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## Article

# Is the Course of Headache Complaints Related to the Course of Orofacial Pain and Disability in Patients Treated for Temporomandibular Pain? An Observational Study

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**Featured Application:** Due to the close relationship between painful TMD and migraine, changes in one of the disorders, for example after treatment, may have a positive effect on the other disorder. Physiotherapists can use this knowledge to apply a more personalized intervention aimed at both disorders, and possibly collaborate with other health professionals for the treatment of subjects with TMD and headaches.

**Abstract:** Migraine, tension-type headache (TTH) and headaches attributed to temporomandibular disorders (TMD) are prevalent in patients with TMD-pain. The objective was to describe the course of headache complaints as compared to the course of TMD complaints in TMD-pain patients with headache during usual care multidisciplinary treatment for TMD. This was a 12-week longitudinal observational study following adults with TMD-pain and headache during a usual-care multidisciplinary TMD-treatment. The Graded Chronic Pain Scale was used for both TMD and headache to measure pain-related disability (primary outcome measure), pain intensity, days with pain and days experiencing disability (secondary outcome measures). Stratified for the headache type, general linear modelling for repeated measures was used to analyze changes over time in the TMD complaints and the headache complaints. TMD-pain patients with migraine ( $n = 22$ ) showed significant decrease of pain-related disability for both TMD and headache complaints over time. No difference in the effect over time was found between the two complaints. Patients with TMD-pain and TTH ( $n = 21$ ) or headache attributed to TMD ( $n = 17$ ) did not improve in disability over time. For the secondary outcome measures, the results were equivocal. In conclusion, TMD-pain patients with migraine, improvement in TMD-related disability was comparable to headache-related disability for TMD-pain patients with TTH or with headache attributed to TMD, no improvements in disability were found.

**Keywords:** temporomandibular disorder; orofacial pain; headache; migraine

## 1. Introduction

One in ten adults in the general population reports the presence of pain in the temporomandibular region [1], which could be an indication for a painful temporomandibular

disorder (TMD) [2]. TMDs are disorders involving the temporomandibular joint, the masticatory muscles and associated structures [2]. Symptoms include orofacial pain, limited function of the masticatory system and joint sounds [2]. Pain in the orofacial region is the main reason patients seek care for their TMD complaints [3], and is often accompanied by other pain complaints [4,5]. One of the most common comorbid conditions in TMD-pain patients is headache, with prevalence ranging up to 83% [6,7]. The most prevalent types of headaches in TMD-pain patients are tension-type headache (TTH; 22–30%), migraine (17–55%) and headache attributed to TMD (5–19%) [6–8]. Despite its high co-occurrence, there seems to be no association between the presence of TTH and TMD; i.e., the prevalence of TTH in TMD patients does not seem to exceed the prevalence of TTH in the general population [6,9]. In contrast, studies have consistently reported migraine to be more prevalent in TMD-pain patients as compared to patients with a function-related TMD, or no TMD at all [6,7,9].

In line with the reported association between the TMD-pain and migraine, studies have shown that TMD treatment has promising outcomes on headache complaints in TMD-pain patients with concomitant migraine [10,11]. Additionally, for headache attributed to TMD, TMD treatment is reported successful in the decrease of the headache complaints [12]. For TMD-pain patients with concomitant TTH, however, no information is available on the effect of TMD multidisciplinary treatment on the headache complaints.

To better understand the associations between different types of headaches and TMD-pain, a longitudinal study following changes in severity of various types of headaches in relation to changes in the TMD complaints is warranted. Therefore, the aim of this study was to describe the course of headache complaints as compared to the course of TMD complaints in TMD-pain patients with various types of headaches (i.e., TTH, migraine, or headache attributed to TMD), during a 12-week usual care treatment period based on a multidisciplinary approach.

## 2. Materials and Methods

### 2.1. Study Design, Ethics and Registration

A longitudinal observational study was used to monitor TMD-pain patients with headache during a 12-week treatment period in which they received usual care for their TMD complaints. This design was chosen to enhance the possibility to detect changes in their complaints and therefore to provide sufficient contrast between patients for the statistical analyses. As part of the usual care, patients received a patient-tailored treatment plan that consisted of an explanation on the diagnosis and etiology, counseling, including pain education (in all cases) and advice about how to decrease oral behaviors (when indicated), splint therapy (in case the patient reported sleep-related bruxism) and jaw exercises (in case the patient reported day-time oral behaviors, muscle tension or joint mobility problems) [13]. After consent on the treatment plan, patients saw one to three specialists (dentist, physiotherapist, psychologist), each up to three times, during the 12-week study period. The end of the study was not necessarily the end of their treatment program, which could last up to one year. The study was approved by the Ethical Committee of Academic Center for Dentistry Amsterdam (ACTA) (file number 2017006). All participants signed an informed consent form before inclusion. This study has been registered in the Netherlands Trial Register (NTR6368).

### 2.2. Study Population

Patients that sought treatment at the Orofacial Pain and Dysfunction (OPD) clinic of ACTA from October 2016 to May 2018 were invited for the study. In the OPD clinic, a multidisciplinary team collaborates in diagnosis and treatment of mostly chronic orofacial pain patients. The team consists of dentists, physiotherapists and a psychologist, all specialized in orofacial pain and dysfunction.

