Psychosocial Profiles of Temporomandibular Disorder Pain Patients: Proposal of a New Approach to Present Complex Data

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Aims: To propose a visual method to screen and assess psychosocial functioning in temporomandibular disorder (TMD) pain patients in comparison with age- and gender-matched healthy controls by forming individual profiles and to evaluate the association between psychosocial profiles and quantitative sensory testing (QST) findings of TMD pain patients. **Methods:** TMD patients (n = 58) and control participants (n = 41) completed a set of questionnaires profiling their psychosocial function, and QST was performed at the temporomandibular joint (TMJ) on both sides of the face in all participants. Psychosocial parameters from the Research Diagnostic Criteria for TMD (RDC/TMD), Oral Health Impact Profile (OHIP), and Pain Catastrophizing Scale (PCS) instruments were transformed into T scores, and QST parameters were transformed into *z* scores based on reference data. Group differences for psychosocial T scores were analyzed with *t* tests. T scores of psychosocial parameters and *z* scores of QST parameters were correlated using Spearman's correlation (ρ). **Results:** Most (96.6%) TMD pain patients exhibited one or more parameters indicative of psychosocial distress, with psychological disability scores being the scores most frequently encountered outside the reference 95% confidence intervals (CI). TMD patients were psychosocially more distressed with regard to all psychosocial parameters compared with controls ($P < .009$). After Bonferroni corrections, a significant correlation was detected between the sleep dysfunction parameter and mechanical detection threshold (MDT) in TMD pain patients ($\rho = 0.427$, $P < .001$). **Conclusion:** T score psychosocial profiles created an easy overview of psychosocial function in TMD pain patients. Increased sensitivity to tactile stimuli was associated with higher sleep dysfunction T scores.
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Temporomandibular disorders (TMD) comprise a number of problems involving the structures in and around the temporomandibular joint (TMJ), the masticatory musculature, or both.[1] TMD is a major cause of nondental pain in the orofacial region.[2] Chronic musculoskeletal pain, by its nature, is associated with negative emotions and psychological distress,[3] and previous findings suggest that TMD is associated with several psychosocial disorders such as depression, anxiety, somatization, and some personality disorders.[4–7] There is extensive evidence that psychosocial factors have a substantial impact on pain persistence as well as on responsiveness to TMD treatment.[8–11] The psychological aspects are categorized as predisposing, initiating, and perpetuating factors of TMD.[12] Moreover, TMD can have a significant negative impact on quality of life.[13–15]

Several standardized self-report questionnaires assessing different dimensions of the psychosocial profile have been developed. Axis II from the Research Diagnostic Criteria for TMD (RDC/TMD) addresses pain intensity, pain-related disability, and psychosocial dysfunctions such as depression and somatization.[16,17] The Oral Health Impact Profile (OHIP) is widely used as an oral health–related quality of life (OHRQoL) instrument[13] and measures the oral health effects on psychosocial well-being.[13,18] Catastrophizing, which is one of the most important psychological predictors of pain experience, can be assessed

with the Pain Catastrophizing Scale (PCS).[19–21] Pain catastrophizing is defined as a negative cognitive-affective response to anticipated or actual pain.[19,22] Several studies have assessed psychosocial variables in TMD patients by comparing them between myofascial and arthrogenous TMD patients,[23–25] between subtypes of TMD based on the Graded Chronic Pain Scale (GCPS) from the RDC/TMD,[8] or before and after the treatment provided.[12,26] A few studies comparing the psychosocial variables between myofascial and arthrogenous TMD patients have demonstrated increased symptoms of psychosocial impairment in myofascial TMD patients,[23,27] but others have shown no differences between the two groups.[7,25] However, in most of these studies, the majority of patients included were of myofascial TMD origin, and TMJ pain patients were small in number.[23,28] Moreover, there is no method for visualization and easy interpretation of the complex psychosocial data in TMD pain patients.

Somatosensory disturbances such as increased pain sensitivity to external stimuli are frequent features of chronic pain,[29,30] and somatosensory abnormalities have been documented in chronic TMD arthrogenous patients.[31–33] Quantitative sensory testing (QST) is a widely accepted tool to investigate somatosensory changes in pain patients.[34] Psychological factors are involved in the perception of pain and, conversely, pain may dramatically affect psychological well-being,[35] implying that psychosocial factors may influence clinical pain and QST responses.[36] A few studies have shown associations between psychosocial variables and pain sensitivity in TMD patients.[37–39] However, studies based on QST in TMD pain patients have not consistently included a psychological assessment of their participants.

Therefore, the aims of this study were to propose a visual method to screen and assess psychosocial function in TMD pain patients in comparison with age- and gender-matched healthy controls by forming individual profiles and to evaluate the association between psychosocial profiles and QST findings of TMD pain patients. It was hypothesized that the proposed method of visualizing the psychosocial function in TMD pain patients would provide an easy yet comprehensive overview of complex psychosocial data in TMD patients compared with healthy controls and that there would be no association between psychosocial profiles and the QST findings of TMD pain patients.

