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Spinal high-velocity low-amplitude manipulation with exercise in women with chronic temporomandibular disorders

A randomized controlled trial comparing to patient education

Temporomandibular disorders (TMD) are musculoskeletal conditions characterized by painful conditions and dysfunctions in the muscles of mastication, the temporomandibular joint (TMJ), and related-tissue components [26]. The prevalence of TMD is estimated to be between 3% and 15% [25]. Primarily middle-aged adults suffer from TMD pain and women are affected twice as often as men [21]. The origin of TMD is multifactorial, comprising local factors such as trauma, occlusal changes, oral parafunctions, and joint overload leading to internal derangement of TMJ and muscles of mastication, together with psychological factors such as depression, anxiety, posttraumatic stress syndrome, or somatization and social factors [15, 28].

Several studies have shown that TMD is associated with other painful conditions such as headache and neck pain [19, 34, 36, 37]. In a population-based study, 53% of those with TMD had severe headache/migraines and 54% had neck pain [32]. When evaluating the prevalence of neck pain in patients with TMD, it was presented that patients had twice the risk of experiencing neck pain as the general population [9]. In a recent

study, painful cervical dysfunctions were determined in 88.24% of patients with TMD compared to 51.35% of patients without TMD [38]. Previous studies have shown that cervical dysfunctions may influence the temporomandibular region and vice versa [5, 6, 12, 18]. A human study found that painful stimulation of the greater occipital nerve responds with referred pain patterns within the distribution of the trigeminal nerve [30]. Regarding recent studies, latent trigger points in masticatory muscles were presented significantly more frequently in patients with chronic neck pain [10], and a positive correlation was observed between cervical and masticatory muscle sensitivities in patients with TMD [2, 31]. According to the literature, most studies reported that the relationship between these conditions could be explained by the neuroanatomical convergence of trigeminal and upper cervical afferents in the medullary dorsal horn of the spinal cord (trigeminal caudal nucleus). Evidence from basic studies on animals has demonstrated the convergence of trigeminal and upper cervical afferents [3, 4, 39], and there is also evidence of this mechanism in humans [7, 30]. Chronic nociceptive

inputs from trigeminal and cervical areas cause central hyperexcitability of the second-order neurons in spinal and/or supraspinal levels [8, 24]. Interaction between trigeminal and upper cervical second-order neurons in the spinal trigeminal subnucleus caudalis may enable the bidirectional transmission of nociceptive information [17, 37]. Due to the pathophysiological relationship, cervical dysfunctions can influence the temporomandibular system.

The aim of this study was to investigate the possible effects of HVLA manipulation of the upper cervical spine combined with neck exercise on pain modulation in the trigeminal area as well as its association with jaw pain intensity, pressure pain thresholds (PPT) of masticatory muscles, pain-free maximum mouth opening (MMO), and quality of life.

Patients and methods

Study design

This prospective, randomized controlled clinical trial used a computer-generated randomization sequence (QuickCalcs; GraphPad, La Jolla, CA, USA) to assign patients to three groups: HVLA upper



Fig. 1 ▲ Position for high-velocity low-amplitude manipulation to cervical spine



Fig. 2 ▲ Position for sham manipulation to the cervicothoracic junction

cervical spinal manipulation plus neck exercises (CSM+NE), sham manipulation and neck exercises (SM+NE), and patient education only (PE). All patients were clinically examined and diagnosed with TMD according with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) guidelines [13]. All assessments of the outcome measures were evaluated at baseline, after six treatment sessions (posttreatment, at least 72 h after the last intervention), and at 1-month follow-up.

The interventions were performed by the same physician who had at least 4 years' experience with manual therapy and had completed a manual medicine training program according to the Core Curriculum and the Guidelines for Basic Training and Education in Manual/Musculoskeletal Medicine issued by the International Federation for Manual/Musculoskeletal Medicine (FIMM; <http://www.fimm-online.com>).

Participants

Sixty women aged between 18 and 50 years diagnosed with TMD were recruited at the Department of Physical Medicine and Rehabilitation in the Faculty Hospital. The faculty's Ethics Committee approved the study protocol in conformity with the Declaration of Helsinki. All participants provided written informed consent at the beginning of the study after receiving full information about its procedures and purposes.

The inclusion criteria were signs and symptoms of exclusively TMJ and cervical pain and dysfunction, i.e., the presence of a unilateral or bilateral painful TMD associated with myofascial pain of at least 6 months' duration, which was classified as category I and/or II (muscles of mastication disorders and/or disc displacements) according to RDC/TMD criteria and with a minimum jaw pain score of 3 points. Furthermore, the patients had to have at least one segmental dysfunction of the upper cervical spine in all groups (by functional and pain provocation tests).

Patients were excluded if they presented with any of the following diagnoses: isolated disc displacement, arthrosis or arthritis of the TMJ according to the RDC/TMD, history of trauma (trauma by birth, whiplash injury, mandibular condyle fracture), or psychosocial stress. In addition, any red flags (vertebral tumor, fracture, dislocation and infection, metabolic diseases, rheumatic and connective tissue diseases, systemic neuromuscular diseases, prolonged history of steroid use), diagnosis of any structural spinal disorders (osteoporosis, disc herniation, myelopathy, spinal stenosis, spondylolisthesis), prior surgery to the cervical spine or TMJ, and medication for tension-type headache or migraine led to exclusion. Treatment for jaw or neck pain within the last 1 month and pregnancy were also reasons for exclusion.

