11 % of men and 13 % of women. The mildest symptom of TMD, i.e. clicking of the TMJ, was the most commonly and difficulties in mouth opening the least commonly reported symptom (Table 1 in Paper I). Because of a wide variety of age ranges in most epidemiological studies concerning TMD, the prevalence levels of these subjects 31-32 years old should be compared with other studies of corresponding age. When comparing prevalences between studies, the differences in methods should be taken into account, and the reported prevalences should be proportionate to the wording of the questions and the suggested descriptors (Goulet *et al.* 1995). Our results are in agreement with the study of Wänman (1996) who found prevalences of mild (AiI) and severe (AiII) symptoms of TMD to be 26 % and 12 %, respectively, in subjects 28 years old, when using questionnaires. However, lower levels have been reported by De Kanter *et al.* (1990), who found prevalences of moderate or severe symptoms of TMD to occur only in 5 % of 30-34-year-olds. When comparing the prevalences of separate symptoms of TMD, the present study corresponds to several population-based studies. Salonen *et al.* (1990) found that TMJ pain on mandibular movement was reported by 7 %, and head and/or facial pain by 11 % of subjects in the age group 30-39 years. Despite differences in methodology, our results are also close to the results of Von Korff *et al.* (1988), who found the six-month prevalence of facial pain to be 10 % among males and 18 % among females in the age group 25-44 years. Instead, frequent or occasional pain in the jaws or face during chewing has been reported by as many as 44 % of 35-year-old subjects (Magnusson *et al.* 2000).

Concerning also other symptoms of TMD, our results are between the levels of other population-based studies. The prevalence of reported TMJ sounds in 25-35-year-olds have been found to vary from 15 % to 38 % (Agerberg & Bergenholtz 1989, Duckro *et al.* 1990, Magnusson *et al.* 2000), and difficulties in mouth opening from 4 % to 13 % (Locker & Slade 1988, Goulet *et al.* 1995, Magnusson *et al.* 2000). Doubt has been cast on the relevance of TMJ clicking for the TMD diagnostic criteria (Salonen *et al.* 1990, Raphael & Marbach 1992, Goulet *et al.* 1995, Könönen *et al.* 1996), and the presence of sounds to joint pathology remains uncertain, except when radiologic findings show frank pathology (Dworkin *et al.* 1990a). Due to these considerations, the clickings of the TMJs were not taken into account when classifying the subgroups of TMD in the clinical part of the study (Paper V).

6.3 Gender differences

Among women, the prevalence of TMD symptoms was higher than among men, and facial pain was reported approximately 1.5 times more commonly by women than by men (Paper I). Although the ratio in the present study was lower than the ones found in other population-based studies in this age group (Agerberg & Inkapööl 1990, Salonen *et al.* 1990, Glass *et al.* 1993, Lipton *et al.* 1993, Magnusson *et al.* 1993, Levitt & McKinney 1994, Wänman 1996), the difference was significant and indicates a higher prevalence of this symptom among women in the general population. In order to explain the gender differences, the role of female reproductive hormones (LeResche *et al.* 1997b, Dao *et al.* 1998), the higher sensitivity of women to painful stimuli (Riley *et al.* 1998b, Bassols *et al.* 1999, Riley & Gilbert 2001), higher scores of stress among women (Kuttila *et al.* 1998) and differences in care-seeking behavior (Bush *et al.* 1993) as well as in coping and emotions (Riley and Gilbert 2001) have been proposed.

6.4 Association between facial pain and TMD

An association between facial pain and symptoms of TMD was noted in the non-selected population-based sample (Paper I), and between symptoms and clinical findings of TMD in facial pain cases (Paper II). Additionally, in the patient sample (Paper V), an effect of conservative treatment of TMD on pain relief was found. These findings indicate an association between TMD and facial pain. The finding also underlines the clinical experience that TMD are multisymptomatic (Magnusson *et al.* 2000). Further, facial pain condition seems to be mostly of myogenous origin in which the pain intensity may also be higher than in other groups. However, muscular pain seems to have the most favorable prognosis in response to conservative treatment of TMD.

