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The effects of trauma-focused treatment on painful temporomandibular disorders, awake bruxism and sleep bruxism in patients with severe post-traumatic stress disorder

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Abstract

Background: Chronic painful temporomandibular disorders (TMD), awake bruxism and sleep bruxism are often comorbid with post-traumatic stress disorder (PTSD), but the implications for treatment are unknown.

Objective(s): To explore the effects of PTSD treatment on these conditions. We hypothesized that chronic painful TMD, pain intensity, pain interference, awake bruxism and sleep bruxism would decrease after evidence-based trauma-focused treatment and that this decrease would be maintained at the 6-month follow-up.

Methods: Individuals referred for PTSD treatment were assessed for chronic painful TMD (temporomandibular disorder pain screener), pain intensity, pain interference (Graded Chronic Pain Scale 2.0), awake bruxism and sleep bruxism (oral behaviours checklist) pre-, post-treatment and at the 6-month follow-up. Hypotheses were tested using the Friedman test, followed by a post hoc Wilcoxon signed-rank test. Effect sizes (Cohen's *r*) are reported. Barely any pain interference was reported, therefore these outcomes were not analysed.

Results: In individuals with chronic painful TMD ($n=98$), pain intensity, awake bruxism and sleep bruxism decreased across the three time points. Post hoc tests showed that chronic painful TMD ($r=0.59$), pain intensity ($r=0.28$), awake bruxism ($r=0.51$) and sleep bruxism ($r=0.35$) decreased between pre- and post-treatment. Between pre-treatment and the 6-month follow-up, chronic painful TMD ($r=0.58$), awake bruxism ($r=0.30$) and sleep bruxism ($r=0.39$) decreased as well.

Conclusion: The results provide preliminary support for a trauma-sensitive approach for patients with chronic painful TMD and PTSD and suggest that trauma-focused treatment may be beneficial for chronic painful TMD, awake bruxism and sleep bruxism in patients with PTSD and chronic painful TMD.

KEYWORDS
awake bruxism, orofacial pain, post-traumatic stress disorder, sleep bruxism, stress disorders, temporomandibular disorders

1 | BACKGROUND

After confronting one or more serious threatening events, individuals may develop a mental health condition called post-traumatic stress disorder (PTSD).[1] PTSD often coincides with chronic pain,[2–4] including chronic painful temporomandibular disorders (TMD).[5–7] The incidence of painful TMD is associated with PTSD[8] and it has been estimated that painful TMD is 3.5 times more prevalent among patients with PTSD than in the general population.[9] Several authors have attempted to explain the co-occurrence of PTSD and chronic pain.[10–13] The 'mutual maintenance model' posits that PTSD is maintained by cognitive, affective and behavioural components of chronic pain, while physiological, affective and avoidance components of PTSD fuel chronic pain.[12] Because these factors may not necessarily be the result of PTSD or chronic pain but may precede them, a second model is introduced: the 'shared vulnerability model'.[13] According to the authors of this model, both the shared vulnerability model and the mutual maintenance model explain the co-occurrence; a causal role of PTSD in chronic pain is not supported.[13] A causal role for traumatic life experiences and PTSD has been suggested by others: a third model in which chronic pain resolves after successful treatment of PTSD.[14,15] Despite a range of studies into these models, convincing evidence favouring any explanatory model over the others is lacking.[16–23]

When suffering from both PTSD and chronic pain, patients' health outcomes are affected negatively.[3,11,18,24] In light of this, not fully understanding this relationship is problematic. This could be addressed by studying the development of either disorder after the other disorder is treated. To this end, a systematic review and meta-analysis was performed, which concluded that psychological interventions are effective in reducing PTSD and pain intensity, but not pain interference.[25,26] However, whether psychological interventions were aimed at PTSD, pain or both was not specified. Two recent controlled studies investigated the effects of PTSD treatment on chronic pain. One study found no beneficial effects in patients with whiplash-associated disorders,[27] while the other study included patients with fibromyalgia who did improve.[28] We found no studies on the effects of PTSD treatment on chronic painful TMD.

In summary, PTSD and chronic pain (including painful TMD) are often comorbid, resulting in worse health outcomes for patients; however, we do not know exactly how to explain this. If traumatic life experiences and PTSD are considered causal factors in chronic pain, this implies that treating PTSD would alleviate chronic pain, but the evidence is inconclusive. Therefore, we aimed to explore the effects of evidence-based trauma-focused PTSD treatment on chronic painful TMD, pain intensity and pain interference. Because painful TMD is often linked to awake bruxism and sleep bruxism,[29] and these may also be associated with PTSD,[9,30] we explored the effect of trauma-focused treatment on awake and sleep bruxism as a second aim.

We hypothesized that individuals with PTSD and chronic painful TMD would report a significant decrease in chronic painful TMD, pain intensity, pain interference, awake bruxism and sleep bruxism after PTSD treatment, which would be maintained at the 6-month follow-up.

