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Original Article

Short-term efficacy of exercise therapy for temporomandibular disorders: a case control study

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Abstract. [Purpose] This study compared the short-term outcomes of manual therapy performed by a dentist and home exercises performed by patients as a single exercise therapy program for temporomandibular joint anterior disc displacement without reduction. [Participants and Methods] In this study we included seventeen patients with temporomandibular joint anterior disc displacement without reduction, moderate or greater temporomandibular joint functional impairment, and no treatment interventions. Patients receiving treatment underwent exercise therapy at the time of their first visit, whereas those in the non-treatment group received only an explanation of the condition. We evaluated the clinical symptoms (maximum painless opening distance, pain on motion and mastication, and degree of difficulty in daily life) at the first visit and at the two-week follow-up visit. [Results] For both groups, maximum painless opening distance and degree of difficulty in daily life improved significantly. For the treatment group, the pain on motion and mastication values significantly improved throughout the assessment period. [Conclusion] An exercise therapy program may be useful for the early treatment of temporomandibular joint anterior disc displacement without disc reduction.

Key words: Temporomandibular disorder, Manual therapy, Home exercise

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INTRODUCTION

A wide variety of treatment methods are available for temporomandibular joint (TMJ) disorders including lifestyle guidance, pharmacotherapy, physical therapy (including exercise therapy), splint therapy, occlusal therapy, cognitive-behavioral therapy, psychosomatic therapy, and surgical treatment. Recently, Kurita et al.[1)] and Sato et al.[2)] reported that symptom improvement occurs throughout the natural disease course. Further, a basic statement of the IADR published in 2010[3)] recommends reversible conservative treatment as first-line therapy for TMJ disorders. Additionally, the effects of various other methods have been investigated. In particular, recent findings have suggested that the use of exercise therapy is beneficial; however, additional high-quality studies will be needed to confirm the effectiveness of the therapy[4, 5)].

To evaluate the efficacy of exercise therapy for TMJ anterior disc displacement without reduction (ADDwoR), a preliminary study of short-term[6, 7)] and immediate[8)] effects of treatment and a dynamic evaluation of the TMJ disc before and after exercise therapy via magnetic resonance imaging (MRI)[9)] were performed. In the treatment of ADDwoR, a type of manual

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therapy, range of motion of the TMJ motion exercise (TMJROME), increases the range of motion of the TMJ immediately after treatment, diminishes pain, and shortens the duration of the disease. However, in clinical practice, even after symptoms improved, symptoms may flare up if home exercise is not performed.

The purpose of this study was to compare the short-term efficacies of manual therapy performed by a dentist and home exercise performed by a patient as a single exercise therapy program for ADDwoR with those patients who received no-treatment but only an explanation of pathology. The authors considered two types of TMJ ADDwoR treatment (1) TMJROME, a type of manual therapy performed by a dentist, and (2) self-traction therapy (STT), a home exercise performed by the patient under the guidance of the dentist. However, previous studies that assessed symptom improvement in temporomandibular disorders (TMDs) have revealed symptom improvement throughout their natural course[1, 2]. Thus far, the clinical question of whether it is beneficial to initiate treatment aggressively or treat the patient throughout follow-up remains unanswered.

We hypothesized that passive exercise therapy performed by the dentist would be more effective than active exercise therapy in improving symptoms in the short term.

PARTICIPANTS AND METHODS

The study design was a two-center, case-control study. The treatment group was recruited from the Taguchi Dental Clinic between February 2017 and January 2018 until a predetermined sample size was reached. (average age: 45.0 years old; average height: 161.1 cm; average weight 56.2 kg) The control group was recruited from the TMJ Clinic of Aichi-Gakuin University Dental Hospital between October 2018 and November 2019 (average age: 51.2 years old; average height: 159.2 cm; average weight: 52.8 kg). As compliant with the diagnostic criteria for TMDs (DC/TMD) as possible, patients diagnosed with ADDwoR based on the diagnostic criteria listed in Table 1 were considered. In addition, we used a classification scheme for TMJ dysfunction that was a modified adaptation of the International Association of Oral and Maxillofacial Surgeons and the American Association of Oral and Maxillofacial Surgeons guidelines (Table 2)[10, 11]. Patients with moderate or greater impairment of any criterion who did not meet the exclusion criteria were included in the study. Moderate or greater disability was defined as a maximum painless opening distance of 34 mm or lower and a visual analog scale (VAS, range: 0–100) score of 34 or greater for various types of pain and disability in daily life (Table 2). Exclusion criteria were as follows: 1) patients aged <15 years and >71 years; 2) patients with a history of mandibular fracture; 3) patients who received anti-inflammatory analgesics for the treatment of other diseases; 4) patients with gastrointestinal bleeding; cardiac, hepatic, renal, or other serious complications; or a history of such complications; and 5) patients for whom more than 1 month elapsed between the initial and first return visit.