Outcomes

Pain intensity

Self-reported jaw pain intensity was evaluated with the numeric rating scale (NRS) presented in RDC/TMD. Patients were asked about the average pain intensity that they had felt in the past week.

Pressure pain thresholds

PPT of masseter and temporalis anterior muscles were measured with a mechanical pressure algometer (Pain Diagnosis and Treatment Inc., Great Neck, NY, USA) consisting of a rubber disc (1 cm²), attached to a pressure gauge which was used in this study. The dial of the gauge is calibrated in kg/cm² and the range of the algometer is 0 to 10 kg with 0.1 kg divisions. The PPT protocol was designed as three consecutive measurements of each site of the masseter and temporalis anterior muscles with a pressure rate of 0.5 kg/s and with an interval of 30 s between each of the measurements [33]. The average of the last two measurements was calculated to obtain a single value for each of the measured sites in each assessment. PPT were assessed at two sites in the masseter muscle (M1: 2.5 cm anterior to the tragus and 1.5 cm inferior to the zygomatic arch and M2: 1 cm superior and 2 cm anterior to the mandibular arch) and one site in the temporalis muscle (T1: 3 cm superior to the midpoint between the end of the eye and the anterior part of the helix) [22]. Compression pressure was gradually increased until the pressure sensation turned into pain or discomfort, and the pressure value at that point was recorded.

Pain-free maximum mouth opening

The distance between the incisal ends of the maxillary and mandibular reference teeth was measured as recommended in RDC/TMD. Patients were asked to open their mouths as wide as possible without pain while they were sitting in an upright position. Pain-free MMO capacity was evaluated in millimeters with a 10-cm ruler.

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Abstract

Background. Evidence indicates that manual therapy alone or in combination with exercise can be beneficial for temporomandibular disorders (TMD). However, there is still insufficient information demonstrating the effectiveness of treatment directed to the cervical spine for the management of TMD. **Objective.** To investigate the effects of spinal high-velocity low-amplitude (HVLA) manipulation with exercise compared to patient education in patients with chronic TMD. Another objective was to assess the effects of adding spinal HVLA manipulation to exercise.

Patients and methods. Sixty female patients with TMD were randomized to three groups:

cervical spinal manipulation plus neck exercise (CSM + NE), sham manipulation plus neck exercise (SM + NE), and patient education only (PE). Scores on a numeric rating scale (NRS), pressure pain thresholds (PPT), pain-free maximum mouth opening (MMO), and Short Form 36 (SF-36) were evaluated at baseline, posttreatment, and 1-month follow-up after randomization. No further treatment of TMD (like dental correction) was applied during the study period.

Results. In terms of pain, significant differences were observed in the CSM + NE group vs. the SM + NE and PE groups posttreatment. Although PPT increased significantly in the CSM + NE group, no significant changes in

any PPT were found in either the SM + NE or PE group. Regarding pain-free MMO and SF-36 scores, there were significant increases posttreatment in the CSM + NE and SM + NE groups compared to the PE group.

Conclusion. Our study suggests that HVLA manipulation of the upper cervical spine with neck exercise can be effective for treatment of pain and dysfunction in patients with chronic TMD, it is not the TMD treatment itself. Therefore, it seems reasonable to add cervical manipulation to the rehabilitation program.

Keywords

Pain · Pain threshold · Manual therapy · Spine · Rehabilitation

Spinale Impuls-Manipulation plus Übungen bei Frauen mit chronischer temporomandibulärer Dysfunktion. Eine randomisierte kontrollierte Studie mit Vergleich zur Patientenedukation

Zusammenfassung

Hintergrund. Es bestehen Anhaltspunkte dafür, dass die manuelle Therapie allein oder in Kombination mit Übungen nützlich bei temporomandibulärer Dysfunktion (TMD) sein kann. Jedoch gibt es bisher noch keine ausreichenden Informationen, die die Wirkung der auf die Halswirbelsäule gerichteten Therapie bei der Behandlung der TMD zeigen. **Ziel.** Ziel war die Untersuchung der Auswirkungen von spinalen Manipulationen mit hoher Geschwindigkeit, aber von geringem Ausmaß, „high-velocity low-amplitude (HVLA) manipulation“, in Kombination mit Übungen im Vergleich zur Patientenedukation bei Patientinnen mit chronischer TMD. Ein weiteres Ziel war es, die Auswirkungen einer spinalen HVLA-Manipulation zusätzlich zu Übungen zu ermitteln.