2 | METHODS

2.1 | Participants

The participants in this study were individuals treated at the Dutch Psychotrauma Expertise Centre (PSYTREC, Bilthoven, The Netherlands). The participants completed the intake assessments between July 2019 and June 2020, with the last participant completing follow-up assessments in February 2021. Assessments include the Clinician Administered PTSD Scale (CAPS-5)[31,32] to classify those with PTSD according to the *Diagnostic and Statistical Manual of Mental Disorders-5*.[1] In addition to a PTSD diagnosis, individuals are eligible for treatment at PSYTREC if they are aged 18 years and older, have sufficient knowledge of the Dutch language and have not attempted suicide within the past 3 months.

All participants completed all assessments as part of the routine treatment procedure; no financial compensation, or other incentive, was offered to participants. Only individuals who consented to the use of their data for research purposes were included in the study. This study was approved by the Ethics Committee of the Academic Center for Dentistry Amsterdam (protocol numbers 2021-64973 and 2021-57658).

2.2 | Procedure

After referral, PTSD was diagnosed by a trained clinical psychologist using the CAPS-5. After assuring eligibility for intensive trauma-focused treatment, participants were informed and asked for written consent for the use of their data for scientific research. Measurements were repeated at several time points, including the reassessment of the PTSD diagnosis. In this study, questionnaires to assess chronic painful TMD, orofacial pain, awake bruxism and sleep bruxism were included in the assessments at intake, post-treatment and the 6-month follow-up. Post-treatment assessments took place approximately 1 week after completing treatment, and follow-up assessments took place after 6 months.

2.3 | Treatment

All patients underwent brief (4–8 days), intensive, trauma-focused treatment for PTSD consisting of daily sessions of prolonged exposure (PE) and eye movement desensitisation and reprocessing (EMDR) therapy, as well as physical exercise and education about PTSD.[33] This intensive treatment program is an effective treatment for PTSD, with a significant and clinically meaningful decline in symptom severity, 74% loss of PTSD diagnosis and low dropout rates.[33]

2.4 | Instruments

As stated above, PTSD was assessed with the CAPS-5, a diagnostic questionnaire that is administered during a clinical interview by a trained professional.[31,32] This instrument provides ratings of the 20 DSM-V-based PTSD symptoms, using 5-point scales for intensity (0 = 'absent' to 4 = 'extreme') and frequency (0 = 'never' to 4 = 'almost daily'). This results in a CAPS-5 severity score ranging from 0 to 80.[31,32] The Dutch translation of the CAPS-5 has high internal consistency and reliability.[31]

Possbile painful TMD was assessed using the long version of the Dutch translation of the TMD pain screener.[34,35] This questionnaire consists of six items, with the first item scored between 0 and 2, and the five other items scored 0 or 1, resulting in a sum score between zero and seven points. Scores of three or higher are considered to indicate probable painful TMD.[34,35] Psychometric evaluation has shown the TMD pain screener to possess excellent overall reliability, with a mean ICC of 0.79 and an excellent level of sensitivity (99.1%) and specificity (96.9%–97.8%).[34] Possible painful TMD was considered chronic when the pain had started three or more months ago. This was assessed by asking patients about the duration of the pain complaints: "How many years or months ago did your pain in the jaw or temple first begin?"

Orofacial pain intensity and pain interference were assessed using the Dutch translation of the Graded Chronic Pain Scale, 1-month version (GCPS 2.0-NL).[36,37] The GCPS 2.0-NL consists of eight items. The second, third and fourth items of the GCPS 2.0-NL form the pain intensity scale. This scale enquires into the intensity of the current, worst and average pain in the past 30 days, rated from 0 (no pain) to 10 (pain as bad as could be).* Pain interference was assessed with the sixth, seventh and eighth items, inquiring into the level of interference with daily activities (item 6), recreational, social and family activities (item 7), and with the ability to work (item 8), on a 0 (no interference) to 10 (unable to carry on any activities) scale. For both pain intensity and interference, the mean of the scores on the three items is computed and multiplied by 10, resulting in a 0–100 score. The GCPS, 1-month version, was shown to possess very good psychometric properties, with the chronic pain intensity score (CPI) as an excellent measure of pain intensity and the interference score as an acceptable measure of pain interference.[38]

Both possible awake bruxism and possible sleep bruxism were measured using an abbreviated six-item version of the Dutch translation of the Oral Behaviours Checklist (OBC).[39,40] Test–retest reliability of the Dutch OBC was shown to be excellent, and the concurrent validity is good.[40] The abbreviated questionnaire contains five items about awake bruxism. These items are scored on a five-point scale ranging from 1 ('none of the time') to 5 ('all of the time'). Possible awake bruxism was considered present when an individual scored four or higher on any of the five questions about awake bruxism. The single item about sleep bruxism is also scored on a five-point scale (1 = 'none of the time', 2 = 'less than 1 night per month', 3 = '1 to 3 nights per month', 4 = '1 to 3 nights a week', 5 = '4 to 7 nights a week'). Possible sleep bruxism was considered to be present when an individual scored four or higher on the question about sleep bruxism.