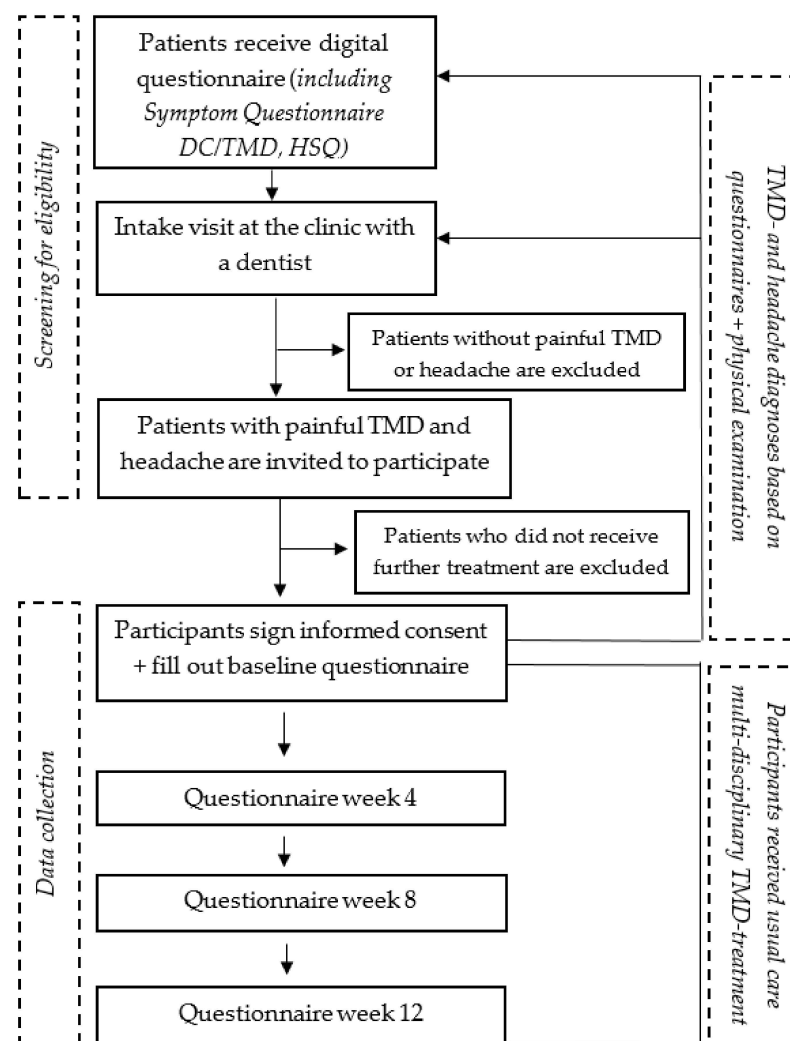
Patients were eligible when they had: (1) TMD-pain diagnosis; (2) headache complaints in the last year; (3) >18 years old; and (4) the ability to communicate in Dutch or

English. Patients were excluded if: (1) no treatment was started at the OPD clinic; (2) their pain was dental-related; and/or (3) their headache was not classified as TTH, migraine or headache attributed to TMD.

### 2.3. Flow of the Study

Before the intake visit, patients filled out a digital questionnaire including all questions from the Diagnostic Criteria for TMD (DC/TMD) axis II [14], as well as the Headache Screening Questionnaire (HSQ) [15]. At the intake visit, one of the dentists performed a standardized clinical examination, as part of the regular intake procedure, including all physical tests as described in the DC/TMD [14], and invited the patients who fulfilled the in- and exclusion criteria to participate in the study.

Included patients then received a baseline study questionnaire (either on paper or digital, dependent on the preference of the patient). The same questionnaire was sent by e-mail at four, eight and twelve weeks after the intake visit (see Figure 1). A reminder was sent within one week by e-mail when the patient did not fill out the questionnaire. If there was still no response, patients were contacted up to two times via telephone call. If patients did not return the baseline or the 12-week (endpoint) questionnaire, they were excluded from the analyses.



**Figure 1.** Flow of the study design, portraying each step the participants take within this study. DC/TMD: diagnostic criteria for temporomandibular disorders; HSQ: headache screening questionnaire.

#### 2.4. TMD-Pain

Patients were diagnosed with TMD-pain when they met the DC/TMD criteria for myalgia and/or arthralgia [14]. The sensitivity of the DC/TMD for TMD-pain diagnoses is 0.86 and the specificity is 0.98 [14]. The TMD-pain diagnoses of the DC/TMD are characterized by pain in the masticatory system which is aggravated by function or parafunction, and can be replicated during the physical examination.

#### 2.5. Headache

TTH and migraine were classified with the HSQ [15]. This questionnaire is based on the International Classification of Headache Disorders 3rd edition (ICHD-3) and screens for the presence of TTH and migraine [15,16]. A patient was classified with either TTH or migraine when they obtained at least 6 (out of 8) points of that type of headache on the HSQ. The sensitivity and specificity of the HSQ are 92% and 48%, respectively for TTH, and 89% and 54% for migraine [15]. In case an equal HSQ score was present for TTH and migraine ( $\geq 6$  points), the patient was classified with migraine [15,16]. Concurrent headaches were noted for descriptive purposes.

Headache attributed to a TMD was established according to the DC/TMD criteria: TMD pain combined with headache complaints in the temporal region which are modified or provoked by oral function [14,17]. When patients fulfilled both the criteria of TTH or migraine and a headache attributed to TMD, the patient was classified as having a headache attributed to a TMD, according to the IHS recommendation [16].

#### 2.6. Outcome Measures

Patients received the Graded Chronic Pain Scale (GCPS) questionnaire [18], which is one of the DC/TMD recommended self-reported measurement instruments to score the severity of the current pain. The GCPS is a reliable measurement instrument for patients with TMD and for patients with headache (reliability coefficients ranging from 0.67 to 1.00) [18,19]. Patients were instructed to rate two sets of GCPS scores: eight questions for the TMD pain as well as for the headache complaints. The questionnaire is available as a Supplementary Material. No further explanations were given to the patient by the dentist or the researcher, other than the standardized written instructions on the questionnaire. The following GCPS outcome measures were extracted for the TMD complaints and for the headache complaints: (1) disability score (DS)—primary outcome; (2) characteristic pain intensity (CPI); (3) days with pain; and (4) days with disability.

