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ORIGINAL ARTICLE

Effect of therapeutic jaw exercise on temporomandibular disorders in individuals with chronic whiplash-associated disorders

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Abstract

Objective. The aim of this study was to investigate the effect of a specific therapeutic jaw exercise on the temporomandibular disorders of patients with chronic whiplash-associated disorders. ***Material and methods.*** Ninety-four consecutive patients with whiplash-related conditions were referred to and accepted for a treatment period at a center for functional evaluation and rehabilitation during 2001–2002. The patients followed a program of physical therapy, occupational therapy, and pain management. At the start of their stay, they were examined by a physician specialized in rehabilitation medicine and also by a dentist who performed a functional examination of the stomatognathic system. Of the 93 patients who accepted participation in the study, 55 were diagnosed with temporomandibular disorders and chronic whiplash-associated disorders in accordance with the inclusion criteria. They were randomized into a jaw exercise group ($n=25$), who performed specific therapeutic jaw exercises, and a control group ($n=30$). Both groups undertook the whiplash rehabilitation program at the center. ***Results.*** There were no inter- or intra-group differences in symptoms and signs of temporomandibular disorders at baseline, nor at the 3-week and 6-month follow-ups, except for an increase of maximum active mouth-opening capacity in the control group. ***Conclusions.*** In conclusion, the therapeutic jaw exercises, in addition to the regular whiplash rehabilitation program, did not reduce symptoms and signs of temporomandibular disorders in patients with chronic whiplash-associated disorders.

Key Words: *Exercise movement techniques, randomized clinical trial, temporomandibular joint disorders, whiplash injuries*

Introduction

Temporomandibular disorders (TMD) are clinical manifestations of disorders causing pain and dysfunction in the temporomandibular joints (TMJs) and masticatory muscles [1]. Whiplash-associated disorders (WAD) are the clinical manifestation of injuries resulting from an acceleration–deceleration mechanism of energy transfer to the neck [2]. TMD is more common in individuals with chronic WAD than in the general population [3].

One treatment modality for TMD is therapeutic jaw exercise (TJE), which has been used for more than 40 years [4]. In Sweden, TJE is taught in both pre- and post-graduate dentistry training and in post-graduate physical therapy training.

The aim of TJE is to improve the biomechanics of joint and muscle function [5], improve mandibular mobility [4,5], improve neuromuscular coordination [4,5], relax tense muscles [4], increase muscular strength [5], improve local circulation [4], and improve patient confidence [4].

TJE is thought to work through physiologic mechanisms such as proprioceptive neuromuscular feedback [6]; reciprocal inhibition [5]; desensitization of the trigger points in the muscles through stretching [6]; and increasing patient's awareness and motor control of their jaw musculature [6], thus contributing to a decrease of bruxism and parafunction while the patient is awake.

The effect of TJE on TMD has been evaluated in several controlled clinical studies. TJE is reported to decrease symptoms of TMD [7–12] and increase the maximum mouth-opening capacity [7–15]. The effect on subjective and clinical outcome has been compared to that of stabilization appliance therapy [16]. Our hypothesis is that the patients performing

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the TJE will perceive a decrease of symptoms of TMD and show an increase of the maximum active mouth-opening capacity.

The aim of this study was to investigate whether a specific TJE, administered by physical therapists, has an additional effect on TMD in patients undergoing a rehabilitation program for chronic WAD.

Patients

Ninety-four individuals with whiplash-related conditions were accepted for a specific residential WAD rehabilitation program at Mälargården Rehabilitation Center, Sigtuna, Sweden, from January 2001 until April 2002. The patients first stayed for a period of 4 weeks at the center and then returned for an additional follow-up week approximately 6 months later. Patients were referred by regional social insurance offices and county councils in Sweden for functional evaluation and rehabilitation. They were informed about the study by letter and invited to participate before their stay at the center. All except one patient gave informed consent to take part in the study.

All patients followed the center's general rehabilitation program of physical therapy, occupational therapy, and training in pain management. The physical therapy program was individualized and emphasized postural and stabilization training, mobilization, and relaxation. Physical therapies included balance training, body awareness training, relaxation exercises, acupuncture, thermal therapies, hydrotherapy, electrical stimulation, and massage. During the first stay, patients were instructed to continue training at home.