*Unfortunately, errors were made when programming the GCPS into the digital environment in which participants completed the questionnaires. As a result, the coding of answers to the third question of the pain intensity scale (i.e., average pain over the last 30 days) rendered the results for this item uninterpretable. The pain intensity was thus calculated for two rather than three items.

2.5 | Data analysis

Descriptive characteristics of the study sample were calculated: age (mean, standard deviation), gender (frequency, percentage) and baseline PTSD symptoms (mean, standard deviation). We tested whether there were significantly more female than male participants in the sample (chi-squared test) and whether there were differences between male and female participants with regard to age, painful TMD and PTSD symptoms. Because the data for all dependent variables were skewed or extremely skewed, we mainly performed non-parametric tests. The CAPS-5 data were normally distributed.

To assess the possible impact of attrition, pre-treatment scores for PTSD severity in participants who did not complete post-treatment assessments were compared to those who did using an independent samples *t*-test. The same was done for the pre-treatment scores of participants who did and did not complete the 6-month follow-up assessments. Similarly, pre-treatment scores for painful TMD, pain intensity, awake bruxism and sleep bruxism of participants who did not complete post-treatment assessments were compared to those who did using a Mann–Whitney *U* test. The same was done with the pre-treatment scores for these variables of participants who did and did not complete 6-month follow-up assessments.

We described any fluctuations in the presence (McNemar test) and severity (Wilcoxon's signed-rank test) of painful TMD, awake bruxism and sleep bruxism across treatment among all participants who completed pre-, post-treatment, and 6-month follow-up assessments. We also assessed whether these changes were associated with the change in PTSD symptoms (Spearman's rank correlation coefficient). The latter analysis was also performed for the final sample of patients who screened positive for chronic painful TMD at intake. In addition to the significance of the correlations, 95% confidence intervals (CI's) are presented. An r_s of .00–.19 was considered as "negligible", of 0.20–0.39 as "weak", of 0.40–0.69 as moderate, of 0.70–0.89 as "strong" and of 0.90–1.0 as "very strong."[41] Only if these analyses pointed towards a reduction in the presence and severity of painful TMD, awake bruxism and sleep bruxism, and this reduction was associated with the reduction of PTSD symptoms, we tested our hypotheses regarding the decrease of (1) chronic painful TMD, (2) pain intensity, (3) pain interference, (4) awake bruxism and (5) sleep bruxism after PTSD treatment in patients with chronic painful TMD in the final sample of participants reporting chronic painful TMD at intake (pain duration of 3 months or more).

Friedman's test was used to test the hypotheses. If a significant difference was found between the three time points, a post hoc Wilcoxon

signed-rank test was conducted to determine the time points between which this change occurred. Effect sizes for significant outcomes were calculated (Cohen's *r*), with effect sizes over 0.1 being considered small, over 0.3 medium and over 0.5 large.[42] Hodges–Lehman median difference and its 95% confidence interval were calculated to indicate the median difference between individual scores.

All statistical analyses were performed using IBM SPSS Statistics for Windows (version 28) with the alpha level set at .05. As advised by both Rubin[43] and García-Pérez[44] in their articles on the appropriateness of statistical correction for multiple testing, no correction for multiple testing was applied for tests that were interpreted in conjunction (so only if all outcomes for that variable pointed in the same direction, the hypothesis was accepted), or when tests were applied to different dependent variables that were interpreted individually.[43] Bonferroni correction for multiple testing was applied for the post hoc Wilcoxon signed-rank tests, resulting in an adjusted alpha level of .017 for these tests.

3 | RESULTS

3.1 | Descriptives

Between July 2019 and June 2020, 882 patients were assessed for PTSD, chronic painful TMD, pain intensity, pain interference, awake bruxism and sleep bruxism. As we used self-report screening instruments to assess painful TMD, awake bruxism and sleep bruxism, these results describe possible painful TMD, possible awake bruxism and possible sleep bruxism.

After excluding 128 patients who did not consent to the use of their data or did not complete all pre-treatment assessments, pre-treatment data were available for 754 patients. After excluding participants who did not complete assessments post-treatment or at the 6-month follow-up, 452 participants remained who completed assessments at all three time points (Figure 1 for participant flow). The last participant completed follow-up assessments in February 2021. Of the participants who completed assessments at all three time points, 78% did not report chronic painful TMD at baseline. As a result, our final sample consisted of 98 participants who consented to the use of their data for research purposes, screened positive for chronic painful TMD, had been suffering from painful TMD for 3 months or more, and completed assessments at all three time points (Figure 1 for participant flow).