Materials and Methods

Overview

This study was part of a previous study in which QST and conditioned pain modulation were assessed in TMD pain patients. Thus, the participants, study setting, and QST data used in this study were the same as those described previously.[40]

Study Participants

In this study, 58 TMD pain patients (48 women and 10 men) and 41 age- and gender-matched healthy controls (30 women and 11 men) participated. The mean (± standard deviation [SD]) age of the TMD pain patients was 37.2 ± 14.9 years (range 20 to 74 years), and the mean age of the healthy controls was 32.0 ± 11.9 years (range 20 to 61 years).[40] The study was performed at the Department of Dentistry, Aarhus University. TMD pain patients were recruited from the Section of Orofacial Pain and Jaw Function, Department of Dentistry, Aarhus University. The healthy participants were recruited by advertising on campus and around the University and on web pages. A clinical examination, including the RDC/TMD protocol, was performed on all participants prior to the study.[17,40] The healthy controls included in the study reported no signs or symptoms of TMD, rheumatologic disease, musculoskeletal disease, or any previous injuries that would interfere with normal somatosensory function, and all healthy controls were able to read and write. The inclusion criteria for TMD pain patients were: adults over the age of 18; TMD pain patients belonging to group IIIa (ie, TMJ arthralgia: spontaneous pain perceived from the TMJ region or pain in the TMJ on movements of the jaw, and pain on palpation of the lateral pole or posterior attachment of the TMJ on the same side) or group IIIb (ie, TMJ osteoarthritis: TMJ arthralgia along with either coarse crepitus in the joint or degenerative changes in the joint supported by cone beam computed tomography [CBCT] findings) from the RDC/TMD[17,40]; and patients reporting TMJ pain longer than 3 months.[40] In addition, comorbid diagnoses of myofascial pain (group I) and disc displacements (group II) with arthralgia or osteoarthritis from RDC/TMD classification were also accepted.[40] Exclusion criteria were TMJ pain conditions related to acute trauma, rheumatoid arthritis or other generalized joint conditions, and any physical or mental illness that would interfere with the ability to complete the study questionnaires. The study mainly focused on patients with TMJ pain (ie, TMJ arthralgia and osteoarthritis); however, as noted above, patients with additional diagnoses of groups I and II from the RDC/TMD classification were also included, and therefore the term TMD pain patients is used throughout the manuscript.[40] All participants gave their written informed consent prior to study participation. The study was conducted in accordance with the guidelines of the World Medical Association Declaration of Helsinki and approved by the local ethics committee in Central Denmark Region, Denmark.

Procedures

At the beginning of the study, all participants completed a set of questionnaires profiling the psychosocial condition. All questionnaires used in the study have previously been tested for validity and reliability.[13,19,41–43] A standardized battery of QST was then performed in all participants according to the German Research Network on Neuropathic Pain (DFNS) protocol.[40,44]

Questionnaires

RDC/TMD History Questionnaire (Axis II)

A Danish version of the RDC/TMD history questionnaire was applied and consisted of the following instruments: GCPS, depressive symptoms, nonspecific physical symptoms (with and without pain items), and symptoms of sleep dysfunction.[16,17] The GCPS assesses pain intensity and pain-related disability.[17] This scale is divided into the following five grades: 0 = no disability; grade I = low pain intensity with low disability; grade II = high pain intensity with low disability; grade III = moderately limiting pain intensity with high disability; and grade IV = severely limiting pain intensity with high disability.[45] The depressive symptoms instrument is based on the Depressive Symptom Scale of the Symptoms Checklist-90 Revised (SCL-90-R),[16] which consists of 20 items that are scored on a 5-point Likert scale. The average of the 20 items is taken as the total depressive symptom score.[16,17] The nonspecific physical symptom scale—ie, somatization scale, which is also based on the SCL-90-R—consists of 12 questions with pain items and 7 questions without pain items.[16,17] This scale is also scored on a 5-point Likert scale.[16] The sleep dysfunction scale consists of three items, is also scored on a 5-point Likert scale, and is also based on the SCL-90-R.[16,17] It is assessed by calculating the average score of the three questions measuring sleep disturbance (early morning awakening, difficulty falling asleep, and restless sleep).[16,17] The RDC/TMD history questionnaire provides a reliable and valid assessment of the above-mentioned psychosocial factors.[43] A detailed description of diagnostic and scoring criteria of Axis II instruments is available.[17]

OHIP-49 Questionnaire

OHRQoL was measured using the Danish version of OHIP-49.[46] This instrument consists of 49 questions distributed among 7 domains, which are functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.[13,46] For each question, the participants described how frequently the problem had occurred within the last month using six different possible answers and corresponding scores: very often (4), fairly often (3), occasionally (2), hardly ever (1), never (0), or I don't know[46] (in the case of this response, no score was given). The score for each question was multiplied by the relevant weight and summed within each domain to calculate seven subscale scores.[13] The overall OHIP score (OHIP-total) for each participant was calculated by adding the scores of the 7 subscales or summing the scores of the 49 answers.[13] Higher scores indicated a poorer quality of life.[47] This instrument has good reliability and construct validity.[13,42]