The sample size was pre-set with α error 0.05 and power 0.8, referring to the results obtained from preliminary studies[6, 7]. The study protocol was in accordance with the Declaration of Helsinki. The participants were fully informed regarding the

Table 1. Clinical diagnostic criteria for anterior disc displacement of the temporomandibular joint

- Sudden restriction of aperture (>30 mm maximum aperture in acute cases, and <40 mm maximum aperture in chronic cases)
- The patient should have a history of clicking immediately before the onset of symptoms
- Subjective symptoms should include a strong feeling of pain and tugging in the affected temporomandibular joint
- No morphological abnormality in the temporomandibular joint on X-ray
- Deviation of the jaw to the affected side when opening the mouth

These diagnostic criteria were established to simplify the diagnosis of anterior disc displacement without reduction at the initial diagnosis.
They have been established in a manner that is compliant to the diagnostic criteria for temporomandibular disorders.

Table 2. Classification of temporomandibular joint dysfunction

Degree of disfunction	Maximum painless opening distance (mm)	Maximum value of one of the following: pain on motion, pain on mastication, or difficulty in daily life. Maximum value (VAS: range 0–100)
None	40≤	0
Mild	35–39	1–33
Moderate	30–34	34–66
Severe	≥29	67–100

The maximum painless opening distance (mm) and the higher of the three visual analog scale (VAS) (0 to 100) shall be selected as the individual's disability level.
Patients with moderate or greater impairment of any criteria who did not meet the exclusion criteria were included in the study. Moderate or greater disability was defined as a maximum painless opening distance of 34 mm or less and a visual analog scale (VAS) (range: 0–100) of 34 or greater for various types of pain and difficulty in daily life.

study, and their free and voluntary consent to participate was obtained in writing. This study was approved by the Ethics Committee of the School of Dentistry, Aichi-Gakuin University (approval no. 381).

Patients of the treatment group underwent manual TMJROME, which was performed by a dentist, and STT, a type of exercise the patient performed at home under the guidance of the dentist. The degree of joint range of motion and pain improvement at each patient's first follow-up versus initial visit were assessed. The period between the initial and the first return visit was set at two weeks, a duration based on previous preliminary studies[6, 7]. Preoperative clinical symptoms were recorded at the first visit, and any conditions and precautions to be taken throughout daily life were explained. TMJROME was then performed and STT was taught. At the initial visit, each patient was asked to perform STT to confirm that they understood how to correctly perform the exercise and were compliant. Clinical symptoms were then recorded at the first return visit.

For patients in the control group, preoperative clinical symptoms were evaluated at the initial visit. Then, any conditions and precautions to be taken throughout daily life were explained. Two weeks later, clinical symptoms were evaluated using the same methodology as was used at the initial visit.

The TMJROME procedure was performed in accordance with a method described by Farrar and McCarty[12]. Briefly, the patient's head was firmly fixed with the left palm while simultaneously palpating the TMJ on the affected side with the third finger (Fig. 1A). The first finger of the right hand was then placed on the patient's molar, and remaining fingers were used to grasp the body of the bone and apply force to rotate the mandible (Fig. 1B). An appropriate quantity of force was determined by relaxing the patient and slowly stretching the TMJ in an anterior downward direction. The duration of traction was approximately 10 to 15 s per repetition, and the procedure was repeated five to six times.

