BRILL

Canadian Jr. of Clinical Perf. Evaluation Malpractice

Efficacy and Safety of General Rehabilitation in Comparison to a Temporomandibular Joint Exercise Program among Patients with Non-catastrophic MVA: Randomized Control Trial

Isabella Thompson

[1] Resident Orthopedics, Surgery Department, Division of Maxillo-facial surgery, Klinik Professor Sailer Centre, Heuelstrasse 28, 8032 Zürich, Schweiz, Switzerland.

Correspondence: isabella.thompson.canada@gmail.com

Abstract: Background: Comprehensive rehabilitation is frequently necessary for whiplash-associated disorders (WAD) stemming from non-fatal motor vehicle accidents. This study concentrated on participants in a specialized residential WAD rehabilitation program, with the main goal being to offer patients referred by county councils and regional social insurance offices therapy and functional evaluation. Objectives: The study's objectives were to evaluate the effects of a therapeutic jaw exercise (TJE) program combined with general rehabilitation on the symptoms, clinical markers, and general well-being of individuals with temporomandibular disorders (TMD) and (WAD). Methods: The program enrolled ninety-four individuals with TMD and persistent WAD. They were randomly assigned to a control group (CG) and a jaw exercise group (JEG). While the CG just got general rehabilitation, the JEG participated in a TJE program in addition to it. The participants' symptoms and clinical indicators were assessed using clinical and anamnestic methods at baseline, three weeks later, and six months later. To evaluate patients' capacity to manage everyday duties and their compliance with exercises, a questionnaire was given out. To ascertain the degree and kind of pain endured, body sketches were studied. Results: There were no statistically significant variations in TMD and WAD symptoms or clinical markers between JEG and CG. On the other hand, the maximal active mouth-opening capacity of the CG significantly improved with time, but this was not seen in the JEG. Most patients reported better daily activity management, and both groups reported strong compliance with general rehabilitation activities. Moreover, the examination of body sketches demonstrated a high prevalence of pain, with a significant proportion of patients reporting non-organic pain, indicating the potential involvement of psychological elements in their ailments. Conclusion: As compared to general therapy alone, the inclusion of a TJE program did not result in statistically significant improvements in TMD and WAD symptoms. The study emphasizes the need of a comprehensive approach to rehabilitation by highlighting the complexity of pain perceptions and the possible impact of psychological variables on the sensation of pain among individuals with TMD and WAD.

Citation: Thompson J. Efficacy and Safety of General Rehabilitation in Comparison to a Temporomandibular Joint Exercise Program among Patients with Non-catastrophic MVA: Randomized Control Trial. Canad. Jr. Clin. Perf. Eval., 2024, 1, 10, 132-147.

Academic Editor: Paul Weber
Received: 15 January 2024
Revised: 24 February 2024
Accepted: 20 March 2024
Published: 24 March 2024

1. Introduction

A variety of clinical illnesses known as temporomandibular disorders (TMD) are characterized by discomfort and dysfunction in the temporomandibular joints (TMJs) and the muscles used for chewing (masticatory muscles).[1] On the other hand, whiplash-associated disorders (WAD) are clinical signs and symptoms of neck injuries brought on by the abrupt acceleration and deceleration of energy.[2] Surprisingly, compared to the general population, TMD is more common in those with chronic WAD.[3]

Therapeutic jaw exercise (TJE), a technique that has been used for more than 40 years, is one strategy for treating TMD.[4] TJE is taught in dentistry and physical therapy programs, a sign of its acknowledged effectiveness and significance.[5] TJE is intended to accomplish a number of therapeutic objectives, including improving the biomechanical function of the TMJs and masticatory muscles, enhancing neuromuscular coordination,

reducing muscle tension, boosting muscular strength, enhancing local circulation, and boosting patient confidence in controlling their condition.[6, 7]