PCS

The PCS measures the degree of catastrophic thoughts about pain.[19] It consists of 13 items that are rated on a 5-point scale from 0 (not at all) to 4 (all the time).[19] The PCS total (PCS-total) score is most commonly used and is calculated by summing all the individual items.[19] It ranges from 0 to 52, and higher scores are indicative of greater pain-related catastrophizing thoughts.[41] It consists of three dimensions of pain catastrophizing: helplessness (items 1–5 and 12), rumination (items 8–11), and magnification (items 6, 7, and 13).[19] Subscale scores can also be calculated.[19] A Danish version of PCS was completed by the participants.[22] The psychometric properties of PCS have been shown to have good reliability and acceptable validity in both clinical and nonclinical populations.[19,41]

QST

QST was performed on the skin overlying the TMJ on both sides of the face in accordance with the standardized protocol of the DFNS in all the patients and healthy controls.[40,44] In patients, the test site was defined as the most painful side and the control site as the nonpainful or less painful side.[40] In healthy controls, the test site was defined as the dominant side.[40]

The standardized QST battery consists of 7 tests measuring 13 parameters that cover relevant nerve function.[48] For a detailed description of the protocol, see Rolke et al.[44] In the present study, the thermal tests consisted of six parameters: cold and warm detection thresholds (CDT, WDT), heat and cold pain thresholds (HPT, CPT), and the number of paradoxical heat sensations (PHS) during the thermal sensory limen (TSL) procedure of alternating warm and cold stimuli.[31,44,49,50] These tests were assessed using a PATHWAY thermal sensory testing device (MEDOC Ltd).[31,49,50]

Mechanical tests consisted of seven different parameters.[31,44,49,50] The mechanical detection threshold (MDT) was measured using a standardized set of von Frey filaments with rounded tips of 0.5-mm diameter (OptiHair2, MARSTOCK nervtest) that exerted forces ranging from 0.25 to 512 mN.[31,44,49,50] A standardized set of seven custom-made weighted pinprick stimulators (made at Aarhus University) were used to determine the mechanical pain threshold (MPT). These stimulators exerted forces between

8 and 512 mN (8, 16, 32, 64, 128, 256, and 512 mN) and had a flat contact surface of 0.2 mm.[31,44,50] Mechanical pain sensitivity (MPS) was assessed using the same pinprick stimulators used to determine the MPT to obtain a stimulus-response function.[31,44,50] Dynamic mechanical allodynia (DMA) was assessed as part of the test above. Three light tactile stimulators were used to assess DMA: a cotton wisp, a cotton wool tip (Q-tip) attached to a flexible handle, and a standardized brush (Somedic).[31,44,50] The wind-up ratio (WUR) for repetitive pinprick stimuli was determined using a custom-made pinprick stimulator, as mentioned above.[31,44,50] The stimulator that delivered a force the participant perceived as slightly painful was selected for the test.[31,44] Vibration detection threshold (VDT) was assessed using a Rydel-Seiffer graded tuning fork (64 Hz, 8/8 scale) placed over the bony prominence.[31,44] Pressure pain threshold (PPT) was measured using a digital pressure algometer (SOMEDIC AB) with a probe area of 1 cm^2.[31,44,49] A detailed description of the QST protocol used in this study has been described previously.[40]

Data Evaluation and Statistical Analyses

Transformation of Psychosocial Parameters into T Scores

The psychosocial parameters from the RDC/TMD Axis II history questionnaire (depressive symptoms, nonspecific physical symptoms with and without pain items, and symptoms of sleep dysfunction), OHIP (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, handicap, and OHIP-total), and PCS (helplessness, rumination, magnification, and PCS-total) were transformed into T scores. To compare a single patient's psychosocial profile with the group mean of the healthy controls, psychosocial data were also transformed into T scores.[16] For this, the data were first transformed into *z* scores using the expression: z score = $(Value_{single\ patient} - Mean_{controls}) / SD_{controls}$.[31,44] Both T scores and *z* scores are standardized scores. *z* scores can easily be transformed into T scores by multiplying the given *z* scores by 10 (SD of the distribution of T scores) and then adding 50 (the mean of the distribution of T scores). Therefore, after *z* score transformation, the expression: T score = 10(*z* score) + 50 was applied to the individual patient's data for each psychosocial parameter. A T score of 50 indicated an individual value corresponding to the group mean of the healthy controls[16]; T scores between 40 and 60 were considered the normal range (as defined by the mean ± SD).[16] Approximately two-thirds of the scores of the reference group were expected to fall within this normal range. A T score above 60 was considered higher than the healthy reference group. Furthermore, 95% of the distribution of healthy reference data were expected to lie within two SD values of the mean (in the present study, T scores between 30 and 70). Thus, scores above 70 were considered unusually high compared with the reference data and were termed as absolute psychosocial distress, while a T score below 30 was considered unusually low compared with the reference data.