An independent samples *t*-test on pre-treatment scores showed no significant difference between the PTSD symptoms of participants who did ($n=592$) and those who did not ($n=162$) complete post-treatment assessments ($p=.064$), or who did ($n=496$) and did not ($n=258$) complete 6-month follow-up assessments ($p=.499$). A Mann–Whitney *U* test showed that the same was true for pre-treatment scores for painful TMD ($p=.909$), pain intensity ($p=.448$), awake bruxism ($p=.719$) and sleep bruxism ($p=.251$) of patients who did and did not complete post-treatment assessments. Patients who did and did not complete follow-up assessments also did not differ significantly in pre-treatment scores for painful TMD ($p=.776$), pain intensity ($p=.211$) and awake bruxism ($p=.166$). Reported sleep bruxism did differ significantly between patients who did (median = 3) and those who did not (median = 1) complete follow-up assessments ($p=.005$).

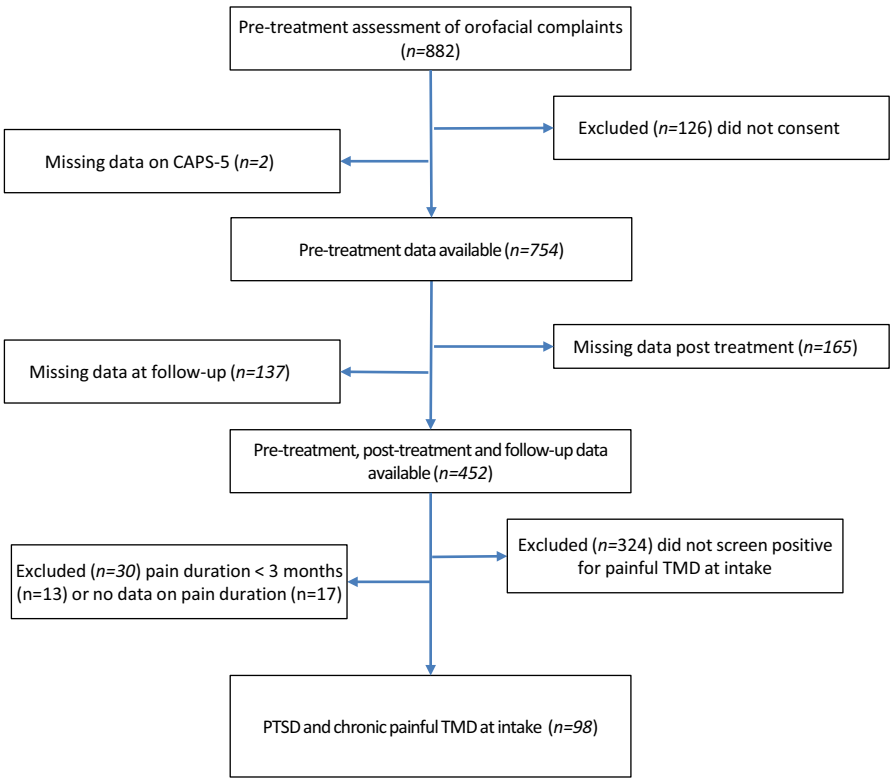

FIGURE 1 Flow chart of patient inclusion. CAPS-5, Clinician Administered PTSD Scale for DSM-5; TMD, temporomandibular disorders; PTSD, post-traumatic stress disorder.

Table 1 shows results for all 452 participants that completed measurements at three timepoints. Among this group as a whole, the presence and severity of painful TMD, awake bruxism and sleep bruxism decreased significantly after treatment ($n=452$) with small to medium effect sizes for the decrease in the severity of painful TMD, awake bruxism and sleep bruxism. Spearman's test for correlations showed a significant correlation between the change in painful TMD, awake bruxism and sleep bruxism and the change in PTSD symptoms between pre- and post-treatment both among all patients completing assessments at all three time points ($n=452$) and among those participants reporting chronic painful TMD at intake ($n=98$; Table 1). Figures 2–4 show scatter plots of the difference scores (pre-treatment scores minus post-treatment scores) of the latter group ($n=98$). Of these participants, 56%

TABLE 1 Descriptives: changes in the presence and symptom levels of painful TMD, awake bruxism and sleep bruxism between pre- and post-treatment, and the association between the change in symptom levels with the decrease in PTSD symptoms.

		TMD pain			Awake bruxism			Sleep bruxism		
Proportion positive screenings										
		Pre	**Post**	**χ^2 (p-value)**	**Pre**	**Post**	**χ^2 (p-value)**	**Pre**	**Post**	**χ^2 (p-value)**
McNemar test ($df=1$; $n=452$)		28.3%	21.5%	9.5 (.002*)	49.1%	34.7%	33.30 (<.001*)	41.8%	36.3%	6.6 (.010*)
Symptom level Pre–Post										
Wilcoxon signed ranks test ($n=452$)	p-value	.002*			<.001*			<.001*		
Effect size[a]	r	−0.14			−0.30			−0.16		
Association with PTSD decrease										
Spearman's test ($n=452$)[b]	r_s	0.16			0.33			0.38		
	95% CI	0.07–0.25			0.24–0.41			0.29–0.45		
	p-value	<.001*			<.001*			<.001*		
Spearman's test ($n=98$)[c]	r_s	0.29			0.41			0.55		
	95% CI	0.10–0.47			0.22–0.56			0.39–0.68		
	p-value	.003*			<.001*			<.001*		

Abbreviation: Pre, pre-treatment; post, post-treatment.