The mechanism by which TJE is thought to function includes physiological processes like proprioceptive neuromuscular feedback (where the body's proprioceptors provide information about joint and muscle position), reciprocal inhibition (where one muscle relaxes when its opposing muscle contracts), desensitization of trigger points in muscles through stretching, and improving the patient's awareness and motor control over their jaw muscles.[8, 9] In the end, these techniques help to lessen bruxism (grinding of teeth) and parafunction (abnormal muscular activity) when awake. Many carefully conducted clinical research have evaluated how TJE affects TMD.[10] The results generally imply that TJE can improve maximal mouth opening and reduce TMD symptoms. The subjective and clinical effects of TJE and stabilizing appliance therapy, a popular TMD treatment strategy, have frequently been compared by researchers.[11]

According to the particular study, patients who participate in TJE provided by physical therapists should have a decrease in TMD symptoms and an improvement in their maximal active mouth-opening capacity. The goal of the research was to determine if this specific TJE, carried out as part of a rehabilitation program, will benefit patients with chronic WAD who also had TMD.

2. Methodology

2.1. Contemplate Significance

The relation between clinical performance, malpractice, and the comparison of general rehabilitation to a temporomandibular joint exercise program among patients with non-catastrophic motor vehicle accidents (MVA) lies in the context of evaluating the efficacy and potential risks of different rehabilitation approaches for whiplash-associated disorders (WAD) and temporomandibular disorders (TMD).

Clinical performance evaluation in this study involves assessing the effectiveness of two rehabilitation approaches, general rehabilitation alone versus a therapeutic jaw exercise (TJE) program combined with general rehabilitation, on the symptoms, clinical markers, and general well-being of individuals with TMD and WAD. This evaluation includes measures such as symptoms assessment, clinical indicators, and functional evaluation at baseline, three weeks, and six months post-treatment.

Malpractice prevention comes into play through the careful monitoring of treatment outcomes and potential adverse events associated with the rehabilitation programs. The study examines the occurrence of any worsening of symptoms or clinical markers in either group, aiming to identify any potential risks that could lead to malpractice claims or patient dissatisfaction.

By comprehensively evaluating the treatment outcomes and potential complications, healthcare providers can make informed decisions regarding the selection of appropriate rehabilitation modalities for patients with TMD and WAD. This can ultimately contribute to both improved clinical performance and reduced risk of malpractice incidents in the management of these conditions following motor vehicle accidents.

2.2. Patients

This research involved a group of 94 individuals who were experiencing conditions related to whiplash-associated disorders (WAD). This disorder resulted from a non-fatal motor vehicle accident. These individuals were enrolled in a specialized residential WAD rehabilitation program at the Rehabilitation Center. The program took place from January 2022 to April 2023. The rehabilitation program was designed to be comprehensive and

residential. Initially, patients spent four weeks at the rehabilitation center. Afterward, they returned for an additional follow-up week approximately six months later. The main objective of the program was to offer rehabilitation and functional assessment to individuals referred by regional social insurance offices and county councils. These patients were referred to the program because they required evaluation and rehabilitation, specifically related to their WAD conditions.

Before being admitted to the rehabilitation center, patients received a letter of invitation providing information about the study. They were informed about the research and invited to participate. Nearly all of the patients, with only one exception, provided their informed consent to be part of the study. This consent allowed them to contribute to the research and the study's findings.

Throughout their participation in the study, all patients followed the general rehabilitation program provided by the Rehabilitation Center. This comprehensive program encompassed different components, including physical therapy, occupational therapy, and pain management training. The objective of these elements was to cater to the diverse needs of the patients undergoing rehabilitation. The physical therapy program was highly personalized, tailoring the treatment to meet each patient's specific requirements. The focus of the physical therapy revolved around several key aspects, which included:

2.2.1. Postural and Stabilization Training: Patients received training to improve their posture and enhance their ability to stabilize their bodies. This was particularly important for individuals with conditions like WAD, as it can affect their posture and stability.

2.2.2. Mobilization: Mobilization techniques were utilized to enhance joint and muscle flexibility and range of motion, which can often be limited or impaired in WAD patients.

2.2.3. Relaxation: Relaxation strategies and exercises were integrated into the program to help patients alleviate muscle tension and reduce stress, both of which are commonly associated with WAD.