Patienten und Methoden. Randomisiert wurden 60 Patientinnen mit TMD in 3 Gruppen aufgeteilt: Halswirbelsäulenmanipula-

tion plus Nackenübungen (CSM + NE), Scheinmanipulation plus Nackenübungen (SM + NE) und alleinige Patientenedukation (PE). Die Werte auf einer numerischen Bewertungsskala („numeric rating scale“, NRS), für die Druckschmerzschwelle („pressure pain thresholds“, PPT), die schmerzfreie maximale Mundöffnung (MMO) und im Fragebogen Short Form-36 (SF-36) wurden zu Beginn, nach Therapie und bei der Nachuntersuchung einen Monat nach Randomisierung bestimmt. Während der Studiendauer erfolgte keine weitere Behandlung der TMD (wie eine Zahnkorrektur).

Ergebnisse. In Bezug auf die Schmerzen wurden nach der Behandlung signifikante Unterschiede in der Gruppe mit CSM + NE gegenüber der Gruppe mit SM + NE sowie der PE-Gruppe festgestellt. Die PPT nahm in der Gruppe mit CSM + NE signifikant zu, aber in der Gruppe mit SM + NE oder der PE-Gruppe

wurden keine signifikanten Veränderungen der PPT beobachtet. Hinsichtlich der schmerzfreien MMO und der SF-36-Werte gab es nach Behandlung signifikante Steigerungen in der Gruppe mit CSM + NE und in der Gruppe mit SM + NE im Vergleich zur PE-Gruppe.

Schlussfolgerung. Die vorliegende Studie ergibt Hinweise darauf, dass die HVLA-Manipulation der oberen Halswirbelsäule zusammen mit Nackenübungen zur Behandlung von Schmerzen und Funktionsstörungen bei Patientinnen mit chronischer TMD wirksam sein kann, sie stellt jedoch nicht die TMD-Therapie an sich dar. Daher scheint es sinnvoll, die Manipulation der Halswirbelsäule in das Rehabilitationsprogramm mit aufzunehmen.

Schlüsselwörter

Schmerz · Schmerzschwelle · Manuelle Therapie · Wirbelsäule · Rehabilitation

Short Form 36

Self-reported health-related quality of life was assessed by Medical Outcomes Study (MOS) with the 36-item Short Form Health Survey (SF-36) developed for use in a wide range of diseases including TMD [35]. In this questionnaire, 36 items rated on Likert scales are summed and then transformed into two

summary scales: physical component summary (PCS) and mental component summary (MCS) scores.

Interventions

Cervical spinal manipulation

Spinal manipulation was performed using a segment-specific technique for seg-

mental dysfunctions of the upper cervical spine as described below (▣ Fig. 1):

- The patient sits in an upright position on a stool with the physician standing at the side of the patient, which is the opposite side of the identified segmental irritation.
- The physician's pelvis is placed in front of the patient's shoulder.

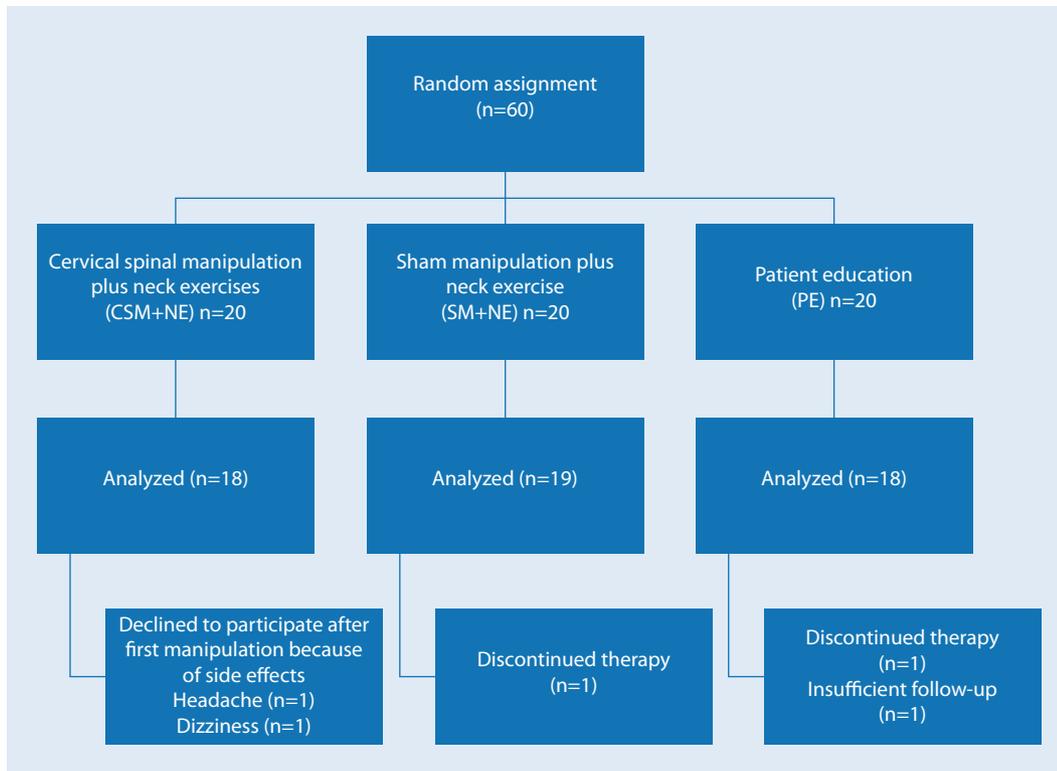


Fig. 3 ◀ Flow diagram of patient recruitment and retention. *CSM + NE* cervical spinal manipulation plus neck exercise, *SM + NE* sham manipulation plus neck exercise, *PE* patient education only

The physician's middle finger on the manipulation hand is placed in a parallel position to the upper transverse process of the identified dysfunctional segment while resting the forearm in a supinated position and elbow in a slightly flexed position.