The DS is the average score of the three disability questions (i.e., social, work and home life). The CPI score is the average score of the three questions regarding pain intensity (i.e., current, maximum, and average pain). The frequency of the TMD pain complaints and headaches was assessed with the outcome measures 'days with pain' and 'days with disability'. Days with pain represents the number of days with pain experienced in the last 30 days, while days with disability represents the number of days in the last 30 days the patients perceived an impact on their life from their pain complaints [18].

#### 2.7. Statistical Analysis

Descriptive statistics were used to characterize the study population. All the outcome measures were normally distributed and presented with means and standard deviations. The study population was stratified by type of headache: migraine, TTH or headache attributed to a TMD. For each subgroup, and for each outcome measure, a general linear modeling with repeated measures (GLM-RM) analysis was applied. This analysis shows whether (1) there are differences in the outcome measures between the TMD complaints and the headache complaints (within-subjects effect), (2) there are changes in the complaints over time (within-subjects effect), and (3) there is evidence for a different effect in change over time between the TMD complaints and the headache complaints. When changes over time are found, and no difference in effect over time between the TMD and headache complaints is shown, this is interpreted as 'a comparable course of TMD complaints and headache complaints over

time'. Analysis of the data was performed using the Statistical Package for the Social Sciences (IBM SPSS) version 24.0 (SPSS Corp, Chicago, IL, USA). In case of missing outcomes of the intermediate time points (i.e., the 4-week and the 8-week measurement), multiple imputation was applied using a linear regression model for scale variables. To account for an increased type-I error rate associated with multiple comparisons, we used Simple Interactive Statistical Analysis (<http://www.quantitativeskills.com/sisa/calculations/bonfer.htm> accessed on 21 August 2021) to calculate an adjusted alpha for each headache subgroup. This adjusted Bonferroni correction is based on the mean correlation between the outcome measures, which was calculated using R statistical software. These correlations and the adjusted alphas were  $r = 0.018$  and  $p < 0.018$  for TMD-pain patients with migraine,  $r = 0.024$  and  $p < 0.024$  for patients with TTH and  $r = 0.017$  and  $p > 0.017$  for patients with headache attributed to TMD [20].

For the DS, a clinically significant change is suggested to be 2 points [21]. A post hoc power calculation was performed using G\*power [22] to check if the number of patients was sufficient to show a clinically significant change based on the estimates presented in this study.

### 3. Results

#### 3.1. Study Population

Seventy TMD-pain patients provided informed consent for study participation, seven patients were excluded due to missing headache classification from the patient file and three were excluded because they failed to return the 12-week questionnaire. From the included 60 patients, 83.3% were female and the age ranged from 18 to 71 years. Myalgia was the most common TMD-pain subtype (61.7%), followed by a combination of myalgia and arthralgia (30.0%) and arthralgia alone (8.3%). Migraine was present in 36.5% of the sample, TTH in 35% and headache attributed to a TMD in 28.3% (Table 1). Based on the post hoc power calculations with the standard deviation found in the present study (i.e.,  $SD_{pooled} = 2.6$ ), power of 80% and  $\alpha = 0.05$ , the sample size needed to show a clinically significant change was 16. All headache groups consisted of more than 16 participants each.

**Table 1.** Baseline demographic and diagnostic characteristics of the study population.

	Overall Study Population (n = 60)	TMD-Pain and Migraine (n = 22)	TMD-Pain and TTH (n = 21)	TMD-Pain and Headache Attributed to TMD (n = 17)
<b>Age; mean <math>\pm</math> sd</b>	41.3 $\pm$ 14.2	46.9 $\pm$ 13.2	39.0 $\pm$ 13.8	36.8 $\pm$ 14.3
<b>Gender; n (%)</b>				
Female	50 (83.3)	20 (90.9)	15 (71.4)	15 (88.2)
Male	10 (16.7)	2 (9.1)	6 (28.6)	2 (11.8)
<b>TMD pain subtype; n (%)</b>				
Myalgia	37 (61.7)	13 (59.1)	13 (61.9)	11 (64.7)
Arthralgia	5 (8.3)	2 (9.1)	3 (14.3)	0 (0.0)
Combined myalgia and arthralgia	18 (30.0)	7 (31.8)	5 (23.8)	6 (35.3)
<b>Headache; n (%)</b>				
(Probable) migraine	36 (60.0)	22 (100)	2 (9.5)	12 (70.6)
(Probable) TTH	48 (80.0)	12 (54.5)	21 (100)	15 (88.2)
Headache attributed to TMD	17 (28.3)	0 (0.0)	0 (0.0)	17 (100)
<b>Duration of TMD pain; n (%)</b>				
<1 year	10 (16.7)	6 (27.3)	3 (14.3)	1 (5.9)
1–10 years	26 (43.3)	7 (31.8)	12 (57.1)	7 (41.2)
>10 years	13 (21.7)	3 (13.6)	3 (14.3)	7 (41.2)
Missing	11 (18.3)	6 (27.3)	3 (14.3)	2 (11.8)

SD: standard deviation; n: number of patients; TMD: temporomandibular disorder; TTH: tension-type headache.

Descriptions of the four outcome measures for TMD and headache are illustrated in Table 2. At baseline, the mean score for the DS was  $3.4 \pm 2.9$  for TMD and  $4.7 \pm 2.8$  for headache. At week 12, DS was  $2.2 \pm 2.4$  for TMD and  $2.9 \pm 2.6$  for headache.