2.2.4. Physical Therapies: Patients were provided with various physical therapies, such as balance training and body awareness training. These therapies aimed to help individuals restore a sense of balance and body awareness, which can be compromised due to WAD.

2.2.5. Complementary Therapies: The rehabilitation program also included complementary treatments, such as acupuncture, thermal therapies (using heat or cold), hydrotherapy (water-based therapy), electrical stimulation, and massage. These therapies can contribute to pain relief and overall well-being improvement.

Moreover, during their initial 4-week stay at the rehabilitation center, patients were educated on how to continue their training and exercises at home. This home-based training regimen was designed to ensure continuity in their rehabilitation efforts, allowing them to sustain their progress even after leaving the center. By integrating these various elements into their rehabilitation program, the center aimed to address the physical, psychological, and pain management aspects of WAD, ultimately striving to enhance the overall well-being and functionality of the patients.

The patients got a thorough examination when they first arrived at the Rehabilitation Center to make sure their medical and rehabilitation needs were met. Both the temporomandibular disorders (TMD) and whiplash-associated disorders (WAD) of the patients were the focus of this diagnostic approach.

An in-depth medical assessment of the patients was performed by a consulting doctor with expertise in rehabilitation medicine. Understanding the patients' general health was an important first step in rehabilitation, especially in light of this medical assessment. It assisted in locating any specific medical issues and made sure the patients were healthy enough to participate in the rehabilitation process. Despite the fact that the diagnosis of WAD was one of the requirements for patient inclusion, the doctor participating in this procedure was not affiliated with the research investigation.

Functional evaluation of the Stomatognathic System: The patients had a standardized functional evaluation of the stomatognathic system done by a dentist the same day they arrived. The functional characteristics of the jaw, teeth, and associated structures were the main emphasis of this investigation. Its objective was to evaluate the condition of the stomatognathic system in TMD patients.

Patients had to meet both the chronic WAD and TMD inclusion criteria for the research. The Quebec Task Force for Whiplash-Associated Disorders' recommended categorization scheme served as the foundation for WAD diagnosis. This system has two axes: a time axis and a clinical-anatomic axis (rated from 0 to IV). On the clinical-anatomic axis, patients participating in the research were classified as having WAD grades II or III.[12] Additionally, all of the research participants were classified as chronic since they had been dealing with their diseases for longer than six months.

There were created specified standards for the diagnosis of TMD. Patients had to achieve a certain level on the Helkimo dysfunction index (Di), which was defined as at least a particular score (DiII). Patients also required to feel discomfort when at least three masticatory muscles were palpated. These requirements made sure that only research participants with a certain degree of TMD severity were included. The thorough evaluation procedure assisted in identifying and confirming the eligibility of patients with chronic WAD and TMD for involvement in the rehabilitation program, ensuring that the research comprised participants with the desired criteria.

The Rehabilitation Center's patient intake procedure comprised putting patients into groups for their rehabilitation program, which could accommodate a maximum of 8 patients per group. These groups were organized such that each year, a total of 8 groups took part in the program. Twelve successive groups of patients were recruited to participate in order to determine the patient makeup for this study. The allocation of patients to further therapeutic jaw exercise (TJE) or not upon the arrival of each group was established by a randomized procedure.

An impartial secretary at the rehab facility carried out the randomization procedure, assuring objectivity in the assignment to treatment groups. The TJE group or the control group was randomly assigned to the complete patient group. To accommodate the total of 93 patients who had given their agreement to participate in the trial, the randomization was done in blocks of 4 patients and was repeated three times. Importantly, this randomization was carried out prior to the diagnosis of temporomandibular disorders (TMD) and whiplash-associated disorders (WAD), ensuring that the allocation to treatment groups was unaffected by the patients' unique diagnoses.

38 patients who didn't fulfill the study's inclusion requirements were taken out of the randomization procedure throughout this step. In the end, 25 patients were in the jaw exercise group (JEG), compared to 30 in the control group (CG), as seen in Figure 1.