- The hypothenar eminence of the holding hand is placed on the mastoid. The cervical spine is guided to a lateral inclination of approximately 15–20° and slight flexion with both hands of the physician without any rotational movement.
- The manipulation hand comes into deep contact with transverse processes, with the middle finger supported by the index finger, and deep force is applied in a dorsal to ventral direction.
- The physician's fingers of the manipulation hand remain in deep contact with the preliminary ventrally directed tension on the transverse process, while bilateral tension of the latissimus dorsi muscle as well as the pectoralis major muscle leads to shoulders being maintained horizontally.

- Further ventrally directed “slack” is taken up as a diagnostic probation mobilization to exclude contraindications (such as pain or dizziness during the test) against an impulse, then return to the initial position.
- With the patient relaxed, the physician applies a HVLA thrust at the starting position described above while ventrally pulling the upper transverse process of the dysfunctional segment.

Sham manipulation

Sham spine manipulation was performed at another segment using a HVLA manipulation to give the patient the same mechanical and acoustic sensations. This sham technique is designed to treat the cervicothoracic junction by an impulse to the spinous process of C7 (■ Fig. 2). This technique in a prone position was applied if the patient had no dysfunctional segment of the cervicothoracic junction. Therefore, this sham procedure avoided any influence on the upper cervical spine and any harm to the patient.

Neck exercises

These patients were asked to perform a home exercise program three days per week, with at least one day between each session, until the follow-up. Patients were instructed on how to perform the exercises at home. They were supervised individually after every manipulation session. Three sets of five repetitions per set for each exercise were performed with a 30- to 60-second rest period between sets. The exercise program consisted of cervical range of motion exercises that served as a warm-up, followed by stretching exercises of the neck and upper body muscles (trapezius, levator scapula, sternocleidomastoid) and strengthening exercises of the neck (cervical isometrics and concentric contraction of deep neck flexor muscles).

Education

These patients were informed about the causes and associations of complaints, treatment options, and management of symptoms to effectively contribute to their care during treatment and follow-up. The education program consisted of information about resting the TMJ and masticatory muscles by limiting jaw

Table 1 Demographic and clinical characteristics of patients

	CSM + NE (n = 18)	SM + NE (n = 19)	PE (n = 18)	
	Mean ± standard deviation (min–max) or (n) %			p-value ^a
Age (years)	27.0 ± 6.3 (19–37)	26.0 ± 7.9 (18–44)	28.8 ± 7.6 (19–42)	0.496
BMI (kg/m ²)	22.0 ± 2.1 (18.3–25.7)	21.7 ± 2.5 (17.5–27.3)	23.0 ± 3.1 (18.3–29.6)	0.515
<i>Duration of jaw pain</i>				
6 months–1 year	4 (22.2%)	7 (36.8%)	8 (44.4%)	0.335
1–2 years	8 (44.4%)	2 (10.5%)	6 (33.3%)	
>2 years	6 (33.3%)	10 (52.6%)	4 (22.2%)	
<i>Comorbidities of TMD</i>				
Neck pain	14 (77.8%)	16 (84.2%)	14 (72.2%)	0.681
Headache	14 (77.8%)	16 (84.2%)	15 (83.3%)	0.864

BMI body mass index; TMD temporomandibular disorders, CSM + NE cervical spinal manipulation plus neck exercise, SM + NE sham manipulation plus neck exercise, PE patient education only
^aKruskal–Wallis test, $\alpha = 0.05$

activity (e. g., reduced talking, chewing, yawning), parafunctional habit modification, postural correction, reducing stress, anxiety and fear, emphasizing a soft diet, and applying heat and/or ice therapy.

Statistical analyses

The Statistical Package for Social Sciences (SPSS 25, IBM Corp., Armonk, NY, USA) software was used for statistical analysis. The normal distribution of the variables was separately determined by the Shapiro–Wilk test for each group and for each measurement. Since there was no normal distribution (except for pain-free MMO and MCS scores) and the sample size of each group was small, we chose nonparametric tests in all statistical analyses to prevent any bias in the interpretation of the results. Descriptive statistics of the data were presented as mean values, standard deviations, minimum and maximum values, and frequency values. The homogeneity between the three groups was assessed using the Kruskal–Wallis test. The Wilcoxon signed ranks test was used to compare the differences within the groups for each group separately. For between-group comparisons, the Kruskal–Wallis test was used. The significance level was regarded as $p < 0.05$. The Mann–Whitney U test was employed in subanalyses of pair-related comparisons and the significance level for the

multiple comparison test was defined as 0.017 using the Bonferroni correction ($p\text{-value} = 0.05/\text{number of pair-related comparisons}$).