Of the patients, 64 % had moderate or severe symptoms of TMD, according to Helkimo's index (Paper V). This finding is supported by the study of Knutsson *et al.* (1989), where the age and sex distribution of patients with chronic orofacial pain was

close to our study. They reported that more than half of the patients presented a TMD diagnosis, and that pain had eased in half of the patients in a one-year follow-up.

The proportion of the moderate or severe TMD was even higher in facial pain cases than in patients (71 % vs. 64 %) (Paper II). This finding gives rise to emphasizing the role of TMD in the facial pain condition in the general population as well, although these samples are not comparable due to a different age distribution. According to expectations, these levels are higher than those reported by Helkimo (1974b) from the normal population, using the same method. He found that 14 % showed moderate, and 24 % severe dysfunction in the age group of 25-34 year-olds. As was expected, the prevalences of moderate or severe TMD in the control group (19 % and 10 %, respectively) (Table 1 in Paper II) were lower than Helkimo's (1974b) findings. However, they were clearly higher than levels in later studies from normal population, from 1 % to 12 % in the age group of 35-year-olds (Salonen 1990, Kuttila *et al.* 1998, Magnusson *et al.* 2000). The finding that TMD signs occur quite frequently even in pain-free population, confirms the theory that the presence of signs does not necessarily tell much about the subjects' disability. It has been stated that some persons with severe dysfunction do not report subjective symptoms at all (Wedel 1988). On the other hand, the high amount of severe and moderate TMD in controls may be due to the possible selectivity of the subjects into the examination, where other symptoms than pain could have an effect on the willingness to participate in the study.

Both the clinical (Paper V) and epidemiological (Paper II) parts of the study show the role of myogenous involvement to be important in facial pain. The finding that over half of the patients belonged to the myogenous group (Paper V) is in agreement with the results of List and Dworkin (1996) who reported that approximately 76 % of patients with TMD have a muscular disorder. However, others have found approximately equal proportions of myogenous vs. arthrogenous subgroups in patient (De Leeuw *et al.* 1994b) and population-based (Kuttila *et al.* 1998) samples. The differences found between the studies may be due to the variability in diagnostic criteria used, and also to the age differences between the samples, in the way that the subjects of the present study were younger than in the others. In the study of Kuttila *et al.* (1998), TMJ clickings were taken into consideration when classifying subjects into the arthrogenous group, while in the present study they were excluded from the criteria. Further, in the study of De Leeuw *et al.* (1994c), pain during active movements of the TMJs or the masticatory muscles was included in the criteria.

The intensity of pain seems to be higher in the myogenous TMD compared with the arthrogenous or combined TMD subgroups (Paper V). These findings are in accordance with the report of McCreary *et al.* (1991) who found higher pain levels in patients with myogenous TMD than with arthrogenous TMD. In contrast, De Leeuw (1994c) found no difference in the pain intensity between these two groups. In addition, reduction of pain was most effective in the myogenous group, which indicates the most positive prognosis with regard to treatment outcome in this group. The result is in contradiction with the study of Scholte *et al.* (1993) who found that patients with mainly myogenous TMD responded less favorably to treatment than those with mainly arthrogenous TMD. Further, these differences are probably due to the variability in the classification criteria for TMD subgroups between the studies.

6.5 Role of occlusion in facial pain

Although the significance of occlusal interferences in the etiology of TMD has been questioned (De Boever *et al.* 2000a), the findings of the present study suggest an association between posterior tooth interferences and facial pain. In the clinical examination included in the case-control study, an association between PTR interferences and facial pain (Paper II), and in the patient sample, a correlation between severe MTR interferences and masticatory muscle pain on palpation (Paper V), was found. These findings support the finding of Kerstein and Farrell (1990), who found a link between the length of time that posterior teeth disclude and masticatory muscle contraction levels. PTR interferences have also been reported by Williamson and Lundquist (1983) to sustain a high level of muscle activity by diminishing the rest period for muscular recovery between contractions. In addition, complete anterior guidance in order to reduce the disclusion time has been described by Kerstein and Farrell (1990) as a successful method of lessening muscle activity in the masseter and temporalis muscles, and of reducing chronic pain symptoms. Additionally, experimental occlusal interferences have been reported to cause changes in the myoelectric contraction pattern of the muscles of the mandible and, at least in short term, to increase signs and symptoms of TMD (Christensen & Rassouli 1995).