*Statistically significant at $p<.05$.

[a]Effect sizes (Cohen's r): ≥.1 = small, ≥0.3 = medium, ≥0.5 = large [42].

[b]Spearman's test for correlations on data for all participants completing all assessments; A r_s of .00–.19 was considered as "negligible", of 0.20–0.39 as "weak", of 0.40–0.69 as moderate, of 0.70–0.89 as "strong" and of 0.90–1.0 as "very strong"[43].

[c]Spearman's test for correlations on data for participants completing all assessments and screening positive for chronic painful TMD pre-treatment; A r_s of .00–.19 was considered as "negligible", of 0.20–0.39 as "weak", of 0.40–0.69 as moderate, of 0.70–0.89 as "strong" and of 0.90–1.0 as "very strong"[43].

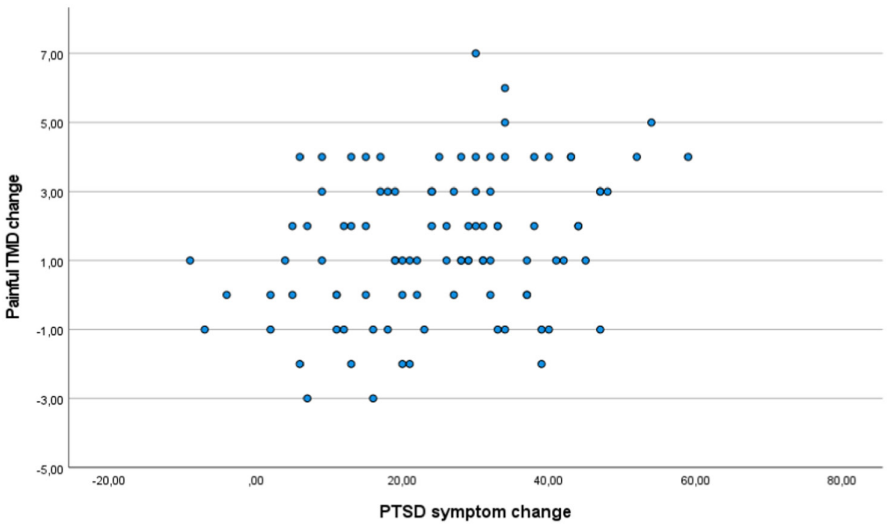

FIGURE 2 Scatter plot of the difference between pre- and post-treatment scores for PTSD symptoms and the difference between pre- and post-treatment scores for painful TMD ($n=98$). Differences were calculated by subtracting post-treatment scores from pre-treatment scores. Positive difference scores represent a reduction in symptoms.

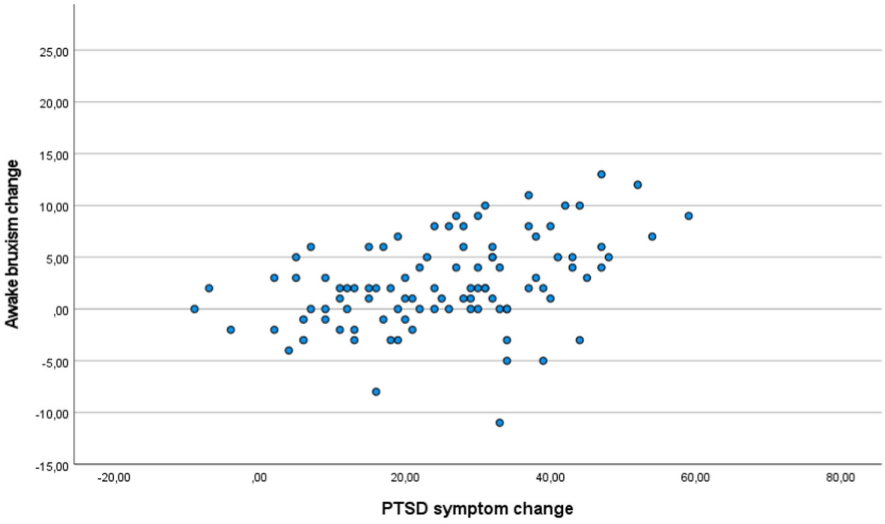

FIGURE 3 Scatter plot of the difference between pre- and post-treatment scores for PTSD symptoms and the difference between pre- and post-treatment scores for awake bruxism ($n = 98$). Differences were calculated by subtracting post-treatment scores from pre-treatment scores. Positive difference scores represent a reduction in symptoms.