Results

The final study sample consisted of 55 patients; 5 patients were excluded from the final analysis due to side effects after the first manipulation session (headache in one patient and dizziness in another patient in the CSM + NE group), discontinued therapy (one in the SM + NE and one in the PE group), and insufficient follow-up (one in the PE group; **Fig. 3**). Demographic and clinical characteristics of the patients were obtained at the baseline assessment and summarized in **Table 1**. There were no statistically significant differences among the three groups in relation to demographic variables and baseline assessments of outcome measures.

Baseline, posttreatment, and follow-up mean (standard deviation) values relevant to outcome measures (NRS, PPT, pain-free MMO, PCS, and MCS scores), and within-group comparisons are given in **Table 2**.

The NRS displayed a significant difference in the CSM + NE group compared to the SM + NE and PE groups posttreatment. However, no significant difference was found between the study groups at the 1-month follow-up (**Table 3**).

PPT changes except for the right masseter-M2 and right temporalis were sig-

nificant in the CSM + NE group compared to the SM + NE and PE groups at each time point. No significant changes in any PPT were found in either the SM + NE or PE group (**Table 3**).

There were significantly bigger changes on pain-free MMO in the CSM + NE and SM + NE groups compared to the PE group posttreatment. However, these significant differences disappeared between SM + NE and PE groups at the 1-month follow-up (**Table 3**).

The PCS and MCS scores increased significantly in the CSM + NE and SM + NE groups compared with the PE group posttreatment. However, these significant differences disappeared between SM + NE and PE groups at the 1-month follow-up (**Table 3**).

Discussion

This prospective randomized controlled trial demonstrates that in the presence of TMD, the HVLA manipulation of the upper cervical spine combined with a neck exercise program reduced jaw pain intensity at least for a limited period, and increased the PPT of masseter and temporalis muscles as well as pain-free MMO; moreover, it improved quality of life in women with TMD after treatment and at the 1-month follow up. The findings of our study are in accordance with a recent systematic review and meta-analysis demonstrating strong favorable effects of cervical manual therapy in TMD [1].

In the literature, the first study by La Touche et al. [22] evaluating the effectiveness of upper cervical mobilization with neck exercises in TMD reported significant effects on PPT of masticatory muscles. However, the lack of a control group in this study does not allow distinction of the actual treatment effect in TMD. Oliveira Campello et al. [29] reported that atlanto-occipital joint manipulation and suboccipital muscle inhibition increased PPT on the latent trigger points of masticatory muscles in asymptomatic patients immediately after application of the technique when compared to a control group. In this study, an increase of approximately 0.2 kg/cm² in PPT, which was not clinically significant, was observed on the latent trigger points in the trigemi-

Table 2 Descriptive data and within-group comparisons of the assessed variables

Outcome measures	Mean ± standard deviation				Within-group comparisons	
	Groups	Baseline	Posttreatment	1-month follow-up	Wilcoxon p-value	
					Baseline vs. posttreatment	Baseline vs. 1-month
NRS (cm)	CSM + NE	4.1 ± 1.9	1.6 ± 1.5	1.5 ± 1.9	0.001*	0.001*
	SM + NE	4.5 ± 1.3	4.1 ± 2.2	3.5 ± 2.5	0.382	0.114
	PE	4.5 ± 2.7	4.6 ± 2.7	3.7 ± 2.4	0.705	0.122
<i>PPT (kg/cm²)</i>						
Right masseter-M1	CSM + NE	1.7 ± 0.4	2.2 ± 0.5	2.3 ± 0.7	0.007*	0.005*
	SM + NE	1.6 ± 0.3	1.5 ± 0.3	1.6 ± 0.4	0.227	0.844
	PE	1.5 ± 0.3	1.4 ± 0.3	1.5 ± 0.3	0.184	0.602
Right masseter-M2	CSM + NE	1.6 ± 0.4	1.9 ± 0.4	2.1 ± 0.6	0.045*	0.033*
	SM + NE	1.5 ± 0.3	1.4 ± 0.4	1.5 ± 0.4	0.477	0.844
	PE	1.4 ± 0.3	1.3 ± 0.4	1.4 ± 0.4	0.168	0.500
Right temporal-T1	CSM + NE	2.3 ± 0.5	2.7 ± 0.7	3.1 ± 0.7	0.072	0.001*
	SM + NE	2.3 ± 0.7	2.2 ± 0.7	2.3 ± 0.8	0.643	0.968
	PE	1.8 ± 0.4	1.7 ± 0.4	1.7 ± 0.3	0.170	0.255
Left masseter-M1	CSM + NE	1.6 ± 0.3	2.2 ± 0.6	2.3 ± 0.7	0.001*	0.002*
	SM + NE	1.4 ± 0.3	1.4 ± 0.2	1.5 ± 0.3	0.760	0.330
	PE	1.4 ± 0.2	1.3 ± 0.2	1.4 ± 0.2	0.260	0.593
Left masseter-M2	CSM + NE	1.4 ± 0.3	1.9 ± 0.5	2.1 ± 0.7	0.009*	0.004*
	SM + NE	1.3 ± 0.2	1.4 ± 0.3	1.3 ± 0.2	0.211	0.588
	PE	1.4 ± 0.4	1.3 ± 0.4	1.4 ± 0.4	0.124	0.659
Left temporal-T1	CSM + NE	2.1 ± 0.5	3.2 ± 0.5	3.1 ± 0.7	0.001*	0.001*
	SM + NE	2.0 ± 0.6	2.0 ± 0.6	2.0 ± 0.6	0.444	0.827
	PE	1.8 ± 0.4	1.7 ± 0.4	1.7 ± 0.4	0.046*	0.379
Pain-free MMO (mm)	CSM + NE	30.1 ± 6.3	36.6 ± 7.3	36.6 ± 7.8	0.002*	0.005*
	SM + NE	33.8 ± 8.6	36.8 ± 7.8	35.1 ± 9.1	0.051	0.531
	PE	35.2 ± 9.1	32.0 ± 8.8	31.0 ± 9.3	0.021*	0.050*
SF-36 PCS	CSM + NE	56.0 ± 11.9	63.1 ± 12.3	66.1 ± 13.0	0.001*	0.004*
	SM + NE	51.8 ± 18.1	57.9 ± 12.5	55.4 ± 17.8	0.064	0.191
	PE	49.6 ± 15.6	44.1 ± 17.5	51.3 ± 17.6	0.017*	0.224
SF-36 MCS	CSM + NE	52.9 ± 17.2	58.2 ± 16.4	61.1 ± 14.8	0.231	0.022*
	SM + NE	49.0 ± 19.2	53.7 ± 17.0	53.2 ± 17.9	0.134	0.215
	PE	49.8 ± 16.9	43.6 ± 19.0	47.0 ± 20.5	0.021*	0.427