An interesting point of view was the relation of reported ”lower jaw clearly backward” to facial pain, according to the computer-aided questionnaire (Paper I). Although understanding and interpreting these kinds of questions may cause a large spectrum of variations and make the diagnostic significance questionable, the result may suggest a correlation of type Angle II-malocclusion with facial pain. This connection has been suggested by clinical studies of Raustia *et al.* (1995b) and Henrikson *et al.* (2000), although in a population-based study of Kitai *et al.* (1997) no correlation between malocclusions and TMD symptoms was found. In any case, no conclusions of the association can be drawn based on the questionnaire, and additional examinations are needed to clarify the connection in the cohort sample.

6.6 Role of traumas in facial pain

Previous traumas were related to reported facial pain according to the computer-aided questionnaire (Paper I), while no connection was found in the case-control study (Paper II). This may be due to the low number of reported traumas, which makes comparisons in the smaller sample difficult. There may be doubt as to the clinical diagnosis of reported facial fractures (Paper I), and no conclusions about the connection with facial pain can be made. In contrast, traumas in the TMJ area were reported more frequently, and the association with facial pain was notable. This finding is in agreement with previous studies from patient (Pullinger & Seligman 1991) and population-based samples (Seligman and Pullinger 1996, Kamisaka *et al.* 2000) that have shown a connection between previous traumas and TMD.

6.7 Facial pain and generalized pain symptoms

Association of facial pain with reported pain in other areas (Papers I, II) confirms the suggestion that facial pain is, at least partly, a pain condition that shares the major characteristics of other chronic pain conditions (Allebring & Hagerstam 1993, Hagberg *et al.* 1994, Turp *et al.* 1998, Hedenberg-Magnusson *et al.* 1999). The relations of reported facial pain to pain in other areas of the body were approximately at the same level in both genders (Paper I). This finding is in contrast with patient studies that have found a connection with TMD and generalized pain to be stronger among women than among men (Hagberg *et al.* 1994, Korszun *et al.* 1998). Due to the population-based study design, the possibility of treatment-seeking effect was excluded, which may equalize the differences between the genders.

6.8 Facial pain and clinical musculoskeletal findings

Besides reported TMD symptoms (Papers I, II), a connection between reported facial pain and clinically assessed neck pain was also found (Paper II). These results are in agreement with studies from patient (de Wijer *et al.* 1996) and population-based samples (Wänman 1995, Ciancaglini *et al.* 1999). Several studies have found a functional relationship between the temporomandibular and cranio-cervical neuromuscular systems (Eriksson *et al.* 2000). Several ways of how pain originating in cervical structures can influence pain in the facial area have been suggested. The influence can be based on direct neural input from the upper cervical nerves, or referred pain due to the convergence of the afferent input. There are also certain functional relationships between the cranium, mandible and cervical spine, including postural and orthostatic stability of these systems (Okeson 1996).

6.9 Other factors related to facial pain

Stress was reported to provoke facial pain by 28 % of the facial pain patients (Paper V) and by 60 % of the cases in the case-control study (Paper II). This finding emphasizes the role of stress on facial pain especially in the younger age group, who may be mostly in their most stressful stage of life, concerning work and family life. This is in agreement with studies where stress has been found to associate with TMD (Niemi *et al.* 1993, Kuttila *et al.* 1997).

It has been suggested that excessive stress results in masticatory muscle hyperactivity which is expressed as parafunctional activities such as bruxism (Haber *et al.* 1983). In the study reported here, however, the equal levels of reported bruxism between facial pain cases and controls (33 % vs. 31 %) (Paper II) do not support the role of bruxism in facial pain of the subjects. Although diagnosis based merely on asking the subject is irrelevant because of the subjects' unawareness of their bruxism (Mohl *et al.* 1988), this finding may be based on the theory at present generally accepted that bruxism is a phenomenon

of centrally mediated neurologic activity related to sleep and sleep disorders, without any putative functional relationship with TMD (Lobbezoo & Lavigne 1997).

Although TMD constitute one of the major sources of orofacial pain, the most common cause of all is said to be dental pathology (Austin & Cubillos 1991). Of the cohort sample of our study, almost half of the subjects reported tooth pain, which also had a relation to facial pain (Paper I). The possibility of dental pathology must be taken into account in differential diagnosis when treating patients with facial pain. On the other hand, tooth pain can be referred from other parts of the masticatory system, especially muscles (Travell & Simons 1983).