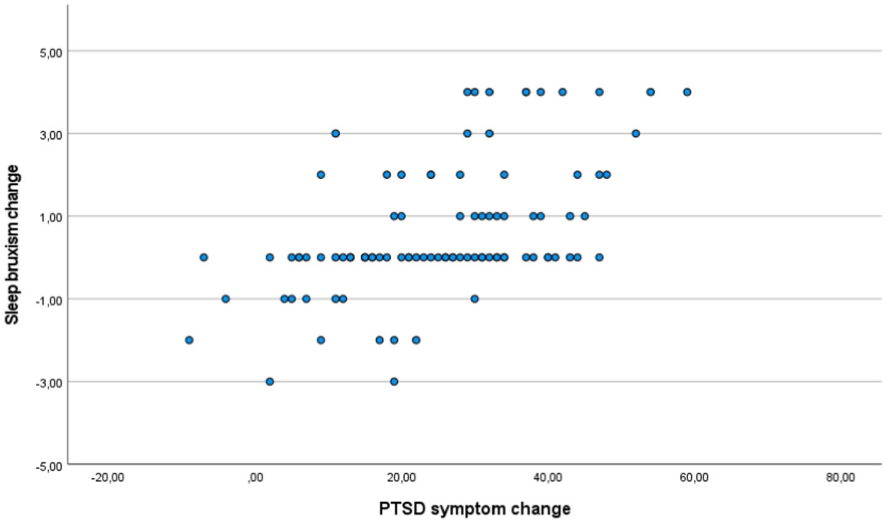

FIGURE 4 Scatter plot of the difference between pre- and post-treatment scores for PTSD symptoms and the difference between pre- and post-treatment scores for sleep bruxism ($n = 98$). Differences were calculated by subtracting post-treatment scores from pre-treatment scores. Positive difference scores represent a reduction in symptoms.

reported a 30% or more improvement in the symptoms of painful TMD, 32% reported a 30% or more improvement in awake bruxism and 27% reported a 30% or more improvement in sleep bruxism. In this group, only 46 participants reported any facial pain and of these 46 people 63% reported a 30% or more improvement of the facial pain intensity after trauma-focused treatment.[45]

The final sample of participants with chronic painful TMD ($n = 98$) consisted of significantly more women ($n = 82$; 83.7%) than men ($\chi^2[1] = 44.4$, $p < .001$). The average age of women ($M = 38.3$, $SD = 11.8$) was lower than the average age of men ($M = 44.6$, $SD = 9.9$) ($t[96] = 2.0$, $p = .048$). Baseline symptoms of chronic painful TMD did not differ significantly between women and men ($U = 633.5$, $p = .821$), nor did baseline PTSD symptoms ($t[96] = 0.1$, $p = .882$). Therefore, we did not adjust for gender in our analyses. Patients in the sample reported high PTSD symptoms on the CAPS-5 at intake ($M = 43.3$, $SD = 7.5$), while the mean CAPS-5 score post-treatment was 18.1 ($SD = 13.6$).

Barely any pain interference was reported. The majority of patients reported no pain interference pre-treatment (84.1%), post-treatment (87.5%) or at 6-month follow-up (76.9%). Therefore, we decided not to analyse the outcomes of the pain interference scale.

3.2 | Changes in chronic painful TMD and pain intensity after PTSD treatment

As can be seen in Table 2, among the final sample of participants with chronic painful TMD ($n = 98$), symptoms measured by the TMD Pain Screener decreased significantly between the three time points among those participants reporting chronic painful TMD at intake. Post hoc tests showed a significant decrease in painful TMD between pre- and post-treatment and between pre-treatment and 6-month follow-up (Table 2). The two-item pain intensity scores also changed significantly between the three time points, while post hoc analyses showed a significant decrease in pain intensity between pre- and post-treatment (Table 2).

3.3 | Changes in awake bruxism and sleep bruxism after PTSD treatment

Among the final sample of participants with chronic painful TMD ($n = 98$), awake bruxism decreased significantly between the three time points, and post hoc tests showed a significant decrease for

TABLE 2 Changes in chronic painful TMD, pain intensity, awake bruxism and sleep bruxism between pre-, post-treatment and follow-up. $n = 98$.

		TMD pain			Pain intensity			Awake bruxism			Sleep bruxism		
Reported symptoms		**Pre**	**Post**	**Fu**	**Pre**	**Post**	**Fu**	**Pre**	**Post**	**Fu**	**Pre**	**Post**	**Fu**
Score range		3–7[a]	0–7	0-7	0-80	0–75	0–85	5–24	5–25	5–25	1–5	1–5	1–5
Percentile scores	25th	3	1	1	0	0	0	12	9	10	4	2	3
	50th	4	3	3	0	0	0	15	13	14	5	5	4
	75th	5	4	4	46	26	40	17	15	16	5	5	5
Difference between time points													
Friedman test	*p*-value	<.001*			.010*			<.001*			<.001*		
Difference pre–post													
Wilcoxon signed ranks test	*p*-value	<.001**			.005**			<.001**			<.001**		
Effect size[b]	*r*	−0.59			−0.28			−0.51			−0.35		
Median difference[c]	Estimate	−1.5			−2.5			−2.5			−0.5		
	95% CI	−2.0–1.0			−12.5–0.0			−3.5–1.5			−1.0–0.0		
Difference pre–fu													
Wilcoxon signed ranks test	*p*-value	<.001**			.344			.003**			<.001**		
Effect size[b]	*r*	−0.58			−0.10			−0.30			−0.39		
Median difference[c]	Estimate	−1.5			0.0			−1.0			−0.5		
	95% CI	−2.0–1.0			−5.0–0.0			−2.0 to −0.5			−0.5–0.0		
Difference post–fu													
Wilcoxon signed ranks test	*p*-value	.691			.055			.003**			.591		
Effect size[b]	*r*	0.04			0.19			0.30			0.05		
Median difference[c]	Estimate	0.0			2.5			1.0			0.0		
	95% CI	0.0–0.5			0.0–7.5			0.5–1.5			0.0–0.0		