On arrival at the center, the patients were medically examined by a consultant physician specialized in rehabilitation medicine. The physician worked independently of this study, although the diagnosis was an inclusion criterion.

The same day, the patients also underwent a standardized functional examination of the stomatognathic system performed by a dentist.

The inclusion criteria for the study were the diagnosis chronic WAD and TMD. WAD was classified on the two axes proposed by the Quebec Task Force for Whiplash-Associated Disorders; a clinical-anatomic axis (grade 0–IV) and a time axis [2]. The distribution of the diagnosis was 13 patients with WAD grade II and 69 patients with WAD grade III on the clinical-anatomic axis. All patients were examined more than 6 months from the time of the injury and were designated as chronic. For TMD a specified minimum level was decided (at least score D_iII) on the dysfunction index of Helkimo (D_i) [17] or pain on palpation of at least three masticatory muscles.

The patients arrived at the center in groups of maximum 8 patients, and there were 8 groups a year. In total, we invited 12 consecutive groups to participate in the study. On arrival, an independent secretary at the center randomized the whole group into either additional TJE or not. The randomization was performed in blocks of 4, repeated 3 times, and was done for the 93 patients giving their consent and before diagnosis of WAD and TMD. Thirty-eight patients not fulfilling the inclusion criteria were excluded. The remaining jaw exercise group (JEG) finally consisted of 25 patients and the control group (CG) consisted of 30 patients (Figure 1). Randomizing into groups instead of on an individual basis minimized the influence between the treatment regimes during the 4-week stay at the center.

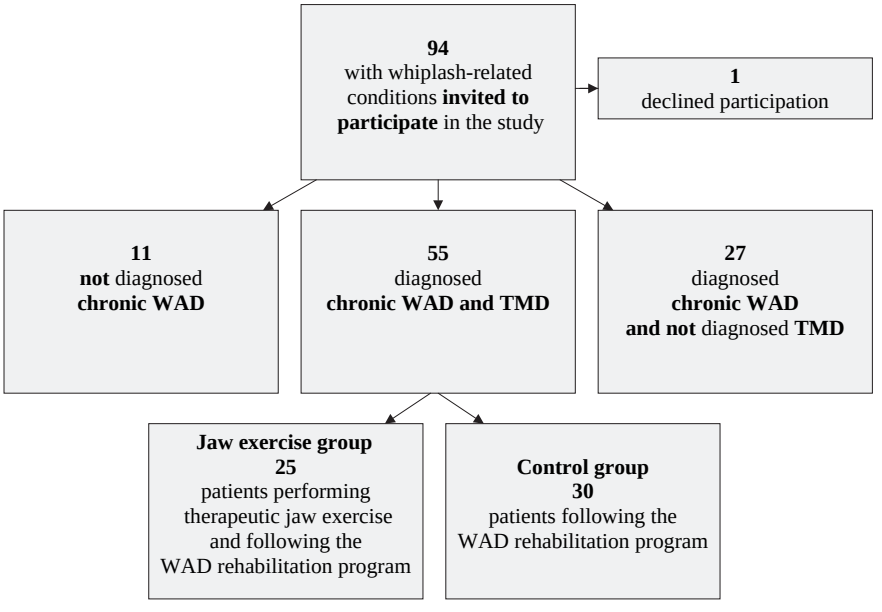

Figure 1. The flow of the 94 consecutive patients invited to participate in the study.

The flow of the 94 patients through each stage of the study is shown in Figure 1.

Methods

Measured parameters

The examiner of the stomatognathic system was blinded to group assignment, both at baseline and at the follow-up examinations, and did not know about the momentary condition of the patients at the follow-ups – not having discussed the patients with the staff at the center.

All patients answered a standardized anamnestic questionnaire before the clinical examination. The anamnestic dysfunction index of Helkimo (A_i0–II) [17] was used to assess symptoms such as TMJ sounds, feeling of fatigue or stiffness in the jaws, difficulty in opening the mouth wide, pain on mandibular movement, pain in the TMJ or masticatory muscle regions and TMJ locking or luxation. The symptoms were graded according to severity, where: A_i0 represented no symptom; A_iI mild symptoms; and A_iII severe symptoms.