NRS numeric rating scale; *PPT* pressure pain thresholds; *MMO* maximum mouth opening; *SF-36* Short Form 36; *PCS* physical component summary; *MCS* mental component summary, *CSM + NE* cervical spinal manipulation plus neck exercise, *SM + NE* sham manipulation plus neck exercise, *PE* patient education only
*Statistically significant changes in the within-groups comparison by Wilcoxon signed rank test ($\alpha = 0.05$)

nal region. This limited mechanical hypoalgesic effect might be because symptomatic patients were not included in the study. In our study, the PPT significantly increased in the upper cervical manipulation group, while there were no changes in the PPT in both the sham manipulation and education groups. This may reflect

the effect of upper cervical manipulation on pain modulation in the trigeminal region. This is probably due to the interruption of nociceptive stimulus from the upper cervical area. Another study by La Touche et al. [23] suggested greater effectiveness of anterior-posterior upper cervical mobilization in improving pain

intensity (visual analog scale [VAS] score) and PPT of masticatory muscles after the second and third sessions of treatment in patients with temporomandibular and neck pain when compared to the control group. In this study, VAS and PPT values were gradual and consistent, improving after treatment sessions, but long-term effects were not achieved. Therefore, it is possible that they will have missed an effect that developed over time. In our study, similar significant favorable posttreatment effects on the NRS were not maintained at the 1-month follow-up. This limitation of the pain reduction is probably related to the recurrence of the cervical dysfunction, as there was no causal TMD therapy by a dentist or an orthodontist during the study period.

Two studies evaluated mouth opening in asymptomatic individuals immediately after the manual therapy treatment compared to the control group. Among these, George et al. [16] observed no improvement, whereas Oliveira Campello et al. [29] noted significant improvement in mouth opening. Since asymptomatic individuals were assessed in these studies, the clinically significant measurement of pain-free MMO could not be used. Previous studies showed that injuries to the cervical region might alter masticatory motor control and reduce mandibular functions [14, 20]. Mansilla-Ferragut et al. [27] reported significant improvement on pain-free MMO in patients with neck pain immediately after atlanto-occipital joint manipulation compared to sham manipulation. In this regard, cervical manipulation might positively influence cervical movements, which can affect temporomandibular movements if cervical dysfunction is present. Moreover, De Laat et al. [11] indicated significant limitation in the mobility of the upper cervical segments in patients with temporomandibular pain. It is highly likely that functional integration exists between jaw and cervical movements. Only one study by La Touche et al. [22] has shown that mobilization of the cervical spine, together with cervical spine exercises, leads to increased pain-free MMO in the long term in a series of patients with TMD. Regarding pain-free MMO in our study, there were significant