z Score Transformation of QST Data

CPT, HPT, VDT, and PHS were normally distributed.[40] Due to skewed distribution, all other parameters were transformed logarithmically before analysis. A small constant (0.1) was added to all pain ratings (MPS, DMA) prior to calculating the logarithm to avoid a loss of zero values.[40] To compare a single patient's QST data profile with the group mean of the healthy controls (mean data from left and right TMJ pooled), the patient's data were *z* transformed for each single parameter using the following expression: z score = $(Value_{single\ patient} - Mean_{controls}) / SD_{controls}$.[40,44] After *z* transformation, all patients' QST data were presented as standard normal distributions (zero mean, unit variance).[48] Values were adjusted for signs in such a way that positive *z* scores indicated gain of somatosensory function, referring to when the patient was more sensitive to the test stimuli compared with controls (ie, hyperesthesia, hyperalgesia, allodynia), and negative *z* scores indicated loss of function, referring to a lower sensitivity of the patient (hypoesthesia, hypoalgesia).[51] A *z* score of 0 represented an individual value corresponding to the group mean of the healthy control subjects.[48] The *z* score 0 ± 1.96 represented the range that would be expected to include 95% of the healthy control subject data; therefore, any *z* scores outside the 95% confidence interval (CI) of healthy control data were considered absolute abnormalities.[40,51] Since DMA was absent in the healthy controls, this measure could not be transformed into *z* scores.[40,48]

Statistical Analyses

An unpaired *t* test was used to compare age between subject groups, and the gender distributions of the two groups were compared using χ^2 test. T score psychosocial data for each parameter were compared between the subject groups by using unpaired *t* tests. T scores of all psychosocial parameters were tested for possible correlations with the *z* scores of QST findings of the TMD pain patients at the test site (most painful side) by means of Spearman's correlation analyses (ρ) with Bonferroni correction for multiple comparisons.

All data are presented as mean ± SD values. For all tests, statistical significance was assigned at $P < .05$. Data were analyzed using Statistica software for Windows (StatSoft Inc).

Results

Participants

There were no significant differences in the age and gender distributions between the TMD pain patients and the healthy controls (age: $P = .061$; gender: $P = .294$).[40] All the included patients had TMD pain according to the clinical RDC/TMD protocol. Of the 58 TMD pain patients, 35 had unilateral pain and 23 had bilateral pain at the TMJ.[40] At the painful TMJ side, there were 30 patients with TMJ osteoarthritis (group IIIb) confirmed by CBCT imaging and 28 patients with TMJ arthralgia (group IIIa). A detailed description of clinical characteristics of the TMD pain patients has been provided previously.[40]

Table 1 Mean RDC/TMD Axis II, OHIP-49, and PCS Scores of Temporomandibular Disorder (TMD) Pain Patients (n = 58) Compared with Healthy Controls (n = 41)

Psychosocial parameter	Healthy controls Mean (SD)	TMD pain patients Mean (SD)	Group differences *P*
RDC/TMD Axis II			
Depressive symptoms	0.27 (0.2)	0.83 (0.7)	< .001
Somatization			
With pain items	0.24 (0.2)	0.93 (0.7)	< .001
Without pain items	0.09 (0.2)	0.65 (0.7)	< .001
Sleep dysfunction	0.46 (0.5)	1.30 (1.1)	< .001
OHIP			
OHIP-total	15.2 (12.5)	80.8 (44.3)	< .001
Functional limitation	4.4 (3.5)	12.7 (7.4)	< .001
Physical pain	6.3 (5.2)	23.6 (10.2)	< .001
Psychological discomfort	1.5 (2.4)	8.9 (6.8)	< .001
Physical disability	0.9 (1.6)	9.2 (8.2)	< .001
Psychological disability	0.7 (1.8)	13.3 (9.9)	< .001
Social disability	0.6 (2.2)	6.7 (7.1)	< .001
Handicap	0.8 (2.4)	6.2 (6.0)	< .001
PCS			
PCS-total	10.3 (9.9)	20.7 (11.0)	< .001
Rumination	4.5 (4.4)	7.0 (4.8)	.005
Helplessness	3.8 (4.1)	9.6 (5.3)	< .001
Magnification	1.8 (1.9)	4.1 (2.9)	< .001

RDC/TMD Axis II = Research Diagnostic Criteria for Temporomandibular Disorders; OHIP-49 = Oral Health Impact Profile; PCS = Pain Catastrophizing Scale.

Psychosocial Profiles

The mean values of Axis II instruments, OHIP-total along with the seven domains, and PCS-total with three dimensions in TMD pain patients and healthy controls are presented in Table 1.