To reduce the possibility of interaction or impact between the various therapy regimes throughout the patients' 4-week stay at the rehabilitation facility, it was decided to randomize patients into groups rather than on an individual basis. During each group of patients' rehabilitation program, this group-based randomization strategy served to provide a more regulated and homogenous treatment environment.

2.3. Measured parameters

The stomatognathic system was examined by an examiner who was kept in the dark about the patients' group placements. This examination included a review of the structures involved in jaw and mouth function. Both at the initial baseline assessment and throughout the follow-up exams, this blinding was upheld. Importantly, throughout the follow-up evaluations, the examiner was kept neutral and unbiased since they were unaware of the patients' present illnesses and there was no communication or conversation with the personnel concerning the patients.

All patients were required to complete a standardized anamnestic questionnaire prior to the clinical assessment. The TMJ and masticatory muscles-related symptoms were evaluated using the anamnestic dysfunction index of Helkimo (Ai0II), which was part of the questionnaire. TMJ noises, feelings of jaw tiredness or stiffness, difficulty opening the mouth wide, pain during mandibular motions, pain in the TMJ or masticatory muscle areas, and TMJ locking or luxation episodes were all included in this group of symptoms.

Patients rated the severity of their symptoms using the questionnaire. There were three levels on the grading scheme that was used:

2.3.1. Ai0 showed that there were no symptoms.

2.3.2. AiI stood for minor symptoms.

2.3.3. AiII stood for serious symptoms.

These symptom assessments made it possible to evaluate patients' stomatognathic system-related feelings and pain in a systematic and quantitative way.

A number of evaluations were included in the standardized clinical examination of the stomatognathic system, including:

2.3.4. Measurements of Active Mandibular Movements: The mandibular range of motion, which includes the patient's capacity to actively open and close their mouth, was measured. Using a ruler, these dimensions were meticulously taken and recorded to the closest millimeter.

2.3.5. Perceived Pain During Mandibular Movements: During the examination, patients were asked to report any discomfort or pain they felt while moving their jaw.

2.3.6. Pain while Manually Pressing on particular areas in Masticatory and Neck Muscles: The examiner evaluated the presence of tenderness or pain when manually pressing on particular areas in the masticatory muscles, which control jaw movement. The Temporomandibular Joints (TMJs), which link the jaw to the skull, were palpated by the examiner to feel for any discomfort or tenderness.

2.3.7. TMJ Sounds: An auditory examination was done to listen for any sounds or noises that the TMJs made as the patients moved their jaws.

Measurements of vertical overbite and horizontal overjet were added to assess the maximal active mouth-opening capacity and mandibular protrusion. These measurements were taken down to the closest millimeter with a ruler and a high degree of precision. Palpation, which is the physical examination of certain anatomical areas for soreness or anomalies, was also a part of the examination. Bilaterally, or on both sides of the body, were palpated the muscle groups and locations listed below:

2.3.8. Masticatory Muscles: Four masticatory muscles were assessed bilaterally:

- Posterior part of the temporal muscle.

- Anterior part of the temporal muscle.
- Insertion part of the temporal muscle.
- Superficial part of the masseter muscle.
- Profound part of the masseter muscle.
- Lateral pterygoid muscle.
- Medial pterygoid muscle.

2.3.9. Neck and Shoulder Muscles: Three muscles of the neck and the shoulders were evaluated bilaterally:

- Sterno-cleido-mastoid muscle.
- Shoulder part of the trapezius muscle.
- Superficial neck muscles.

A rating system was used for the neck and masticatory muscles. If a patient mentioned having discomfort from a muscle spot unilaterally, they were given one point. One point was only given if there was a palpable autonomous response, such as an eyeblink or evasive motion, when there was reported bilateral discomfort. As a result, each patient was only allowed to amass a maximum of three points on the neck muscle score and seven points on the masticatory muscle score. specific results were used to evaluate the existence and degree of pain and discomfort in specific muscle groups.