To perform STT, the patient leaned slightly forward while in a seated position and placed their second and third fingers of both hands over their mandibular anterior teeth; the first finger grasped the muzzle (Fig. 2A). In this state, the mandible was pulled forward and downward (Fig. 2B). Patients were instructed to use force sufficient for feeling that the TMJ and masticatory muscles were being stretched. We instructed each patient to perform two sets of STTs per day (in the morning and before bedtime) that consisted of 10 traction cycles lasting approximately 10 s per cycle. When performing the exercise,

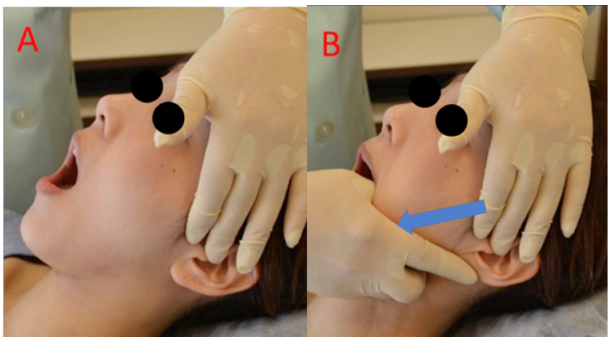

Fig. 1. Range of motion of the temporomandibular joint motion exercise as manual therapy (TMJROME)[9]. The patient's head was firmly fixed using the left palm while simultaneously palpating the temporomandibular joint on the affected side by using the third finger (A). The first finger of the right hand was then placed on the patient's molar, and the remaining fingers were used to grasp the body of the bone and apply force to rotate the mandible (B).

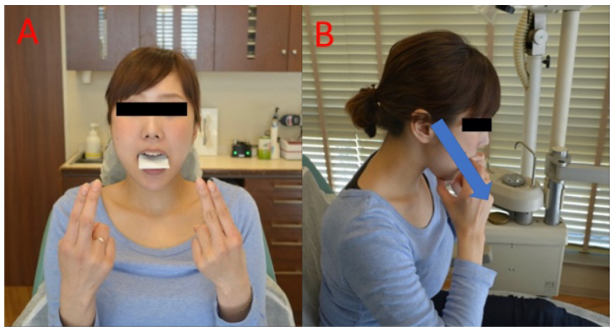

Fig. 2. Self-traction therapy as home exercise (STT)[9]. To perform STT, the patient leaned slightly forward while in a seated position and placed their second and third fingers of both hands over their mandibular anterior teeth. The first finger grasped the muzzle (A). In this state, the mandible was pulled forward and downward (B).

stretching the mandible in the direction of the running muscle is important, and the strength should be approximately 4–5 mm above the painless maximum opening range at the anterior teeth.

Outcomes were assessed by determining maximum painless opening distance, pain on motion, pain on mastication, and difficulty in daily life values. The maximum painless opening distance was measured as the distance between the upper and lower incisor edges, including the vertical cap (mm). A VAS (0–100) was used to assess the degree of pain and difficulty in daily life.

To examine the short-term effects of exercise therapy, baseline comparisons were made using the Kolmogorov–Smirnov test to confirm the normality of endpoints at the initial and first return visits. Although some items assessed were determined to be normally distributed, histograms revealed non-normal distributions; therefore, we assumed that no items assessed were normally distributed. The Mann–Whitney U test was used to compare non-matched data, and the Wilcoxon signed-rank test was used to assess data with correspondence. SPSS was used as the statistical software. The significance level was set at <5%. The percentage of patients with severe or moderate disability at the time of the first visit who became mildly disabled or had no disability at the time of the first return visit was calculated for each symptom considered, revealing the percentage of patients whose symptoms improved. All findings were tabulated and statistically reviewed by the principal investigator, who was not the dentist performing treatment.

RESULTS

Neither group was missing by the end of the evaluation period. Baseline values of the treatment and control groups determined at the initial visit are included in Table 3. Overall, few between-group differences were observed, however, male/female ratios and maximum painless opening distance values differed slightly and significantly, respectively.

A comparison of the clinical symptoms of the treatment and control groups at the initial and first return visits is included in Table 4. For both groups, maximum painless opening distances and degree of difficulty in daily life values measured at the initial versus first return visit significantly differed. In addition, the pain on motion and mastication values determined at the initial versus return visit in the treatment but not in the control group differed. Further, as shown in Table 5, the degree of maximum painless opening distance and difficulty in daily life improvement were greater in the treatment than in the control group.

DISCUSSION

In this study, symptom improvement in patients of both the treatment and control groups was observed at the first return versus initial visit; however, the degree of symptom improvement was greater in the treatment group than in the control group who received only an explanation of their condition. Notably, the pain on motion and mastication values of patients undergoing treatment improved during the assessment period, whereas those of the control patients did not.