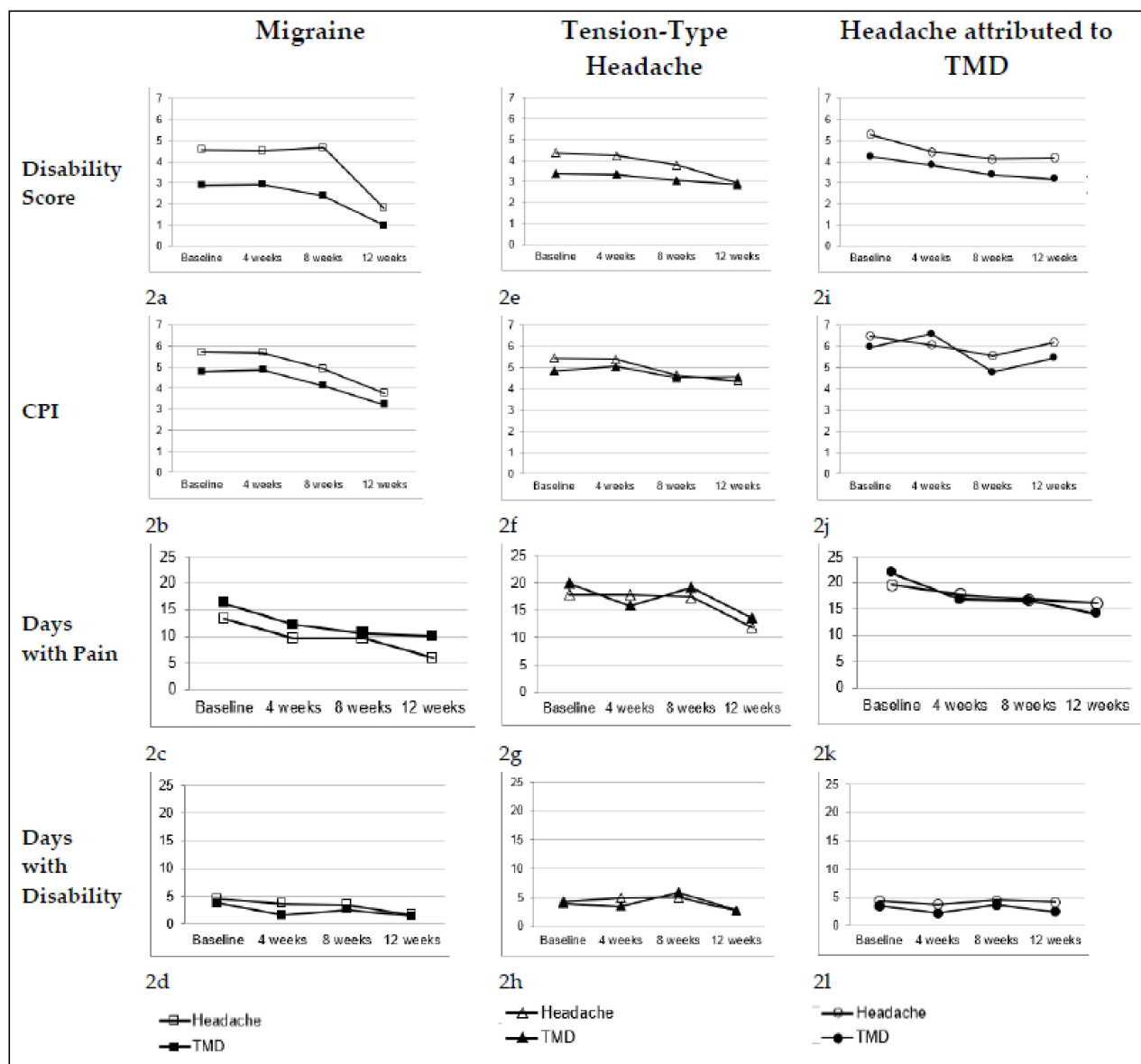
**Table 2.** Descriptions and general linear modeling of the Graded Chronic Pain Scale on baseline, week 4, week 8 and week 12 for the complaints related to TMD-pain and to headache.

Outcome Measure	Type of Pain Complaint	Baseline Mean ± sd	Week 4 Mean ± sd	Week 8 Mean ± sd	Week 12 Mean ± sd	Difference between Complaints F ( <i>p</i> -Value)	Change over Time F ( <i>p</i> -Value)	Difference between Complaints over Time F ( <i>p</i> -Value)
Migraine (N = 22)								
Disability Score (0–10)	TMD complaints	2.9 ± 3.1	2.9 ± 2.4	2.4 ± 2.8	1.0 ± 1.1	17.162 (0.000)	8.707 (0.001)	1.928 (0.159)
	Headache complaints	4.6 ± 3.0	4.4 ± 2.7	4.7 ± 3.4	1.8 ± 2.0			
CPI (0–10)	TMD complaints	4.8 ± 2.6	5.0 ± 2.6	4.1 ± 2.3	3.2 ± 2.0	2.740 (0.113)	6.229 (0.004)	0.578 (0.637)
	Headache complaints	5.7 ± 1.6	5.7 ± 1.7	4.9 ± 1.8	3.8 ± 1.7			
Days with pain (0–30)	TMD complaints	16.2 ± 11.1	11.9 ± 8.4	10.6 ± 8.1	10.0 ± 9.4	3.470 (0.077)	4.378 (0.017)	2.236 (0.117)
	Headache complaints	13.3 ± 8.8	9.3 ± 5.7	9.6 ± 5.3	5.8 ± 3.6			
Days with Disability (0–30)	TMD complaints	3.8 ± 6.0	1.6 ± 2.0	2.6 ± 3.6	1.4 ± 2.9	4.448 (0.047)	1.724 (0.196)	0.920 (0.450)
	Headache complaints	4.6 ± 5.8	3.7 ± 5.0	3.5 ± 4.2	1.6 ± 2.9			
Tension-Type Headache (N = 21)								
Disability Score (0–10)	TMD complaints	3.4 ± 2.8	3.2 ± 3.0	3.1 ± 2.6	2.8 ± 2.8	5.072 (0.036)	2.111 (0.135)	1.352 (0.289)
	Headache complaints	4.4 ± 2.9	4.1 ± 2.7	3.8 ± 2.6	2.9 ± 2.8			
CPI (0–10)	TMD complaints	4.8 ± 2.6	5.0 ± 2.8	4.5 ± 2.3	4.5 ± 2.0	0.325 (0.575)	2.533 (0.089)	0.634 (0.603)
	Headache complaints	5.4 ± 2.1	5.2 ± 2.1	4.6 ± 2.6	4.4 ± 2.4			
Days with pain (0–30)	TMD complaints	20.0 ± 10.4	16.8 ± 11.0	19.2 ± 10.2	13.5 ± 10.7	0.248 (0.624)	6.043 (0.005)	2.236 (0.119)
	Headache complaints	17.9 ± 10.5	18.6 ± 2.1	17.4 ± 10.0	11.9 ± 10.3			
Days with Disability (0–30)	TMD complaints	4.0 ± 8.2	3.4 ± 5.8	5.9 ± 8.1	2.8 ± 4.7	0.882 (0.359)	2.758 (0.072)	1.137 (0.361)
	Headache complaints	4.3 ± 8.9	4.9 ± 6.8	5.1 ± 6.6	2.7 ± 4.7			
Headache attributed to TMD (N = 17)								
Disability Score (0–10)	TMD complaints	4.2 ± 2.8	4.1 ± 2.9	3.4 ± 2.9	3.2 ± 2.3	2.329 (0.146)	1.659 (0.221)	0.274 (0.843)
	Headache complaints	5.3 ± 2.4	4.7 ± 2.6	4.1 ± 2.7	4.2 ± 2.6			
CPI(0–10)	TMD complaints	6.0 ± 2.5	6.6 ± 1.5	4.8 ± 2.5	5.5 ± 2.2	1.133 (0.303)	1.975 (0.164)	3.057 (0.063)
	Headache complaints	6.5 ± 2.1	6.2 ± 2.1	5.6 ± 1.9	6.2 ± 1.9			
Days with pain (0–30)	TMD complaints	21.8 ± 10.5	16.1 ± 9.2	16.6 ± 10.8	14.1 ± 10.9	0.020 (0.889)	3.520 (0.043)	1.598 (0.234)
	Headache complaints	19.6 ± 11.6	17.6 ± 10.1	16.7 ± 8.9	16.1 ± 10.5			
Days with Disability (0–30)	TMD complaints	3.5 ± 4.5	2.4 ± 2.8	3.7 ± 4.9	2.5 ± 5.4	1.900 (0.187)	0.783 (0.523)	0.392 (0.760)
	Headache complaints	4.4 ± 5.0	4.0 ± 5.2	4.5 ± 4.8	4.2 ± 6.1			