The clinical evaluation of the stomatognathic system took into account a number of factors:

2.3.10. TMJ Palpation Pain Experience: The examiner felt for sensitivity or pain in several locations around the temporomandibular joints (TMJs). When a person claimed unilateral discomfort or a definite autonomous response, such an eyeblink or an evasive response, was noticed, pain was noted.

2.3.11. TMJ Sounds: Any sounds or noises coming from the TMJs were also captured on tape. While the patient actively opened and closed their mouth, these noises were assessed.

2.3.12. Dysfunction Index of Helkimo (Di0-III): The dysfunction index of Helkimo (Di0-III) was used to offer a thorough review of the clinical indicators within the stomatognathic system. With Di0 denoting the lack of clinical indicators and DiIII denoting the presence of serious clinical signs, this index classified dysfunction severity.

After the clinical evaluation, the patients were given instructions to create body drawings that represented the various sorts of pain or sensations they had felt. These body drawings showed the human body's contour and came with printed instructions outlining the symbols to use for different kinds of pain. After a three-week waiting period, the dentist picked up the finished drawings.

After three weeks, both the control group (CG) and the jaw exercise group (JEG) had a second standardized evaluation of the stomatognathic system. It was also done again during the 6-month follow-up. The patients also answered to a survey created for the physical therapists during the six-month follow-up. With the use of a questionnaire, we were able to assess how well they were following the general home exercise program, the therapeutic jaw exercise, their capacity to manage daily tasks, and their present jaw complaints. Importantly, up until the study's completion, the authors were uninformed of the patients' replies.

In order to determine the degree of widespread pain, the study also included an examination of the body sketches made by the participants at the start of the study. The body drawings were examined using a technique previously outlined by Visscher et al. [13] to identify whether widespread discomfort was present. This technique required counting the number of sore body locations below the cervical spine (range from 0 to 5). The procedure was modified from an older one that Turp et al. [14] first suggested.

Additional examination of the body drawings was done to classify the types of pain experienced by the patients in addition to counting the number of uncomfortable places. There were two categories for pain: "organic" and "non-organic." Organic pain was characterized as suffering largely from a physiological problem or physical tissue disruption. Contrarily, non-organic pain was related by Mann et al. [15] to the patient's emotional or mental condition.

This research sought to identify the degree and underlying causes of the patients' discomfort by offering insights into the distribution and type of pain they were feeling.

2.4. Therapeutic jaw exercises

The rehabilitation center's standard physical treatment was supplemented with a special therapeutic jaw exercise (TJE) program for the jaw exercise group (JEG). The TJE program featured a number of exercises and methods intended to enhance the jaw's mobility and function as well as to lessen the symptoms of temporomandibular disorders (TMD). The TJE program's elements were as follows:

2.4.1. Relaxation: To reduce jaw and associated muscular tension, patients were advised to begin with relaxation techniques. This entailed conducting small, controlled, and moderate active mandibular motions.

2.4.2. Maximum active mandibular motions were exercised by the patients, who improved mobility by using their jaw's complete range of motion.

2.4.3. This section of the program featured exercises that required active motions against resistance, with a 6-second hold at the conclusion of the action, to develop the jaw muscles.

2.4.4. Mouth closure against resistance: In a manner similar to the last exercise, resistance was now added when the mouth was closing.

2.4.5. To increase flexibility, patients stretched for five seconds while expanding their mouths widest.

2.4.6. Relaxation: To ease any stress that may have developed during the exercises, the session concluded with relaxation exercises.

Patients were told to execute the full program three times daily and to repeat each exercise 5–10 times. Importantly, patients were instructed to stop performing any activity that hurt. They were told to cut out the portion of the program that caused them discomfort or agony from their routine and try to reinstate it after a week.

The physical therapists at the rehabilitation facility oversaw the TJE program and gave the patients both verbal and written instructions. Additionally, these therapists promoted teamwork among patients, provided direction and encouragement to ensure that the TJE was continued at home, and addressed any issues or challenges that patients could experience while performing their exercises. The TJE's objective was to enhance the jaw's functionality and general health while reducing any pain or discomfort.