One of the peculiarities of this study was that the initial treatment of the control group contained only an explanation of the disorder and daily life guidance. Currently, in Japan, ethical considerations are becoming increasingly strict; therefore, it is often difficult to establish a no-treatment group when assessing potential therapies for TMDs. However, at the TMJ Clinic of Aichi-Gakuin University Dental Hospital, in cases where there is no reason to rapidly proceed with treatment, such as suspicion of a tumor, MRI is arranged at the first visit. Then, a definitive diagnosis is made based on imaging findings and clinical symptoms approximately 2 weeks thereafter. This diagnostic protocol made it possible to establish a control group consisting of patients who had not received treatment, although it was not randomized. In addition, few prior studies have assessed the same disease subtypes and outcomes were considered in this study. We believe that the subtypes considered will

Table 3. Baseline comparison

	Age (median, years)	Visit interval (median, days)	Maximum painless opening distance (median, mm)	Pain on motion (median, VAS)	Pain on mastication (median, VAS)	Difficulty of daily life (median, VAS)
Treatment group (n=17)	46 (32–53)	14 (14–15)	27 (26–36)	39 (11–76)	77 (48–84)	58 (45–87)
Control group (n=17)	49 (35–60)	15 (14–17)	25 (22–28)	60 (28–68)	59 (36–74)	47 (33–69)
p value	0.61	0.24	0.001*	0.69	0.19	0.41

Treatment group: Male 6, Female 11 Control group: Male 2, Female 15
Maximum painless opening distance (mm), Pain on motion, pain on mastication, difficulty of daily life (VAS; range 0–100), *p<0.05 via Mann Whitney U test. VAS: Visual analog scale.
Few between-group differences were observed. However, male/female ratios and maximum painless opening distance values differed slightly and significantly, respectively.

Table 4. Results of various evaluation items

		1st visit		2nd visit		p-value
		Median	Interquartile range	Median	Interquartile range	
Mouth opening distance	Treatment	27	(26–36)	39	(33–41)	0.001*
	Control	25	(22–28)	30	(26–32)	0.001*
Pain on motion	Treatment	39	(11–76)	9	(3–32)	0.001*
	Control	60	(28–68)	38	(25–49)	0.23
Pain on mastication	Treatment	77	(48–84)	32	(6–50)	0.002*
	Control	59	(36–74)	44	(21–70)	0.3
Difficulty of daily life	Treatment	58	(45–87)	32	(8–51)	0.001*
	Control	47	(33–69)	30	(11–44)	0.007*

Maximum painless opening distance (mm), Pain on motion, Pain on mastication, Difficulty of daily life (VAS; range 0–100)
Treatment group: temporomandibular joint motion exercise (TMJROME)+self-traction therapy (STT), Control group: pathological explanation, *p<0.05 via Mann–Whitney U test.
For both groups, maximum painless opening distances and degree of difficulty in daily life values measured at the initial versus first return visit significantly differed. In addition, the pain on motion and during mastication values determined at the initial versus return visit in the treatment group differed. However, it did not differ in the control group.

Table 5. Comparison of improvement rates

	Maximum painless opening distance improvement (% of patients)	Pain on motion improvement (% of patients)	Pain on mastication improvement (% of patients)	Difficulty of daily life improvement (% of patients)
Treatment group	58	55	42	46
Control group	5	25	31	50
			Exacerbation: 1 case	Exacerbation: 2 cases

Patients with symptom improvement had severe or moderate disability at the initial visit and mild or no disability at the first return visit. Exacerbations are defined as cases with mild or no disability at the initial visit who had severe or moderate disability at the return visit. The degree of maximum painless opening distance and the difficulty in daily life improvement were greater in the treatment group than in the control group.

be more uniformly defined, as the DC/TMD are increasingly applied. To better compare studies, the application of uniform outcome assessment methodologies based on a global standard is needed.

When conducting a nonrandomized study that compares outcomes of patients admitted to different centers, it is important to ensure that patients enrolled at each center have similar baseline values. Therefore, baseline values were assessed (Table 3). The results revealed that the baseline maximum painless opening distance values differed among the groups. Both groups showed significant maximum painless opening distance improvement; however, this finding is somewhat questionable. Based on the TMJ dysfunction classification, both treatment and control groups were severely impaired. Therefore, both groups were determined to be similar at baseline.