This feasibility study of transforming raw psychosocial data into standardized T scores showed that most of the TMD pain patients (96.6%, n = 56) exhibited at least one or more psychosocial parameters indicative of psychosocial distress. The most frequent psychosocial distress parameters (outside 95% CI of the healthy reference data) found in the TMD pain patients were (in order of frequency): psychological disability in 84.5% (n = 49), handicap in 62.1% (n = 36), social disability in 60.3% (n = 35), physical disability and nonspecific physical symptoms without pain items in 58.6% (n = 34) each, OHIP-total in 56.9% (n = 33), nonspecific physical symptoms with pain items in 48.3% (n = 28), depressive symptoms in 36.2% (n = 21), helplessness in 32.8% (n = 19), psychological discomfort in 27.6% (n= 16), PCS-total in 24.1% (n = 14), and sleep dysfunction in 22.4% (n = 13). None of the patients had T scores above 70 for the parameters of physical pain, functional limitation, rumination, or magnification (Table 2). The individual psychosocial profiles of the TMD pain patients, shown as T scores, are illustrated in Fig 1. A few psychosocial parameters indicative of psychosocial distress were also found in healthy controls, with a total of 24.4% (n = 10) showing one or more values outside the 95% CI (Table 2).

Further, 98.3% (n = 57) of TMD pain patients had T scores above 60 for one or more psychosocial parameters, indicating that these scores were higher than the reference group. Frequency of T scores above 60 for each psychosocial parameter in TMD pain patients were (in order of frequency): psychological disability and OHIP-total in 87.9% (n = 51) each, psychological discomfort in 79.6% (n = 47), handicap and physical disability in 77.6% (n = 45) each, physical pain in 72.4% (n = 42), nonspecific physical symptoms with pain items in 70.1% (n = 41), nonspecific physical symptoms without pain items in 60.3% (n = 35), helplessness and sleep dysfunction in 58.6% (n = 34) each, depressive symptoms in 53.4% (n = 31), functional limitation in 48.3% (n = 28), PCS-total in 46.6% (n = 27), magnification in 39.7% (n = 23), and rumination in 20.7% (n = 12).

Comparison of the T scores of each psychosocial parameter between the subject groups revealed that, compared with healthy controls, TMD pain patients had significantly higher depressive symptoms scores ($P < .001$), sleep dysfunction scores ($P < .001$), and somatization scores ($P < .001$) (Table 2). The OHIP-total score and the scores of individual domains of TMD pain patients were significantly higher than for the control group subjects ($P < .001$) (Table 2). TMD pain patients exhibited significantly greater pain-related catastrophizing (PCS-total) compared with the healthy controls ($P < .001$). Ruminative thoughts, helplessness, and magnification were

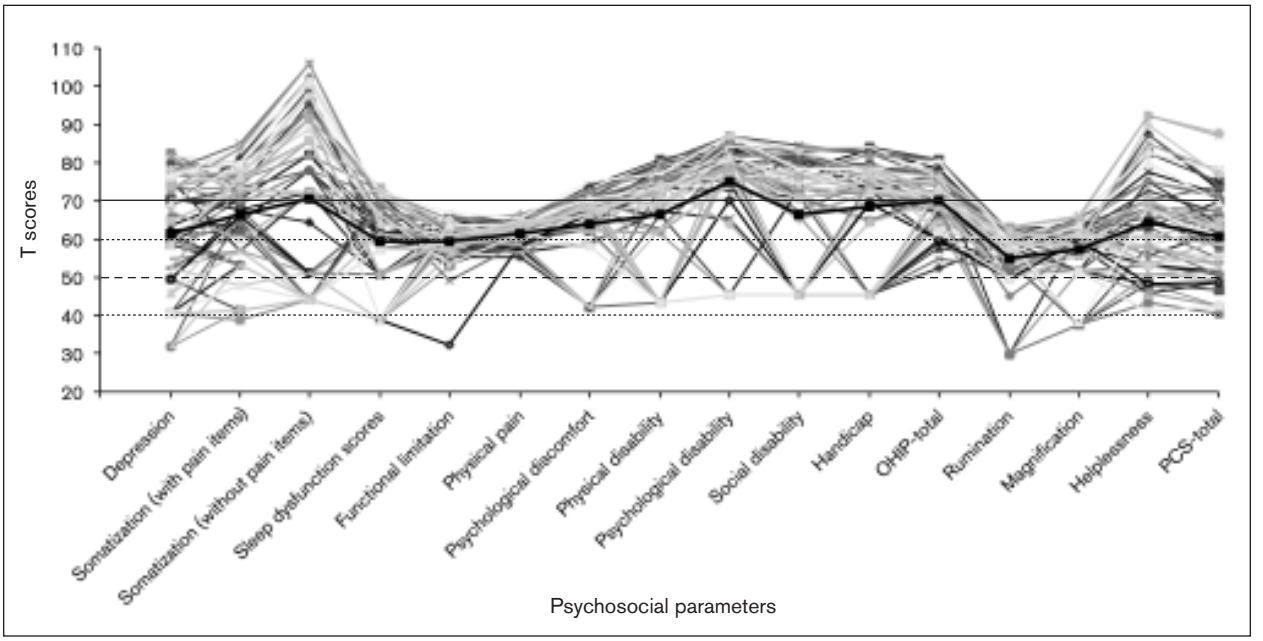

Fig 1 Individual T score psychosocial profiles of temporomandibular disorder (TMD) pain patients (n = 58). The mean psychosocial profile T score for all patients is indicated with a black line. A T score of 50 indicates the group mean of healthy reference data, and a T score between 40 and 60 indicates normal range. A T score above 70 (outside the 95% confidence interval) indicates psychosocial distress.