Abbreviation: fu, follow-up; Pre, pre-treatment; post, post-treatment.

*Statistically significant at $p < .05$. **Statistically significant at $p < .017$ (Bonferroni correction for multiple testing).

[a]Only patients who screened positive for chronic painful TMD pre-treatment were included.

[b]Effect sizes (Cohen's *r*): ≥.1 = small, ≥0.3 = medium, ≥0.5 = large[42].

[c]Related samples Hodges–Lehman median difference estimate and 95% confidence interval for non-parametric data.

awake bruxism between pre- and post-treatment, a significant increase between post-treatment and follow-up, and a significant decrease between pre-treatment and follow-up (Table 2).

Sleep bruxism changed significantly across the three time points, with post hoc analyses showing a significant decrease between pre- and post-treatment scores and between pre-treatment and follow-up scores (Table 2).

4 | DISCUSSION

As hypothesized, chronic painful TMD decreased after trauma-focused PTSD treatment in individuals with both PTSD and chronic painful TMD. This result was maintained at 6-month follow-up. In addition, awake bruxism and sleep bruxism decreased, which was also maintained at 6-month follow-up. Awake bruxism relapsed during the 6 months after treatment, but participants still reported less awake bruxism at the 6-month follow-up than before treatment. To the best of our knowledge, this is the first study to examine whether chronic painful TMD, awake bruxism and sleep bruxism decrease after treatment of PTSD.

While the decrease in chronic painful TMD was maintained at 6-month follow-up, our results regarding pain intensity were mixed. Pain intensity decreased after treatment but results at 6-month follow-up are inconclusive, showing no significant relapse, but no significant difference with pre-treatment scores either. These results are in line with some of the studies into PTSD treatment and chronic pain.[25,28]

Emerging evidence shows comorbidity between awake bruxism and sleep bruxism on the one hand, and PTSD on the other.[9,30] This study suggests that if there is comorbid PTSD, patients seeking treatment for the negative consequences of awake bruxism and/or sleep bruxism may benefit from adding a referral for the treatment of PTSD to the treatment plan. However, further studies on patients seeking treatment for the negative consequences of awake bruxism or sleep bruxism are needed. These studies would need to confirm that comorbidity exists and replicate the present findings.