Table 3 Between-group comparisons of the assessed variables

Outcome measures	Pairwise comparisons	Between-group comparisons			
		Mann–Whitney U <i>p</i> -value		Kruskal–Wallis <i>p</i> -value	
		Baseline vs. posttreatment	Baseline vs. 1-month	Baseline vs. posttreatment	Baseline vs. 1-month
<i>NRS (cm)</i>	CSM + NE vs SM + NE	0.003 ^b	0.038	0.000 ^a	0.034 ^a
	CSM + NE vs PE	0.000 ^b	0.017		
	SM + NE vs PE	0.281	0.874		
<i>PPT (kg/cm²)</i>					
Right masseter-M1	CSM + NE vs SM + NE	0.001 ^b	0.003 ^b	0.001 ^a	0.007 ^a
	CSM + NE vs PE	0.001 ^b	0.013 ^b		
	SM + NE vs PE	0.940	0.538		
Right masseter-M2	CSM + NE vs SM + NE	0.031	0.046	0.030 ^a	0.049 ^a
	CSM + NE vs PE	0.016 ^b	0.031		
	SM + NE vs PE	0.845	0.391		
Right temporal-T1	CSM + NE vs SM + NE	0.039	0.001 ^b	0.030 ^a	0.000 ^a
	CSM + NE vs PE	0.014 ^b	0.000 ^b		
	SM + NE vs PE	0.753	0.461		
Left masseter-M1	CSM + NE vs SM + NE	0.000 ^b	0.000 ^b	0.000 ^a	0.000 ^a
	CSM + NE vs PE	0.000 ^b	0.000 ^b		
	SM + NE vs PE	0.271	0.663		
Left masseter-M2	CSM + NE vs SM + NE	0.009 ^b	0.000 ^b	0.001 ^a	0.000 ^a
	CSM + NE vs PE	0.001 ^b	0.000 ^b		
	SM + NE vs PE	0.049	0.461		
Left temporal-T1	CSM + NE vs SM + NE	0.000 ^b	0.000 ^b	0.000 ^a	0.000 ^a
	CSM + NE vs PE	0.000 ^b	0.000 ^b		
	SM + NE vs PE	0.057	0.480		
<i>Pain-free MMO (mm)</i>	CSM + NE vs SM + NE	0.134	0.046	0.000 ^a	0.001 ^a
	CSM + NE vs PE	0.000 ^b	0.000 ^b		
	SM + NE vs PE	0.006 ^b	0.053		
<i>SF-36 PCS</i>	CSM + NE vs SM + NE	0.358	0.098	0.000 ^a	0.032 ^a
	CSM + NE vs PE	0.000 ^b	0.006 ^b		
	SM + NE vs PE	0.004 ^b	0.538		
<i>SF-36 MCS</i>	CSM + NE vs SM + NE	0.893	0.518	0.019 ^a	0.055
	CSM + NE vs PE	0.016 ^b	0.014 ^b		
	SM + NE vs PE	0.012 ^b	0.126		

NRS numeric rating scale; *PPT* pressure pain thresholds; *MMO* maximum mouth opening;

SF-36 Short Form 36; *PCS* physical component summary; *MCS* mental component summary

^aStatistically significant changes in the between-groups comparison by Kruskal–Wallis test ($\alpha = 0.05$)

^bStatistically significant in the pairwise comparisons by Mann–Whitney U test with Bonferroni correction ($p < 0.017$)

increases posttreatment in both groups of cervical intervention compared to the education group. However, this effect was larger in the cervical manipulation group and persisted during follow-up. It was possible that the changes in pain-free MMO in the sham manipulation group were the reflection of increased cervical mobility in response to exercise. A significant difference in the sham manipulation group is expected to disappear during follow-up, because our intervention program did not specifically target treatment of cervical dysfunctions or change any asymmetry in functional occlusion. Additionally, it may be related to the lack of supervised exercises during follow-up.

We found more improvement in both PCS and MCS scores in the manipulation and sham manipulation groups compared to the education group posttreatment, despite the lack of evaluation of quality of life in previous studies. It is apparent that the changes in PCS and MCS scores may have been associated with pain intensity and mandibular functions.

Strengths and limitations of the study

To our knowledge, this study is the first randomized clinical trial to directly compare the effectiveness of upper cervical manipulation, sham manipulation, and education in patients with TMD. Our study design allowed us to assess the added benefit of upper cervical spinal manipulation in combination with exercise and to evaluate the effects of spinal HVLA manipulation with exercise compared to the control group. The patient education group was the control group. In our study, it is important that manipulation is applied only to the upper cervical segments where dysfunction is detected. In contrast, many previous studies used manual therapy applications non-specifically, although the effects of manual therapy applied to the non-dysfunctional cervical segment are controversial. The chosen sham manipulation in this trial is related to the actual manipulation.

When the limitations of our study are evaluated, the duration of follow-up in our study is short. As we expected, due to

a lack of causal TMD therapy, recurrences developed fast. Compliance with exercise was not measured during the follow-up, and therefore, we do not know whether this affected the outcomes. Another limitation of our study is that we were unable to blind the patients or treating physician due to the study design. However, independent examiners who were blinded to treatment allocation and clinical evolution could have been involved in the trial.

In addition, manual manipulative treatment to the upper cervical spine can only be recommended in cases where there is no further component besides real upper cervical and temporomandibular dysfunction, i. e., no causes outside the TMJ, the occlusion of the teeth, and the control of the masticatory muscles. As TMD is a very complex condition, taking of a most detailed case history and performing exact examination of the patient's whole body and psychosocial conditions is essential to decide the most appropriate treatment of TMD.