Table 2 Mean T Scores of Psychosocial Parameters of TMD Pain Patients Compared with Healthy Controls and Frequency of Patients and Healthy Controls Showing Psychosocial Distress

	Reference data (n = 41)		Patient data (n = 58)		
Psychosocial parameter	T score mean (SD)	Distress[a] n (%)	T score mean (SD)	Distress n (%)	Group differences *P*
SCL-90-R depression scale scores	50 (10)	1 (2.4)	61.6 (14.3)	21 (36.2)	< .001
SCL-90-R somatization scale scores					
With pain items	50 (10)	1 (2.4)	66.2 (12.3)	28 (48.3)	< .001
Without pain items	50 (10)	2 (4.9)	70.4 (21.9)	34 (58.6)	< .001
SCL-90-R sleep dysfunction score	50 (10)	2 (4.9)	59.3 (11.6)	13 (22.4)	< .001
OHIP-total	50 (10)	1 (2.4)	70.2 (6.6)	33 (56.9)	< .001
Functional limitation	50 (10)	0 (0.0)	59.3 (5.6)	0 (0.0)	< .001
Physical pain	50 (10)	0 (0.0)	61.5 (2.8)	0 (0.0)	< .001
Psychological discomfort	50 (10)	0 (0.0)	64.1 (9.5)	16 (27.6)	< .001
Physical disability	50 (10)	1 (2.4)	66.4 (13.2)	34 (58.6)	< .001
Psychological disability	50 (10)	3 (7.3)	75.2 (12.3)	49 (84.5)	< .001
Social disability	50 (10)	3 (7.3)	66.6 (15.1)	35 (60.3)	< .001
Handicap	50 (10)	1 (2.4)	68.3 (13.2)	36 (62.1)	< .001
PCS-total	50 (10)	1 (2.4)	60.5 (11.0)	14 (24.1)	< .001
Rumination	50 (10)	0 (0.0)	55.0 (9.0)	0 (0.0)	.009
Helplessness	50 (10)	0 (0.0)	64.4 (13.2)	19 (32.8)	< .001
Magnification	50 (10)	0 (0.0)	57.3 (7.8)	0 (0.0)	< .001

[a]Distress is indicated by a T score above 70.

significantly more common among TMD pain patients compared with the healthy controls ($P < .009$) (Table 2).

Correlations

The results of QST in the TMD pain patients and healthy controls have been previously reported,[40] and the same QST data are utilized in this study. Correlation analyses between the T scores of psychosocial parameters and *z* scores of the QST parameters at the test site of the TMD pain patients showed that there was a significant positive correlation between the T scores of sleep dysfunction and *z* scores of MDT ($\rho = 0.427$; $P < .001$). T scores of functional limitation were significantly negatively correlated with *z* scores of CDT ($\rho = -0.270$; $P = .039$), WDT ($\rho = -0.327$; $P = .012$), and MPS ($\rho = -0.334$; $P = .010$) and positively correlated with *z* scores of

MPT (ρ = 0.300; P = .021). Also, T scores of physical pain were negatively correlated with z scores of TSL (ρ = −0.268, = .041) and MDT (ρ = −0.324, P = .013). Psychological discomfort T scores were negatively correlated with z scores of MPS (ρ = −0.364, P = .005) and WUR (ρ = −0.295, P = .024). There was also a negative correlation between T scores of physical disability and z scores of MPS (ρ = −0.330, P = .011). T scores of OHIP-total and rumination were positively correlated with z scores of PPT (ρ > 0.274; P < .037). However, considering a .004 significance level after Bonferroni corrections, all the correlations were eliminated except for the positive correlation between T scores of sleep dysfunction and z scores of MDT (ρ = 0.427; P < .004).

Discussion

This study has proposed a new method for assessment and visualization of psychosocial function in TMD pain patients in comparison to healthy controls by forming individual psychosocial profiles using T scores. The study thus represented a feasibility study of transforming self-reported measures of pain and psychosocial status of TMD pain patients from raw scale score data to standardized T scores. The majority of the TMD pain patients (96.6%) were psychosocially distressed compared to age- and gender-matched healthy controls and exhibited at least one or more parameters indicative of psychosocial distress. In addition, this study evaluated associations between the psychosocial profiles and somatosensory function in TMD pain patients. No correlations were found between the QST findings and psychosocial parameters except for a correlation between the sleep dysfunction parameter and z scores for mechanical detection sensitivity (ie, MDT).