The standardized clinical examination of the stomatognathic system included: measurements of active mandibular movements; the registration of perceived pain during mandibular movements; pain on palpation of the masticatory muscles and the neck muscles; pain on palpation of the TMJs; and TMJ sounds. The vertical overbite and horizontal overjet were included in the measurement of the maximum active mouth-opening capacity and mandibular protrusion. The mandibular movement measurements were taken with a ruler to the nearest millimeter. The following seven sites in four masticatory muscles and three sites in three muscles of the neck and the shoulders were palpated bilaterally: posterior, anterior and insertion part of the temporal muscle; superficial and profound part of the masseter muscle; lateral and the medial pterygoid muscles; sterno-cleido-mastoid muscle; shoulder part of the trapezius muscle; and superficial neck muscles. A masticatory muscle score and a neck muscle score were calculated. One point was given when the individual reported unilateral pain from a muscle site. When the individual reported bilateral pain, one point was given only if a clear autonomous reaction, i.e. a palpebral reflex or evasive action, was also provoked. Each individual could thus receive a maximum of seven points on the masticatory muscle score and a maximum of three points on the neck muscle score.

Pain experience on lateral and posterior TMJ palpation was registered when the individual reported unilateral pain or where a clear autonomous reaction could be seen. TMJ sounds were registered during palpation of the lateral aspects of the joints during active mouth opening and closing.

To summarize the clinical signs in the stomatognathic system, the dysfunction index of Helkimo (D_i0-III) (17) was used. Dysfunction was graded according to severity, where D_i0 represented absence of clinical signs and D_iIII represented severe signs.

After the clinical examination, the patients were asked to draw body drawings on a formula with the contour of a body and written instructions about which symbols to use for different sensations of pain. The formulas were handed back to the dentist 3 weeks later.

The standardized examination of the stomatognathic system for the JEG and the CG was repeated after 3 weeks and again at the 6-month follow-up when the patients also answered a questionnaire for the physical therapists. The questionnaire assessed compliance to both the general home exercise regime and the TJE, how they managed daily activities, and their present jaw symptoms. The authors were unaware of the answers until after termination of the study.

To determine to what extent the patients had widespread pain, body drawings done by the patients at the start of the study were analyzed. Widespread pain was assessed according to a protocol previously described by Visscher et al. [18] determining the number of painful body areas (0–5) below the cervical spine. The protocol was derived from a protocol originally suggested by Türp et al. [19].

In further analysis of the body drawings, the pain described by the patients was categorized as organic, i.e. pain originating mainly from a tissue disturbance, or non-organic, i.e. pain attributed to the patient's mental state, according to Mann et al. [20].

Therapeutic jaw exercise

The JEG received a TJE program in addition to the physical therapy given at the center. The TJE consisted of: relaxation; small active mandibular movements; maximum active mandibular movements; active movements against resistance with 6 s of static resistance at the end of the movement; rest; mouth closing against resistance with 6 s of static resistance halfway on mouth closing; rest; 5 s of stretching at maximum mouth opening; and relaxation. The patients were instructed to repeat each part of the program 5–10 times and to perform the program three times daily. The patients should not experience pain during the TJE. If a part of the program induced pain, the patients were instructed to exclude that specific part from the program and try to reintroduce the excluded part of the program after 1 week.

The physical therapists at the center administered the TJE with verbal and written instructions to the patients. Every day they encouraged cooperation among the patients and instructed and motivated them to continue the TJE at home.

Statistics

Comparisons between independent groups were performed with Student's *t*-test on continuous variables and with the Chi-square test on categorical variables. For ordered categorical variables, the Chi-square test for trend was used. Exact tests were used when the numbers of observations were low in one or more categories. Comparisons of related samples were performed with the non-parametric Friedman's test. Simultaneous comparisons of continuous variables within and between groups were performed with repeated measurement ANOVA [21,22]. $p < 0.05$ was considered statistically significant. The study was approved by the local ethics committee of the Karolinska Institute, Stockholm.

Results

At baseline, the JEG consisted of 18 (72%) women and the CG of 21 (70%) women. The mean age for the JEG was 38.5 years (R = 24–60) and 36.2 years (R = 21–55) for the CG. The mean time elapsed from the reported injury was 42.1 months (R = 10–159: JEG) and 46.8 months (R = 10–201: CG). The number of patients declined in both the JEG and the CG at the 3-week follow-up because two patients left the center earlier than planned (Table II). At the 6-month follow-up, 6 patients did not attend (Table II), 2 patients did not want to participate in the examination of the stomatognathic system (Table II) and 2 of the patients did not answer the questionnaire administered by the physical therapists (Table III).