Besides other factors, the association of allergies with facial pain (Paper II) suggests the role of allergies in the pain condition to be important. This finding may be supported by the study by Emschoff *et al.* (1999) which showed an association between maxillary pain and chronic mucosal inflammation of the maxillary sinus.

6.10 Facial pain and depressiveness

The association of pain-related symptoms of TMD to depressiveness was clearly seen (Paper III). Our results are in line with the earlier population-based study by VonKorff *et al.* (1988), involving 1,016 subjects. They found that subjects with facial pain showed a prevalence of 10 % of major depression, which was five times higher than in non-pain subjects. Further, in the population-based study of Vimpari *et al.* (1995) a connection between depression and TMD was found in 780 55-year-old subjects. In a longitudinal study at 3-year follow-up, VonKorff *et al.* (1993) found that persons with depressive symptoms were more likely to develop a chronic pain condition than non-depressive subjects. In the present study, however, it should be noted that information about the chronicity of the pain was not obtained.

It has been shown that chronic pain conditions and depressive disorders share some common pathophysiologic characteristics (Magni 1987). Several theories explaining the relation between pain and depression have been proposed, but the evidence to support any particular theory is scant. The clinical overlap of pain and depression has been explained with the anatomical coincidence of both nociseptive and affective pathways (Basbaum & Fields 1978). Norepinephrine and serotonine, the two neurotransmitters most implicated in the pathophysiology of mood disorders, are also involved in the gate-control mechanism of pain (Lindsay & Olsen 1985), and antidepressants have been found to have an effect on chronic pain (Lindsay & Olsen 1985). Some speculate that chronic pain conditions are variants of depression (e.g. "masked depression") (Lesse 1974), or that the stress of living with pain contributes to the onset of depression (Dohrenwend *et al.* 1999). Because of the cross-sectional study design, the present study does not give any information about the possible cause-effect-relationship between pain and depression. Interestingly, however, there were more frequently associations of TMD symptoms to positive SCL-25 than to recognized depression (diagnosed by a doctor). This finding may suggest that the connection between depression and TMD symptoms was not, at least primarily, based on the selective factors in treatment-seeking.

Negative emotions such as depression have been noted to associate more closely with pain among women than among men (Magni *et al.* 1990). In the present study, the more frequent relation of pain symptoms to reported depression among women compared with men suggests that these pain conditions may more commonly have a connection to psychopathology among women. However, the finding that the gender difference was observed especially in recognized depression, but not in depressiveness measured with SCL-25, may indicate that the differences may be due to the variability in care-seeking behavior between the genders, at least partly in depressive subjects.

6.11 Facial pain and alexithymia

Alexithymia seems to have a connection with certain symptoms of TMD and pain conditions in the oral area, which was observed even after controlling for depressiveness and sociodemographic background (Paper IV). The prevalence levels of alexithymia found in the present sample were 9.4 % in men and 5.2 % in women (Kokkonen *et al.* 2001). Taking into consideration the relatively low prevalence of alexithymia in the normal population, the large size of the sample gave the possibility to make comparisons between the groups.

The only published study concerning TMD and alexithymia is by Heiberg *et al.* (1978), who found an association with the degree of alexithymic traits in patients with TMD. This study supports our findings, although it was performed with the method that at present is not comparable with modern concepts used in the measurement of alexithymia. The connection between alexithymia and oro-lingual pain, is supported by clinical studies where alexithymia has been linked with burning mouth syndrome (Jerlang 1997) and “glossodynia” (Miyaoka *et al.* 1996).

It is not clear how alexithymia may influence the phenomenology of the pain experience. Although alexithymia has been found to be related to increased illness behavior, it may not be related to the presence or severity of organic disease (Lumley *et al.* 1997b). One explanation is that affect regulation failure, which is linked with chronic pain, also exists in the background of alexithymia (Taylor 1997).

Comorbidity between alexithymia and depression has been found (Honkalampi *et al.* 2000). Jerlang (1997) has postulated that alexithymia is particularly related to disability when depression also occurs, explaining that patients express their negative feelings through physical symptoms. Based on this, the significant crude association between alexithymia and facial pain found in the present study may be explained.