Psychosocial Profiles

The literature suggests the psychosocial aspects of TMD assessment are important for treatment planning and in predicting treatment outcomes, thus lending support to the need for a thorough psychosocial assessment of TMD patients.[52] Therefore, this study evaluated a wide range of psychosocial variables in TMD pain patients in comparison to healthy controls. The psychosocial variables assessed in this study included GCPS, depressive symptoms, somatization levels, and sleep dysfunction from the RDC/TMD Axis II history questionnaire, OHIP-total and its domains from OHIP-49, and PCS. Many studies have assessed single or multiple psychosocial parameters—including the above-mentioned variables—in both myogenous and arthrogenous TMD patients[53,54]; however, none of the studies have proposed a method of visualizing the complex psychosocial data to create an easy yet comprehensive overview in TMD pain patients. Moreover, interpretation of the raw psychosocial data would be difficult if multiple psychosocial parameters and their variability across age and gender are taken into account.

Interestingly, for the first time, this feasibility study proposed a method of assessing and examining the complex psychosocial data in TMD pain patients by forming individual psychosocial profiles. These profiles were created by transforming a patient's raw psychosocial data into standardized T scores. A T score is a statistical measurement of a score's relationship to the mean in a group of scores; hence, the psychosocial profile of a given patient can be more conveniently displayed as a T score, where each individual parameter is related to patient age and gender-specific reference range and displayed as the number of SDs above or below the normal mean. Further, the interpretation of T scores also depends on the direction of the scale used. For example, certain psychosocial measuring instruments, such as Rand-36, behave differently. In this instrument, higher scores indicate higher levels of functioning or well-being,[55] which is opposite to the instruments employed in the present study, where higher scores indicate a more serious problem or increased psychosocial distress. In instruments such as Rand-36, a T score below 30 can be considered unusually high and T score above 70 can be considered unusually low. Further, T scores can also evaluate the patient's centile position relative to the normative data. Thus, a T score of 60, regardless of the symptom dimension, will place an individual in the 84th percentile of the normative sample; a score of 70 places the individual at approximately the 98th percentile.[16] This kind of data presentation will provide at-a-glance identification of patterns of psychosocial distress in patients. Moreover, it appears that none of the TMD studies reported in the literature have used this approach, and therefore its usefulness and validity have not yet been demonstrated.

Therefore, the results of the present study are preliminary findings of the feasibility of transforming raw psychosocial data of TMD pain patients into standardized T scores. However, this approach is a well-established and commonly used method for psychological testing in clinical psychology.[56] Advantages of the T scores are that they are easy to interpret, that constructing individual profiles of patients, which is a typical clinical matter, can be done using T scores, and that T score transformation ensures that all subscales and the total score can be interpreted along the same scale with the same mean and SD, even though they initially had different numbers of items and different nontransformed

means. Therefore, it is proposed that using T scores to evaluate psychosocial parameters in TMD patients in comparison to healthy individuals could be a useful new way to get an overview and assess psychosocial function. In addition, these psychosocial profiles may be useful for monitoring changes in psychosocial function over time and also for comparing psychosocial variables between different groups of patients.

The results of the present study showed that 96.6% of the TMD pain patients presented with parameters indicative of psychosocial distress compared to the age- and gender-matched reference group. The most common psychosocial distress identified in TMD pain patients was psychological disability, a domain of OHIP. Only a few studies have evaluated different domains of OHIP in TMD patients. Most of the studies have employed only OHIP summary scores to assess OHRQoL in TMD patients, the disadvantage being several functional, emotional, psychological, and social impacts due to pain are described with only one score, thus losing important information relevant for treatment planning and evaluation.[57,58] In the present study, different domains of OHIP were also evaluated in addition to the OHIP summary score. Moreover, studies evaluating different domains of OHIP along with summary scores have only compared mean scores and subscores between the TMD patients and controls[59]; none have specified the frequency of occurrence of these domains. In addition to psychological disability, handicap and social disability were seen frequently in 62.1% and 60.3% of the TMD pain patients, respectively. Further, TMD pain patients showed significantly higher scores for OHIP-total—as well as for its domains—compared with healthy controls, indicating that TMJ pain may have a significant impact on OHRQoL. Previous findings also suggest that TMD patients experience more decreased OHRQoL than patients in almost any other dental subgroup.[54] The results of the present study are in line with previous studies using the OHIP-49, with TMD patients showing significant levels of impairment compared to the control group.[54,57–59] Thus, OHIP with its domains can comprehensively assess a variety of functional and psychosocial consequences of TMJ pain.

In addition, psychological impairment in the form of depressive symptoms and somatization have also been assessed in TMD patients in several studies using RDC/TMD Axis II. These studies showed increased stress, depressive symptoms, and somatization in patients compared with healthy controls.[60,61] The present study also demonstrated increased levels of depression and somatization in TMD pain patients compared with healthy controls. A few studies comparing psychometric characteristics between arthrogenous and myogenous TMD patients have suggested that there are differences between these two groups, but some studies have shown no differences.[7,23,25,27] However, the present study was not designed to compare the psychosocial parameters between different TMD subgroups; instead, the objective was to propose a method for visualization of the complex psychosocial data. Research suggests that, in addition to general psychological distress, catastrophizing may be another important cognitive factor that affects the perception of and response to persistent pain.[41] It has been described that in patients with TMD, catastrophizing may contribute to the chronification of pain and disability.[62] Consistent with the literature findings, TMD pain patients in the present study reported higher levels of catastrophizing compared with controls.[9,37,63] For the four psychosocial parameters, none of the patients exhibited T scores above 70. However, the majority of the patients had scores between 60 and 70 for these parameters, indicating that they had significantly higher scores than the controls. Thus, the psychosocial findings in the present study correlate with and strengthen the current perception that TMD is a complex condition, no longer regarded solely as a localized orofacial pain condition and best viewed within a biopsychosocial model of illness that involves a combination of biologic, psychological, and social factors.[64,65]