While providing some valuable insights, this study also has shortcomings. Notably, we discovered programming errors in GCPS 2.0-NL (as described in the Methods section). It is unclear how the deletion of the item rating average pain affects the outcomes of the pain intensity scale. The outcome may be less reliable with this omission, as both remaining items inquire about pain at one specific moment (current or worst). Therefore, pain intensity outcomes should be interpreted with caution. Nevertheless, in our opinion, the effort made by patients to answer these questions results in a moral obligation to publish the results. Keeping this limitation in mind, pain intensity, as rated by the two remaining items, was significantly reduced after treatment. The second limitation pertains to the skewed outcomes of the GCPS 2.0. The GCPS 2.0 has proven to be an excellent measure of pain intensity and an acceptable measure of pain interference,[38] and is part of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), the global consensus instrument for screening and diagnosing TMDs.[46] However, it was striking that many patients who screened positive for self-reported chronic painful TMD reported zero pain intensity (53.1%) and no pain interference (87.9%) at baseline. While the much more disabling presence of PTSD may explain the absence of pain interference, it does not explain the large number of study participants who reported painful TMD but no facial pain. Possibly, the different wording for the location of the pain in the TMD pain screener and GCPS 2.0 (i.e. pain in the jaw or temple area versus facial pain) was of influence. A third limitation is that, although the TMD pain screener and OBC are reliable and valid instruments, these are (just) screeners.[35,40] Clinical examination is a more reliable and valid method of assessing painful TMD and awake bruxism, whereas sleep bruxism may be assessed more reliably and validly by repeated self-report, clinical evaluation and instrumental assessment.[37,47] However, as our study was the first to study this topic and patients were referred for PTSD treatment, not for treatment of chronic painful TMD, we deemed it ethical to not burden them with clinical assessments unrelated to their reasons for seeking treatment. The results of this study may warrant other decisions in follow-up studies. A fourth limitation pertains to the relatively large number of patients who did not complete all assessments (39.7%). Nevertheless, attrition does not appear to exert a major influence on the results. Patients who did not complete all assessments did not differ significantly on the outcome variables measured pre-treatment from those who did. This may not hold true for sleep bruxism because patients who completed the 6-month follow-up assessments reported significantly more sleep bruxism pre-treatment than those who did not. Finally, a major limitation of our study is that it was observational and lacked a no-treatment control group. This is a shortcoming as painful TMD, awake bruxism and sleep bruxism are known to fluctuate over time.[48,49] However, several aspects support the notion that the observed changes were the result of treatment. First, symptoms decreased in patients with chronic painful TMD (≥3 months) between pre- and post-treatment, and changes were maintained during the 6 months after treatment. Second, among all individuals who completed the assessments at the three time points ($n=452$), there was a significant reduction in the proportion of individuals reporting painful TMD, awake bruxism and sleep bruxism. Third, symptom levels also decreased in this group. Fourth, a decrease in symptoms between pre- and post-treatment was associated with a decrease in PTSD symptoms. It can be argued that if PTSD treatment did not affect our dependent variables, then, in a sample that was not selected based on the presence of painful TMD, the proportion of positive screenings and symptom levels for all dependent variables would be expected to remain roughly the same. If present, any change in symptoms would not be associated with a decrease in PTSD symptoms. The fact that among all participants who completed all assessments, including those without pre-treatment painful TMD, the presence and severity of painful TMD, awake bruxism and sleep bruxism decreased across treatment, and that this decrease was associated with a decrease in PTSD symptoms, contradicts the notion that our results would be due merely to the passage of time. Nevertheless, in future studies, it would be advisable to address this issue. Ethical concerns would possibly preclude including a control group as this means withholding trauma-focused treatment from patients who are suffering from this severe mental health condition. However, multiple baseline measurements or a single-case experimental design with varied baseline measurements could be considered.

Notwithstanding its shortcomings, this study has some important strengths. A major strength is the evidence-based treatment used to treat PTSD.[33] This is in contrast to previous studies on the effects of PTSD treatment on pain.[25] The same holds true for the sample size, with the present study involving a larger sample size than earlier studies.[25] Moreover, our study focused on awake bruxism and sleep bruxism, suggesting that awake bruxism and sleep bruxism may decrease after PTSD treatment in patients with PTSD and chronic painful TMD.

Although a single study does not warrant definite conclusions, these results may contribute to efforts to gain more insight into the mechanisms underlying the comorbidity between chronic (TMD) pain and PTSD. The improvements in painful TMD and pain intensity after PTSD treatment appear to be consistent with models that place PTSD in the aetiology of comorbid chronic pain.[15,50] However, the fact that approximately half of the patients still reported painful TMD after PTSD treatment indicates that this is not a full explanation. Possibly, there is also a role for shared vulnerability, as this implies that pain would remain unaltered as long as treatment is not aimed at the underlying shared vulnerabilities.[13] Nevertheless, the results of this study justify taking PTSD seriously as a possible aetiological factor and focus for additional treatment in patients seeking care for chronic painful TMD. Unfortunately, PTSD is often overlooked in health care settings, including mental health care.[51,52] Therefore, a trauma-sensitive approach is advisable, especially if treatment of PTSD could possibly contribute to alleviating other conditions such as painful TMD.

5 | CONCLUSIONS

This study is the first to suggest that trauma-focused treatment may contribute to the reduction of chronic painful TMD, awake bruxism and sleep bruxism in patients with PTSD and chronic painful TMD, with improvements persisting at 6-month follow-up. These results

provide preliminary support for a trauma-sensitive approach to patients presenting with chronic painful TMD. Referring patients with comorbid PTSD for trauma-focused treatment may be a worthwhile addition to treatment plans for patients with chronic painful TMD.

AUTHOR CONTRIBUTIONS

All authors are fully accountable for the text and agree to its submission. Wendy Knibbe contributed to the conceptualisation, formal analysis, investigation, methodology and writing—original draft. Ad de Jongh contributed to the conceptualisation, investigation, methodology, writing—review and editing. Kübra Acar-Ceylan and Zahra Al Hamami were involved in conceptualisation, methodology and writing—review and editing. Corine M. Visscher contributed to the conceptualisation, formal analysis, methodology and writing—review and editing. Frank Lobbezoo contributed to the conceptualisation, investigation, methodology and writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

F. Lobbezoo receives research grants from Sunstar Suisse, S.A., Vivisol-Resmed and Health Holland, which are unrelated to this paper. F. Lobbezoo is an unsalaried member of the Academic Advisory Board of Sunstar Suisse S.A. for GrindCare. A. de Jongh receives income from published books on EMDR therapy and the training of postdoctoral professionals in this method. The other authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author [Wendy Knibbe; w.knibbe@acta.nl]. The data are not publicly available due to information that could compromise the privacy of research participants.

PEER REVIEW

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