TMD: temporomandibular disorder; N: number of patients; sd: standard deviation; F: F-value; CPI: characteristic pain intensity.

### 3.2. Longitudinal Course of TMD and Migraine Complaints

For the DS, the migraine complaints had overall higher scores than the TMD complaints ( $p = 0.000$ ). There was a significant improvement over time ( $p = 0.001$ ), and this improvement was not different for the TMD complaints as compared to the migraine complaints. CPI and days with pain also showed significant improvements over time ( $p < 0.018$ ), which were not different for the TMD and the headache complaints. For days with disability, no changes over time were found (Table 2; Figure 2a–d).



**Figure 2.** Visual representation of the outcome measures for patients with TMD stratified per headache type (migraine, TTH and headache attributed to TMD): Disability Score (a,e,i), Characteristic Pain Intensity (b,f,j), Days with Pain (c,g,k), and Days with Disability (d,h,l). CPI: Characteristic Pain Intensity; TMD: Temporomandibular Disorder.

### 3.3. Longitudinal Course of TMD and Tension-Type Headache Complaints

The DS was generally higher for the TTH complaints as compared to the TMD complaints, though not significant after correcting for multiple comparisons ( $p = 0.036$ ). The DS did not change over time, and no differences between the two complaints over time were observed. Only for days with pain a significant improvement over time was found



( $p = 0.005$ ), which was not different for the TTH complaints as compared to the TMD complaints (Table 2; Figure 2e–h).

### 3.4. Longitudinal Course of TMD and Headache Attributed to TMD Complaints

No difference was found in DS between the TMD complaints and the headache attributed to TMD complaints. No changes over time were found, and no differences between the TMD complaints and the headache complaints attributed to this TMD was observed. For days with pain an improvement over time was found, though not significant after correcting for multiple comparisons ( $p = 0.043$ ), and this change was not different for the TMD complaints and the headache complaints attributed to this TMD. For the other outcome measures no improvements over time were observed (Table 2; Figure 2i–l).

## 4. Discussion

The course of TMD complaints and headache complaints is dependent on the type of headache, in a TMD patient population that was followed during usual care multidisciplinary treatment. In patients with TMD-pain and migraine, similar changes in the TMD complaints as compared to the headache complaints were observed over time. In patients with TMD-pain with TTH or headache attributed to TMD no changes over time were found, except for days with pain.

### 4.1. Primary Outcome Measure: Disability Score

The concomitant decrease in DS as related to TMD and to headache in patients with migraine may be attributed to the hypothesis of shared etiological factors; in case two disorders share the same etiological factors, treatment directed at these etiological factors would benefit both disorders. There is a strong association between TMD-pain and (probable) migraine [6,7], and this association can be related to the presence of bruxism [6], indicating that bruxism may play a role in the etiology of both disorders. One of the possible treatment options for sleep-related bruxism is splint therapy, which was not only found effective for TMD-pain, but also showed favorable effects on complaints of headache in TMD patients with migraine, in a previous study [10]. Our results add to this body of knowledge and provides additional evidence for the association between TMD and migraine.

Such associations are not found for TMD and TTH, neither in previous studies [6,9] nor in the current study. One cross-sectional study showed that there was an association between TMD and headache, specifically in patients with mild TMD-pain, but this association was no longer significant after adjusting for shared prognostic factors such as age, gender and somatization [9]. The co-occurrence between TMD-pain and TTH in some cases could be explained by shared prognostic factors, which are the underlying explanation for these comorbidities to be present at the same time [23]. Despite this overlap in shared prognostic factors, TTH and TMD-pain seem to be separate entities and should be approached as such [24].