Conclusion

Our data provide new evidence about the efficacy of treatment for TMD focused on the upper cervical region. The findings of this study indicate that HVLA manipulation, which is used as a noninvasive treatment for cervical dysfunction, can be used with neck exercise for the management of patients with chronic TMD. Based on the results, our study proves that upper cervical spine manipulations play an important role in the treatment of pain and dysfunction in the presence of TMD by interruption of the nociceptive vice versa effects of trigemino-cervical convergence. However, this role is only one aspect along the path to curing TMD, as it is also necessary to promote occlusal adjustment to prevent recurrence. Although these results are encouraging, large-scale interventional studies with the additional treatment of occlusion asymmetry and longer follow-up periods are still necessary to confirm these results for the management of patients with TMD and long-term efficacy.

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Compliance with ethical guidelines

Conflict of interest. M. Corum, C. Basoglu, M. Topaloglu, D. Diracoglu, and C. Aksoy declare that they have no competing interests.

This study was approved by the Ethics Committee of the Istanbul University Faculty of Medicine (IRB study protocol: 2014/1805). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants from whom identifying information is included in this article.

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Modellprojekt zur Fernbehandlung startet

Ab März wird die ambulante Versorgung in Baden-Württemberg um eine Facette reicher. In zwei Regionen startet ein Projekt zur Fernbehandlung. Bei „Doc Direkt“ bekommen GKV-Patienten binnen 30 Minuten qualifizierten ärztlichen Rat.

Der Landkreis Tuttlingen im Schwäbischen wird zusammen mit Stuttgart die Modellregion bilden, in der Vertragsärzte bundesweit erstmals – ohne vorherigen Kontakt – telemedizinisch beraten und behandeln. Das Projekt der Kassenärztlichen Vereinigung Baden-Württemberg soll im März starten. Ziel des „Doc Direkt“ genannten Projekts ist letztlich die Patientensteuerung. Die KV will im kleinen Maßstab in Erfahrung bringen, ob ein ärztlich besetztes Callcenter Versicherte davon abhalten kann, das Krankenhaus aufzusuchen. Hintergrund ist das viel diskutierte Phänomen, dass Patienten teilweise auch mit Befindlichkeitsstörungen die Notaufnahme aufsuchen. Die KVBW kooperiert dazu mit der Münchener TeleClinic GmbH.

Ersteinschätzung durch MFA

Im KV-Projekt können GKV-Versicherte in den beiden Modellregionen ab März bei Gesundheitsbeschwerden ein Callcenter anrufen, und zwar werktags zwischen 9 und 19 Uhr. Dort erfolgt durch eine speziell geschulte MFA eine Ersteinschätzung: Im Falle eines Notfalls wird der Anrufer sofort an die Rettungsleitstelle weitergeleitet. Anderenfalls wird der Versicherte binnen 30 Minuten von einem Arzt zurückgerufen. 89 Vertragsärzte haben sich bisher beworben, als Telearzt zu arbeiten. Ergibt sich aus dem Gespräch, dass die Beschwerden nicht abschließend geklärt werden können, wird dem Patient am gleichen Tag ein Termin in einer Vertragsarztpraxis in der Nähe vermittelt.

Bereits 72 PEP-Praxen

Diese teilnehmenden PEP-Praxen (Patienten erreichbare Portalpraxen) sind über eine webbasierte telemedizinische Plattform mit dem Callcenter verbunden. Sie müssen also keine zusätzliche Software auf den Praxisrechnern installieren. 72 Praxen haben bisher ihr Interesse bekundet, als PEP-Praxis zu agieren. Davon stammen 51 aus Stuttgart und sieben aus dem Landkreis Tuttlingen. 14 weitere Praxen sind in ganz Baden-Württemberg verteilt. 25 Euro Honorar erhält der

Telearzt im Projekt „Doc Direkt“ für jeden Anruf – extrabudgetär.

Der Ausschluss eines Arztes soll insbesondere bei „wiederholter Nichterreichbarkeit“ während der abgestimmten Ansprechzeiten sowie bei „begründeten Patientenbeschwerden“ möglich sein. Wichtig zudem: Die Berufshaftpflicht der teilnehmenden Ärzte muss auch die spezifischen Risiken telemedizinischer Beratung und Behandlung abdecken und eine Deckungssumme von mindestens drei Millionen Euro aufweisen. Vorgesehen ist, dass die PEP-Praxis für jeden über „Doc Direkt“ vermittelten Patienten einen extrabudgetären Fallwertzuschlag in Höhe von 20 Euro erhält. Ihre Leistungen kann die Praxis zudem außerhalb des RLV abrechnen. Die Fälle müssen durch Verwendung einer Pseudo-GOP gekennzeichnet werden. Der Telearzt, der das Erstgespräch führt, soll jeden Anruf mit 25 Euro extrabudgetär honoriert bekommen. Das auf zwei Jahre angelegte Projekt enthält eine Verlängerungsoption – doch dürfte sich relativ rasch abzeichnen, welche Bedeutung die Fernbehandlung in der vertragsärztlichen Versorgung spielen kann. Ausdrücklich heißt es, die Einbindung weiterer Regionen in das Projekt „ist vorgesehen“.

**Quelle: Ärzte Zeitung
(www.aerztezeitung.de)**