Anamnestic and clinical findings

There were no differences between or within the JEG and CG groups for the anamnestic dysfunction index (A_i) and the clinical dysfunction index (D_i) at any time during the course of the study (Table II).

Between groups, there was no statistically significant difference regarding the clinical parameters at any time of the study. Within groups, only in the CG was one clinical parameter (the maximum active mouth-opening capacity) changed significantly (Table I).

The questionnaire administered by the physical therapists at the 6-month follow-up

This questionnaire showed that during the 5 months at home, 10 patients in the CG had been given some kind of jaw exercises by other therapists. However, the only difference between the two groups was that JEG performed TJE more often. More than half of the patients in both groups did not consider that the jaw symptoms had changed (Table III). There was a high compliance rate (86–96%) regarding the general physical therapy home exercises. A majority of the patients indicated that they managed daily activities better or much better compared to 5 months before (Table III).

Pain drawing

All except three patients (1 in the JEG and 2 in the CG) noted painful areas below the cervical spine. The mean value of the number of painful body areas below the cervical spine was 3.04 (R = 0–5) for JEG and 3.10 (R = 0–5) for CG. Sixty-four percent of the patients in the JEG and 60% in the CG drew non-organic pain drawings.

Discussion

TJE did not reduce symptoms or clinical signs of TMD in patients with chronic WAD compared to other controlled studies, where alleviation of TMD

Table I. Clinical signs in the jaw exercise group (JEG) and in the control group (CG) at baseline, 3 weeks and 6 months

	Baseline		3 weeks		6 months	
	JEG ($n=25$)	CG ($n=30$)	JEG ($n=24$)	CG ($n=29$)	JEG ($n=20$)	CG ($n=27$)
Maximum active mouth-opening capacity, mean value (mm)	46.0	45.6*	46.0	44.8*	46.0	46.6*
Maximum active mouth-opening capacity <40 mm (%)	16.0	20.0	16.7	20.7	20.0	7.4
Pain on mandibular movement (%)	40.0	33.3	50.0	48.3	65.0	63.0
Masticatory muscle score (0–7) on palpation, mean value	2.96	3.00	3.04	3.41	2.20	2.89
Neck muscle score (0–3) on palpation, mean value	1.64	1.47	1.17	1.82	1.00	1.22
Temporomandibular joint pain on lateral palpation (%)	52.0	43.3	54.2	48.3	50.0	44.4
Temporomandibular joint pain on posterior palpation (%)	35.3	24.0	18.8	33.3	20.0	25.9
Temporomandibular joint clicking (%)	40.0	23.3	41.7	34.5	30.0	25.9
Temporomandibular joint crepitation (%)	28.0	16.7	12.5	20.7	5.0	7.4

*$p < 0.05$ within the CG.

Table II. The anamnestic dysfunction index score, according to Helkimo (Ai0–II), and the clinical dysfunction index score, according to Helkimo (Di0–III), in the jaw exercise group (JEG) and in the control group (CG) at baseline, after 3 weeks, and after 6 months, number of patients (%)

	Baseline		3 weeks		6 months	
	JEG ($n=25$)	CG ($n=30$)	JEG ($n=24$)	CG ($n=29$)	JEG ($n=22$)	CG ($n=27$)
A_i0	4	0	0	0	0	4
A_iI	4	17	8	14	5	4
A_iII	92	83	92	86	95	92
D_i0	0	0	4	0	5*	0
D_iI	4	27	25	24	25*	22
D_iII	72	50	38	28	35*	48
D_iIII	24	23	33	48	35*	30

*$n=20$.

symptoms and/or an increase of the maximum active mouth-opening capacity have been shown [7–15].

The CG showed an increase of the maximum active mouth-opening capacity, but too small to be clinically relevant.

There are several differences between groups over time, in favor of the treatment group, but these differences did not reach statistical significance (Tables I and III). This may have been due to an insufficient number of subjects. The drop-out was 20% of the JEG (Table I) and 13% of the CG (Table III). The baseline data of these patients did not differ numerically from the patients that could be followed for 6 months. It is unlikely that the drop-outs have had any major influence on the results.