2.5. Statistical analysis

Statistical analyses in this study involved several methods for comparing groups and variables. Continuous variables were compared using Student's t-test. Categorical variables were compared using the Chi-square test. For ordered categorical variables, the Chi-square test for trend was used. Exact tests were applied when there were low observations in one or more categories. Comparisons within related samples were performed using the non-parametric Friedman's test. Repeated measurement ANOVA was used for simultaneous comparisons of continuous variables within and between groups. A significance level of $p < 0.05$ was considered as the threshold for statistical significance. The study was approved by the local ethics committee, ensuring that it adhered to ethical standards and regulations.

3. Results

The Jaw Exercise Group (JEG) and the Control Group (CG) were the two groups used in the study. The following are some significant specifics on the makeup and involvement of these groups at various phases of the study:

3.1. Standard Composition:

In comparison to the CG, which had 21 people (70% women), the JEG had 18 people (72% women). The JEG had an average age of 38.5 years (range: 24-60), whereas the CG had an average age of 36.2 years (range: 21-55). For the JEG and CG, the mean number of months since the reported injury was 42.1 and 46.8, respectively.

3.2. Follow up Information:

The number of participants in both groups fluctuated a bit during the trial. Two patients from the JEG and the CG departed the facility sooner than expected during the 3-week follow-up. Several patients missed the follow-up exams during the 6-month follow-up. Six patients, specifically, from each group were not present. Additionally, two patients from each group declined to take part in the 6-month follow-up stomatognathic system evaluation. At the 6-month follow-up, two patients from each group did not answer a questionnaire given by the physical therapists.

These specifics shed light on the characteristics of the research groups and how those characteristics changed throughout the course of the study's several phases. When analyzing the study's findings, it is important to take these things into account. Table 1

Table 1. 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.

3.3. Anamnestic and clinical findings

According to the study, there were no significant changes between the JEG and CG in the reported symptoms or clinical indicators of temporomandibular disorders (TMD) during the course of the investigation. The "maximum active mouth-opening capacity" did, however, significantly change in the CG but not the JEG. These results imply that the jaw exercise program had no appreciable influence on the clinical signs and symptoms of TMD assessed in this research.

3.3.1. Anamnestic Dysfunction Index (Ai): The Ai assesses temporomandibular symptoms as jaw discomfort, TMJ noises, and mouth movement. At no point in the trial were there statistically significant differences between the JEG and CG groups. This suggests that the groups' reported symptoms were similar.

3.3.2. Clinical Dysfunction Index (Di): The Di evaluates temporomandibular system-related clinical signs and symptoms, such as jaw discomfort, muscular soreness, and TMJ function. At any point during the trial, there were no significant differences between the JEG and CG groups, unlike the Ai. This implies that the clinical symptoms and indications in both groups remained consistent.

3.3.3. Changes Over Time: It was discovered that just one clinical measure, the "maximum active mouth-opening capacity," substantially changed over time, and that this change only happened in the Control Group (CG). Table 2

Table 2. 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

*$n=20$.

3.4. The physical therapists' questionnaire given at the six-month check-up

The questionnaire findings show that even though the JEG did the prescribed jaw exercises more often, both groups reported experiencing the same improvements in jaw discomfort. Even though the rehabilitation program may not have made a significant difference in the patients' jaw-related symptoms, the high compliance rate for general physical therapy home exercises and the improvement in ability to manage daily activities suggest that the program had a positive impact on the patients' overall well-being.

3.4.1. Jaw Exercises: During their five months at home, 10 patients in the Control Group (CG) had some type of jaw exercise from other therapists. However, the only significant distinction between the Jaw Exercise Group (JEG) and the Control Group (CG) was the frequency with which the JEG group carried out the prescribed therapeutic jaw exercises (TJE).

3.4.2. Perception of Jaw Symptoms: It's interesting to note that more than half of patients in both JEG and CG groups didn't think their jaw symptoms had altered considerably. This may indicate that the reported effects of jaw exercises or other treatments on jaw problems were minimal.