The different effects over time between TMD-pain patients with different types of headaches might indicate that different etiological processes are involved in these subtypes of patients.

### 4.2. Secondary Outcome Measures: Pain Intensity, Days with Pain and Days with Disability

For the secondary outcome measures used in this study, the results vary for the three subgroups. The decrease in headache pain intensity over time was comparable to the decrease in TMD-pain intensity in patients with migraine, but no decrease in pain intensity was found for TMD-pain patients with TTH or headache attributed to TMD. This corroborates the findings from the primary outcome measure in this study. In all headache groups, there was a decrease of the number of headache days as well as days with TMD-pain. According to the guidelines of the International Headache Society, 50% of reduction on the number of days with pain is considered clinically relevant in patients with

migraine [25]. In the present study, the reduction in headache days reached this clinically relevant level in all three subgroups.

For the first time, the longitudinal course of TMD complaints and headache was followed in TMD-pain patients with different types of headaches during a period of usual care multidisciplinary treatment. Although exploring the effects of this treatment was not the aim of this study, some interesting aspects of the treatment can be observed in our results. The treatment focused on the TMD complaints included occlusal splints and physiotherapy techniques such as relaxation exercises to the jaw, myofeedback, self-massage of the masticatory muscles and advice for the management of daily parafunction. Previously, these techniques were reported to improve headache intensity and frequency [26]. Additionally, the treatment addressed more general aspects related to chronic pain such as pain education, focusing on the concepts of sensitization, pain modulation and self-management in pain [27,28]. Since both TMD and headaches are highly associated with psychological factors like stress and pain catastrophizing [29–32], receiving proper pain education is important to reduce pain, disability and stress in patients with musculoskeletal pain [33,34]. This study suggests that there may be a different effect of pain education between different headache types in patients with TMD, that should be explored further.

A strength of this study is that all patients were seen in the OPD clinic, where standardized diagnostic procedures are implemented as part of the usual care. These procedures adhere to the full DC/TMD protocol [14], as well as incorporate a validated instrument to screen for migraine and TTH according to the ICHD-3 criteria [15]. Often, studies regarding TMD and headaches only address self-reported headache, and not headache subtypes. Taking different subtypes into consideration increases the external validity of the results and provide relevant information on differences between TMD patients with various types of headaches.

#### 4.3. Limitations of the Study

Recruiting patients for a clinical study, who fulfill a set of inclusion criteria and retain their involvement during the follow-up measurements is a challenge. Together with the stratified analyses for the different headache types, the sample size of the subgroups (17 to 22 subjects) can be considered a limitation of the study. Still, the post hoc power calculations showed that 16 patients were sufficient to show a clinically relevant change in disability score. Researchers have been encouraged to also present clinical relevance analysis in order to simplify the transfer of knowledge from research into practice [35,36].

Many participants experienced more than one headache type. In the TMD pain and migraine group, 54.5% also experienced a probable TTH, and in the group with headache attributed to a TMD more than 70% experienced a probable migraine and/or probable TTH. In case a participant fulfilled the criteria of more than one type of headache, the dominant headache, which was used for the stratified analyses, was assigned according to the IHS criteria. The presence of concurrent types of headaches can, however, have influenced the interpretation of the findings; especially for the patients with a headache attributed to a TMD the majority also reported concurrent symptoms of migraine and/or TTH. Perhaps, the limited improvement over time in this group of patients is related to the higher complexity of complaints and should be studied further.

The medication use of the patients was not tracked during the study, which could have provided more information on the perception and intensity of the complaints. Furthermore, to facilitate enough change over time in this mostly chronic patient population, an observational study design was chosen in which TMD-pain patients with headache were followed during a 12-week of usual care treatment. We did not intend to study the effects of a specific TMD-treatment and therefore no control group was included. In fact, the variation within the TMD-pain groups with different types of headaches allowed for the contrast needed in the regression analyses. The literature supports that attention, good communication and empathy improve the effects of all kinds of therapies, generating a placebo effect [37,38]. In this study, the amount of attention provided by multiple staff

persons in a specialty clinic has probably caused a placebo effect that was not measure because we believe that it is present in all subgroups and both complaints, so this would not influence on answering our research question.

As this is a prospective observational study, there is always the risk of some bias [39]. Response bias could happen due to differences in the responses according to the patient's mood, for example. Using recommended and validated questionnaires should reduce the risk of response bias. Nevertheless, the risk of response bias was probably the same between the subgroups and did not influence the results of this study.

For future studies, adding a control group which does not receive treatment or incorporate a pre-treatment period in the longitudinal design and extend the follow-up period, could make the conclusions more robust. Including daily diaries for headache, reporting the medication intake and including outcomes related to psychological aspects could provide additional information and is also encouraged.

#### 4.4. Practical Implications

Physiotherapists who frequently see patients with TMD-pain should be aware of the association between TMD-pain and different headache types. When, for example, a TMD-pain patient with migraine presents at a clinic, they should know that there is a strong association between the TMD and migraine, even during TMD-treatment. This is less so for concurrent TTH. It is therefore important that physiotherapists have a good understanding of the association between these two disorders and how this can be of value within the treatment process. When necessary, the physiotherapist can refer the patient to a specialized dentist, neurologist, psychologist or other health professional who can support the treatment.

### 5. Conclusions

In TMD-pain patients with migraine, improvement in TMD-pain related disability was comparable to improvement in headache-related disability. For TMD-pain patients with TTH or with headache attributed to the TMD, no improvements in disability were found.

**Supplementary Materials:** The following are available online at <https://www.mdpi.com/article/10.3390/app11177780/s1>, Figure S1: Graded Chronic Pain Scale questionnaire used to evaluate orofacial pain and headache.