Chronic pain has the potential to both influence the perception of pain and to cause maladaptive behaviors in input as well as output systems [23]. Many other controlled studies do not state general co-morbidity [7–12,15], therefore the patients suffering from chronic WAD in this study may have been more burdened by generalized pain compared to the patients in the other studies.

The patients in the present study had widespread pain to a greater extent than the patients examined by Visscher et al. with both cervical spine disorders and TMD, which shows that those in the present study are chronic pain patients with a relatively large extent of pain [18]. As the patients' general pain may in part result from the influence of chronic pain on the input nervous systems, successful treatment outcomes of TJE on TMD in other studies [7–12,15,16] may therefore not be applicable to this patient group.

It has been emphasized that TJE should not be painful during or after the performance [4,5]. In order to avoid exaggeration of the jaw training, the patients in this study were followed for 4 weeks by physical therapists who instructed the patients how to avoid the latter parts of the training program if

Table III. Self-reported compliance with recommended home-based exercise regimes and subjectively estimated difference in jaw symptoms and ability to manage daily activities at the 6-month follow-up (%)

	JEG ($n=21$)	CG ($n=26$)	p-value
1. Have you performed a jaw exercise program at home during the past 5 months?			
Yes	24	23	
Yes, but less than recommended	71	15	<0.001
No	5	62	
2. How are your jaw symptoms compared to 5 months ago?			
Worse	14	15	
Unchanged	57	65	
Better	14	19	ns
Much better	10	0	
I don't know	5	0	
3. Have you performed the physical therapy home exercises administered 5 months ago by a physical therapist at the center?			
Yes	62	50	
Yes, but less than recommended	24	46	ns
No	14	4	
4. How do you manage daily activities in general compared to 5 months ago?			
Worse	28	12	
Unchanged	14	27	
Better	48	58	ns
Much better	10	4	
I don't know	0	0	

pain occurred during TJE or afterwards. Despite this, no significant reduction of TMD symptoms and signs were noted at the follow-ups. However, 95% of the patients in the JEG reported that they continued with the TJE at home. Possible factors influencing compliance to self-administrated therapeutic exercises are the effectiveness in reducing symptoms and the patient's sense of loyalty to the therapist [24]. Increased knowledge of the pain condition and a greater sense of controlling the symptoms may also have contributed to compliance. Another explanation for the high degree of compliance could be that the patients experienced momentary relief from jaw symptoms during the performance of TJE, which, however, did not continue over the period. Other explanations for the compliance could have been influenced by recall bias.

A chronic pain condition influences both somatic and psychogenic factors. The patients' pain drawings were classified as characterizing organic (somatic) or non-organic (psychogenic) factors. Non-organic pain drawings have been related to low psychological scores on the Short Form 36 questionnaire measuring general health and well being [25] and have also been correlated with psychological characteristics predicting poor outcome of spinal surgery in patients with low back pain [25]. In this study, approximately 60% of the patients drew non-organic pain drawings indicating a possibly extensive influence of chronic pain on the output nervous systems. The prevalence of mental dysfunction in patients suffering pain indicates a poor outcome and must be considered when deciding strategies for pain management [23], and was not considered in the treatment of TMD in this study.

As all patients in this study suffered from neck pain, referred pain from the neck could be suspected, contributing to the limited results of the TJE. However, this may not be a full explanation, because both this study and the study by Klobas et al. [3] determined a high prevalence of clinical signs in the stomatognathic system classifying TMD patients from cervical spine disorders patients [26,27]. It is therefore likely that the TMD of these patients is a co-existing problem that may, or may not, be evoked by the neck trauma.

The questionnaire answered at the physical therapist 6-month follow-up revealed that 10 of the 26 individuals in the CG had been instructed by other therapists to perform some kind of jaw exercises between the 3-week and 6-month follow-ups. As this information was given by the patients in a questionnaire, it was not analyzed further. However, as neither of the groups improved during the observation time, this is unlikely to have confounded the results.

In conclusion, this specific therapeutic jaw exercise program, as a single rehabilitation modality, was not additional to the physical therapy, the occupational therapy and pain management in reducing symptoms and signs of temporomandibular disorders in patients with chronic whiplash-associated disorders.

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