6.12 Clinical implications

Facial pain is quite a common symptom, which has a negative impact on the quality of life and productivity (Turk & Rudy 1990, Dao *et al.* 1994a). The fact that patients with TMD initially seek care from physicians can be problematic because about 40 % of TMD patients may have been misdiagnosed by physicians (Glass & Glaros 1995). The

connection between facial pain and TMD should be emphasized especially when the patient seeks help from a general health practitioner.

Treatment should always be based on accurate clinical examination and diagnosis. In the treatment of TMD, basic attention should be given to conservative therapy, including occlusal splint therapy, occlusal adjustment and physical therapy, that facilitates the natural healing capacity of the musculoskeletal system, and to treatment that involves the patients in the physical and behavioral management of their own problem. In the occlusal treatment, one should pay special attention to occlusal interferences. Further, the role of traumas should be taken into consideration when treating patients with TMD, especially cases that are unresponsive to treatment. In these cases, additional examinations are needed in order to clarify the possible role of traumas in the TMJ involvement.

On the other hand, it should be noted that there can also be overlapping symptomatology between TMD and other medical disorders, such as other pain conditions and psychological problems. It appears that there may be a large "symptom iceberg" for many psychological and physical illnesses, suggesting that the decision to consult other specialists may depend on symptom severity in combination with complex psychological and social influences, or when no response to conservative treatment has been achieved. Nevertheless, the use of occlusal splints in the treatment of facial pain in the absence of evidence of TMD should not be embarked upon until medical examination has excluded the possibility of other diseases. There are numerous diseases that may be diagnosed incorrectly as TMD because of similar signs and symptoms, such as malignant diseases or infections, for example (Lader 1990, Telfer *et al.* 1990, Raustia *et al.* 1993).

Subjects with facial pain show a high comorbidity with other stress-associated disorders and depression. A team approach is often required for evaluating psychological disorders that may be present. Dentists can play an important role in the early diagnosis of these conditions by addressing generalized symptoms in their evaluation of patients with TMD. A multidisciplinary approach to chronic facial pain that cuts across the traditional boundaries of such medical disciplines as dentistry, otorhinolaryngoloy, neurology, rheumatology, gastroenterology, endocrinology, and psychiatry will lead to a more rational approach to diagnostic classification and treatment options for these complex symptoms.

Physicians may also mistake the physical symptoms of these patients for undetected organic pathology, which results in overestimation and overtreatment and frequently adds iatrogenic complications to the patient´s disorder. In treating patients particularly with unspecific pain symptoms in the orofacial and jaw region, clinicians should consider the possible association with psychological factors such as alexithymia and associated difficulties in emotional regulation, which may contribute to presenting symptoms, abnormal illness behavior, or maladaptive modes of emotion regulation.

This study provides support for the suggestion that in future individualizing treatments and outcome measures based on patient characteristics may improve treatment efficacy and outcome evaluation.

7 Conclusions

Facial pain is a common symptom in population. The prevalence of reported facial pain is higher among women compared with men. Heterogenous factors associate with the facial pain condition. It is strongly associated with symptoms and clinical findings of TMD. Local factors, such as occlusal interferences and previous traumas, especially in the TMJ area, seem to indicate a risk for facial pain. Besides local factors, however, facial pain can also be a part of a generalized pain condition in the body. Stress is reported to provoke facial pain in most of the cases. Additionally, psychological problems, i.e. depression and alexithymia, associate with the pain.

When TMD are suspected as a cause of facial pain, conservative stomatognathic treatment, and necessary prosthetic treatment, seems to be effective in relieving pain and decreasing clinical signs and symptoms of TMD in most of the patients with facial pain, especially of myogenous origin. This point of view may also be a useful approach for differential diagnosis of the facial pain itself.

If there is no response to conservative treatment, referral for additional consultations or examinations is indicated because of the possible overlapping symptomatology between TMD and other medical disorders, such as other pain conditions, especially in the neck area, and psychological disorders. In the more complicated pain conditions, especially those unresponsive to treatment, the role of psychological problems, such as depressiveness and alexithymic personality, should be suspected. The establishment of a multidisciplinary pain team can assist the medical practitioners in both diagnosis and treatment of these patients.

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