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**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethical Committee of Academic Center for Dentistry Amsterdam (ACTA) not to fall under the provisions of the Medical Research Involving Human Subjects Act (file number 2017006).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

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## References

1. LeResche, L. Epidemiology of Temporomandibular Disorders: Implications for the Investigation of Etiologic Factors. *Crit. Rev. Oral Biol. Med.* **1997**, *8*, 291–305. [CrossRef]
2. de Leeuw, R.; Klasser, G.D. *American Academy of Orofacial Pain Guidelines for Assessment, Diagnosis, and Management*, 6th ed.; Quintessence Publishing Co.: Berlin, Germany, 2018.
3. Rollman, A.; Visscher, C.M.; Gorter, R.C.; Naeije, M. Care seeking for orofacial pain. *J. Orofac. Pain* **2012**, *26*, 206–214. [PubMed]
4. Türp, J.; Kowalski, C.; O’Leary, N.; Stohler, C. Pain Maps from Facial Pain Patients Indicate a Broad Pain Geography. *J. Dent. Res.* **1998**, *77*, 1465–1472. [CrossRef]
5. Visscher, C.M.; Lobbezoo, F.; De Boer, W.; Van Der Zaag, J.; Naeije, M. Prevalence of cervical spinal pain in craniomandibular pain patients. *Eur. J. Oral Sci.* **2001**, *109*, 76–80. [CrossRef]
6. Van der Meer, H.A.; Speksnijder, C.M.; Engelbert, R.H.H.; Lobbezoo, F.; Nijhuis-van der Sanden, M.W.G.; Visscher, C.M. The association between headaches and temporomandibular disorders is confounded by bruxism and somatic complaints. *Clin. J. Pain* **2017**, *33*, 835–843. [CrossRef]
7. Franco, A.L.; Gonçalves, D.; Castanharo, S.M.; Speciali, J.G.; Bigal, M.E.; Camparis, C.M. Migraine is the most prevalent primary headache in individuals with temporomandibular disorders. *J. Orofac. Pain* **2010**, *24*, 287–292.
8. Di Paolo, C.; D’Urso, A.; Papi, P.; Di Sabato, F.; Rosella, D.; Pompa, G.; Polimeni, A. Temporomandibular Disorders and Headache: A Retrospective Analysis of 1198 Patients. *Pain Res. Manag.* **2017**, *2017*, 3203027. [CrossRef] [PubMed]
9. Goncalves, D.A.G.; Camparis, C.M.; Speciali, J.G.; Franco, A.L.; Castanharo, S.M.; Bigal, M.E. Temporomandibular Disorders are differentially associated with headache diagnoses; a controlled study. *Clin. J. Pain.* **2011**, *27*, 611–615. [CrossRef] [PubMed]
10. Goncalves, D.A.G.; Camparis, C.M.; Speciali, J.G.; Castanharo, S.M.; Ujikawa, L.T.; Lipton, R.B.; Bigal, M.E. Treatment of Comorbid Migraine and Temporomandibular Disorders: A Factorial, Double-Blind, Randomized, Placebo-Controlled Study. *J. Orofac. Pain* **2013**, *27*, 325–335. [CrossRef]
11. Garrigós Pedrón, M.; La Touche, R.; Navarro-Desentre, P.; Gracia-Naya, M.; Segura-Ortí, E. Effects of a Physical Therapy Protocol in Patients with Chronic Migraine and Temporomandibular Disorders: A Randomized, Single-Blinded, Clinical Trial. *J. Oral Fac. Pain Headache* **2018**, *32*, 137–150. [CrossRef] [PubMed]
12. Hara, K.; Shinozaki, T.; Okada-Ogawa, A.; Matsukawa, Y.; Dezawa, K.; Nakaya, Y.; Chen, J.-Y.; Noma, N.; Oka, S.; Iwata, K.; et al. Headache attributed to temporomandibular disorders and masticatory myofascial pain. *J. Oral Sci.* **2016**, *58*, 195–204. [CrossRef]
13. Su, N.; Visscher, C.M.; Van Wijk, A.J.; Lobbezoo, F.; Van Der Heijden, G.J. A Prediction Model for Types of Treatment Indicated for Patients with Temporomandibular Disorders. *J. Oral Fac. Pain Headache* **2019**, *33*, 25–38. [CrossRef]
14. Schiffman, E.; Ohrbach, R.; Truelove, E.; Look, J.; Anderson, G.; Goulet, J.-P.; List, T.; Svensson, P.; Gonzalez, Y.; Lobbezoo, F.; et al. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *J. Oral Fac. Pain Headache* **2014**, *28*, 6–27. [CrossRef]
15. Van Der Meer, H.A.; Visscher, C.M.; Engelbert, R.H.H.; Mulleners, W.M.; Nijhuis-van der Sanden, M.W.G.; Speksnijder, C.M. Development and psychometric validation of the headache screening questionnaire—Dutch Version. *Musculoskelet. Sci. Pract.* **2017**, *31*, 52–61. [CrossRef]
16. Headache Classification Committee of the International Headache Society (IHS). The International Classification of Headache Disorders, 3rd edition. *Cephalalgia* **2018**, *38*, 1–211. [CrossRef] [PubMed]
17. Schiffman, E.; Ohrbach, R.; List, T.; Anderson, G.; Jensen, R.; John, M.T.; Nixdorf, D.; Goulet, J.-P.; Kang, W.; Truelove, E.; et al. Diagnostic criteria for headache attributed to temporomandibular disorders. *Cephalalgia* **2012**, *32*, 683–692. [CrossRef] [PubMed]
18. Von Korff, M.; Ormel, J.; Keefe, F.J.; Dworkin, S.F. Grading the severity of chronic pain. *Pain* **1992**, *50*, 133–149. [CrossRef]
19. Günther, T.; Schierz, O.; Hahnel, S.; Rauch, A. Field-testing a psychosocial assessment scoring form for TMD patients—Summarizing axis II instruments. *BMC Oral Health* **2020**, *20*, 267. [CrossRef] [PubMed]
20. R Core Team. R: A Language and Environment for Statistical Computing. Available online: <https://www.r-project.org/> (accessed on 21 August 2021).
21. Salaffi, F.; Stancati, A.; Silvestri, C.A.; Ciapetti, A.; Grassi, W. Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *Eur. J. Pain* **2004**, *8*, 283–291. [CrossRef]
22. Faul, F.; Erdfelder, E.; Lang, A.-G.; Buchner, A. G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* **2007**, *39*, 175–191. [CrossRef]
23. Kang, J.-H. Effects on migraine, neck pain, and head and neck posture, of temporomandibular disorder treatment: Study of a retrospective cohort. *Arch. Oral Biol.* **2020**, *114*, 104718. [CrossRef]
24. Conti, P.C.R.; Costa, Y.M.; Gonçalves, D.A.; Svensson, P. Headaches and myofascial temporomandibular disorders: Overlapping entities, separate managements? *J. Oral Rehabil.* **2016**, *43*, 702–715. [CrossRef]
25. Tassorelli, C.; Diener, H.-C.; Dodick, D.W.; Silberstein, S.D.; Lipton, R.B.; Ashina, M.; Becker, W.J.; Ferrari, M.D.; Goadsby, P.J.; Pozo-Rosich, P.; et al. Guidelines of the International Headache Society for controlled trials of preventive treatment of chronic migraine in adults. *Cephalalgia* **2018**, *38*, 815–832. [CrossRef]
26. Van der Meer, H.A.; Calixtre, L.B.; Engelbert, R.H.H.; Visscher, C.M.; Nijhuis-van der Sanden, M.W.; Speksnijder, C.M. Effects of physical therapy for temporomandibular disorders on headache pain intensity: A systematic review. *Musculoskelet. Sci. Pract.* **2020**, *50*, 102277. [CrossRef]