The study participants were clinically diagnosed with ADDwoR based on an interview, palpation, and an imaging examination with panoramic radiographic findings at the time of the first visit. It is known that MRI is needed for a definitive diagnosis based on the DC/TMD[13]. However, it is not practical to perform MRI on all patients with suspected ADDwoR at the time of the initial visit owing to time and cost constraints. According to Yatani et al.[14] and Orsini et al.[15], the rate of positive ADDwoR diagnosis using clinical findings is not sufficiently high; however, as the number of confirmed findings increases, it continues to improve correspondingly. In many cases, a diagnosis can be made without MRI. Therefore, a clinical diagnosis of ADDwoR was made based on the clinical diagnostic criteria listed in Table 1.

We compared the value of maximum painless opening distance determined in this study with those reported by previous studies. Although improvement was observed in all studies, manual therapy alone or in combination resulted in a greater degree of improvement after a short period than the natural course of improvement reported by Kurita et al.[16] and Sato et al.[2] or home exercise alone, as reported by Nagata et al.[17], Haketa et al.[18], and Meltezah et al.[19]. A possible reason for this is that active home exercises are different from passive exercises performed in manual therapy in terms of the forces applied to the TMJ. Therefore, it is necessary to perform range-of-motion exercises to not only actively but passively exercise the TMJ.

The VAS scores of both groups at the initial versus first return visit were also compared. The degree of improvement observed in both groups was similar. For the treatment group, it was difficult to compare pain on motion values. However, no significant differences in pain on mastication and difficulty in daily life were observed between the treatment group in this study and other treatments. Those were treatment with TMJ lavage therapy reported by Nakatsuka et al.[20] or with anti-

inflammatory analgesics for 12 weeks reported by Yuasa et al.[21]. The TMJROME exercise proposed by the authors is a type of range-of-motion exercise. This exercise is designed to have the following effects. First effect is to improve muscle and joint contractures caused by range-of-motion restriction due to pain or abnormal disc positioning. Second effect is to normalize joint function by moving the joint, circulate synovial fluid, eliminate suspended matter and painful substances in synovial fluid, detach mild fibrous adhesions[22]. Home exercise has a similar effect, but it seemed that stronger force worked in manual therapy. Kurita et al.[16] reported that the mechanism by which natural processes mitigate clinical symptoms remains a matter of speculation, and future biochemical and pathological studies will be needed to elucidate mechanistic details of symptom improvement. The mechanism by which the exercise therapy used in this study improves symptoms has also been discussed. However, it also remains incompletely understood and should be investigated in the future.

Kurita et al.[1] and Sato et al.[2] reported that TMJ disorders improve in a certain number of patients throughout the natural disease course. However, we believe that early intervention benefits patients. Kobayashi et al.[23] and Segami et al.[24] reported the presence of fibrous adhesions in patients with TMJ disk disorders, and Nakatsuka et al.[20] reported that the adhesions may prevent the success of conservative treatment. Dijkgraaf et al.[25] indicated that degenerative changes are preceded by biochemical reactions in an early disease stage, which are not observable via imaging owing to a lack of histological changes. Manual therapy improves symptoms in the short term more effectively than home exercise. The force applied by manual therapy is more effective than that applied during home exercise. Therefore, manual therapy may promote the detachment of fine fibrous adhesions. In addition, the rapid improvement of pain and functional disability leads to disease period shortening and quality of life improvement. In addition, peripheral sensitization and central sensitization suppression in the TMJ area may help prevent chronic pain.

In this study an exercise therapy program that involved manual therapy and home exercise resulted in symptom improvement in the early disease stage. The findings of the study suggest that a clinical diagnosis based on appropriate examination and early exercise therapy may improve outcomes in patients with TMJ ADDwoR.

There are two limitations of this study. One is that it could not be a randomized controlled trial. Blinding is difficult because the treatments are known. In addition, the lack of uniformity in evaluation methods makes comparisons with other studies difficult.

Recommendations suggest that it is desirable to verify the appropriate force for Manual therapy. A core outcome set should also be developed to facilitate comparison and review with other studies.

Funding and Conflict of interest

None.

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