Psychosocial parameters indicative of psychosocial distress were also found in a few healthy controls, with a total of 24.4% showing one or more values outside the 95% CI. Based on the simple calculation of the chance probability of being healthy and having at least 1 of the 16 values being outside the 95% CI ($(1 - 0.95^{16}) = 55.9\%$), this frequency is actually lower than would be expected. This finding may nevertheless be considered one of the disadvantages of the comprehensive psychosocial profiles.

Correlations

In the present study, correlations were performed to evaluate the possible association between the psychosocial parameters and QST findings. Moreover, information about the association between psychological vulnerability and pain outcomes, and the differentiation between state and trait psychological variables, is important when possible interventions such as cognitive behavioral therapy or identification of possible high-risk patients are to be conducted.[66] In the present study, significant correlation was found only between the T scores of the sleep dysfunction parameter and the *z* scores for mechanical detection sensitivity in TMD pain patients, indicating that increased sensitivity to tactile stimuli is associated with higher sleep dysfunction. However, studies have shown no changes in detection threshold of nonnociceptive modalities, including MDT, in subjects with

total sleep deprivation, although they have shown sleep deprivation can be associated with hyperalgesia to nociceptive parameters.[67,68] However, these studies were conducted in healthy participants and not in TMD patients. It is possible that the correlation found in the present study may be a chance finding.

No other robust significant correlations were found between the T scores of psychosocial parameters and *z* scores of QST parameters at the test site of the TMD pain patients. Moreover, the results from the literature are also inconsistent, with one study associating situational pain catastrophizing with greater sensitivity to experimental pain in TMD patients,[37] and another study showing no correlation between the levels of nonspecific physical symptoms—excluding pain items and PPT—in a group of painful TMD patients.[69] Further studies may be needed to clarify this issue. Nevertheless, the lack of association between subjective measures of pain—ie, between QST findings and psychosocial parameters, as found in the present study—also parallels the findings of no association between objective findings (radiographic findings) and subjective measures of pain (psychosocial parameters).[70] Thus, this implies that not all chronic pain patients may suffer from psychosocial distress, and not all persons with psychosocial disorders may develop pain. However, assessment of psychosocial parameters is important, as it can provide information on prognosis and management.

The present study had some limitations that should be taken into account. First, the sample size was relatively small, and the patients recruited were mostly from a tertiary care unit. Because of these limitations, the results of the present study cannot be generalized to the general population. Importantly, this study did not aim to set normative generalizable values for each of the psychosocial parameters. Rather, as a feasibility study, it aimed at proposing application of a well-established psychometric approach for convenient and illustrative visualization of complex psychosocial data in TMD pain patients. Third, the patient group was larger in size than the control group. In studies where psychosocial functions are evaluated in patients, a large control group is considered optimal to have better control over the psychosocial parameters, which can be influenced by the self-reported measures. However, in the present study, QST was also performed, which requires age- and gender-matched cases and controls. Therefore, a larger patient group was included to match for age and gender of the controls. Fourth, due to the relatively small sample size, correlations were not analyzed using regression models, which are considered the best approach for analyzing multiple correlations having a single dependent variable. Finally, the reliability and validity of the psychosocial profile approach of this study were not tested, and this may be considered a weakness. However, as mentioned before, this was not the main objective of the study; moreover, all the questionnaires used in this study are reliable and validated. In addition, the reliability of the T scores, like *z* scores, is mathematically very closely related to the reliability of the absolute values of the scale used for each questionnaire.[71] Further studies with larger sample sizes are warranted to overcome these limitations.

Conclusions

T score psychosocial profiles provided a feasible method for at-a-glance evaluation of psychosocial distress in TMD pain patients compared with age- and gender-matched healthy controls. The profiling of the wide range of psychosocial parameters provided a simple yet comprehensive way of obtaining an overview on complex psychosocial data, thereby facilitating easy interpretation. The results showed that TMD pain patients had significantly poorer OHRQoL than healthy controls. TMD pain patients had elevated scores of depressive symptoms, somatization, sleep dysfunction, and increased levels of catastrophic thoughts, which is consistent with previous findings. Thus, the findings support the current perspective that TMD is multidimensional, with a combination of physical, psychological, and social factors contributing to the overall presentation of this disorder. However, further studies with larger sample sizes and adequate controls are required to determine whether the findings can be applied to the general population. Nevertheless, with the use of T scores, easy visualization of psychosocial status of TMD pain patients was accomplished and could possibly be useful in evaluation of management effects in TMD pain patients.

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