27. Moseley, G.L.; Butler, D.S. Fifteen Years of Explaining Pain: The Past, Present, and Future. *J. Pain* **2015**, *16*, 807–813. [[CrossRef](#)] [[PubMed](#)]
28. Lotze, M.; Moseley, G.L. Theoretical Considerations for Chronic Pain Rehabilitation. *Phys. Ther.* **2015**, *95*, 1316–1320. [[CrossRef](#)]
29. Ohrbach, R.; Fillingim, R.B.; Mulkey, F.; Gonzalez, Y.; Gordon, S.; Gremillion, H.; Lim, P.-F.; Ribeiro-Dasilva, M.; Greenspan, J.D.; Knott, C.; et al. Clinical Findings and Pain Symptoms as Potential Risk Factors for Chronic TMD: Descriptive Data and Empirically Identified Domains from the OPPERA Case-Control Study. *J. Pain* **2011**, *12*, T27–T45. [[CrossRef](#)]
30. Ligthart, L.; Gerrits, M.M.J.G.; Boomsma, D.I.; Penninx, B.W.J.H. Anxiety and Depression Are Associated With Migraine and Pain in General: An Investigation of the Interrelationships. *J. Pain* **2013**, *14*, 363–370. [[CrossRef](#)] [[PubMed](#)]
31. Seng, E.K.; Buse, D.C.; Klepper, J.E.; Ma, J.E.K.; Ma, S.J.M.; Ma, A.S.G.; Grosberg, B.M.; Pavlovic, J.M.; Robbins, M.S.; Vollbracht, S.E.; et al. Psychological Factors Associated With Chronic Migraine and Severe Migraine-Related Disability: An Observational Study in a Tertiary Headache Center. *Headache J. Head Face Pain* **2017**, *57*, 593–604. [[CrossRef](#)] [[PubMed](#)]
32. Bond, D.S.; Buse, D.C.; Lipton, R.B.; Thomas, J.G.; Rathier, L.; Roth, J.; Pavlovic, J.M.; Evans, E.W.; Wing, R.R. Clinical Pain Catastrophizing in Women With Migraine and Obesity. *Headache* **2015**, *55*, 923–933. [[CrossRef](#)]
33. Wieckiewicz, M.; Zietek, M.; Smardz, J.; Zenczak-Wieckiewicz, D.; Grychowska, N. Mental Status as a Common Factor for Masticatory Muscle Pain: A Systematic Review. *Front. Psychol.* **2017**, *8*, 646. [[CrossRef](#)]
34. Louw, A.; Diener, I.; Butler, D.S.; Puente-dura, E.J. The Effect of Neuroscience Education on Pain, Disability, Anxiety, and Stress in Chronic Musculoskeletal Pain. *Arch. Phys. Med. Rehabil.* **2011**, *92*, 2041–2056. [[CrossRef](#)] [[PubMed](#)]
35. Armijo-Olivo, S.; Warren, S.; Fuentes, J.; Magee, D.J. Clinical relevance vs. statistical significance: Using neck outcomes in patients with temporomandibular disorders as an example. *Man. Ther.* **2011**, *16*, 563–572. [[CrossRef](#)] [[PubMed](#)]
36. Armijo-Olivo, S. The importance of determining the clinical significance of research results in physical therapy clinical research. *Braz. J. Phys. Ther.* **2018**, *22*, 175–176. [[CrossRef](#)]
37. Annoni, M.; Miller, F.G. Placebo Effects and the Ethics of Therapeutic Communication: A Pragmatic Perspective. *Kennedy Inst. Ethic J.* **2016**, *26*, 79–103. [[CrossRef](#)]
38. Elliott, R.; Bohart, A.C.; Watson, J.C.; Murphy, D. Therapist empathy and client outcome: An updated meta-analysis. *Psychotherapy* **2018**, *55*, 399–410. [[CrossRef](#)] [[PubMed](#)]
39. Sedgwick, P. Bias in observational study designs: Prospective. *BMJ* **2014**, *349*, g7731. [[CrossRef](#)] [[PubMed](#)]