3.4.3. High Compliance with General Exercises: The general physical therapy home exercises had a high compliance rate (varying from 86% to 96%) among patients, meaning that the majority of them frequently performed the exercises as directed. Table 3

Table 3. 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	

3.4.4. Improved Daily Activity Management: Regardless of their group assignment, the majority of patients stated that they were better or much better at managing their daily activities than they had been five months prior. This can mean that the rehabilitation program as a whole improved their capacity to carry out daily chores.

3.5. Visual representation of pain

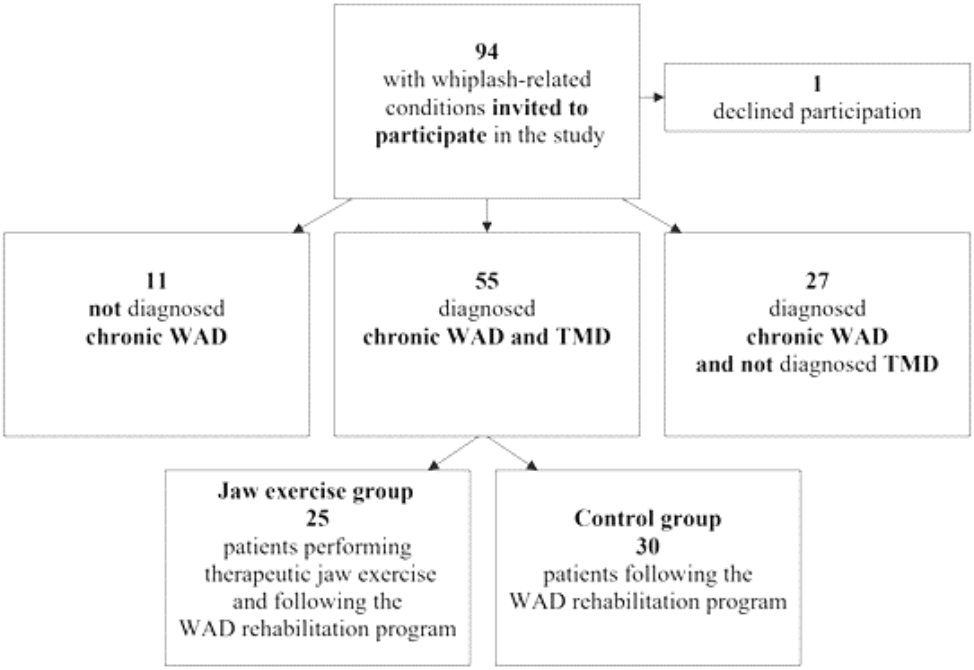
Both groups of patients included a significant number of patients with pain below the cervical spine, and a sizable percentage of these individuals may have pain that is impacted by non-physical causes. It highlights the complexity of pain perceptions and suggests that psychological or emotional variables may play a part in these patients' illnesses.

All patients reported experiencing discomfort below the cervical spine, with the exception of three (3 in the control group, CG, and 1 in the jaw exercise group, JEG). This indicates that almost all participants in both groups complained of neck, upper back, or other areas below the cervical spine pain or discomfort.

The JEG and CG had mean values (averages) of 3.04 and 3.10, respectively, for the number of uncomfortable body locations below the cervical spine. This suggests that there were around three sites below the cervical spine where individuals in both groups experienced pain or discomfort on average. These might be different neck and upper body regions, the shoulders, or the upper back.

Sixty-four percent of the patients in the JEG and sixty percent of the patients in the CG created "non-organic" pain pictures. Generally speaking, pain descriptions that lack a distinct physical or anatomical basis are referred to as non-organic pain drawings. Rather, they can be linked to psychological or psychosocial elements, indicating that these patients' suffering might not be solely physical in nature.

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



4. Discussion

Despite certain patterns that benefited the treatment group, the study indicates that TJE did not significantly alleviate TMD symptoms in individuals with chronic WAD.[16] The study's findings could have been influenced by the limited sample size and the possible impact of persistent and widespread pain. When evaluating the results and the efficacy of TJE in this particular patient population, several considerations must be taken into account.

In contrast to earlier controlled trials, the study results show that therapeutic jaw exercise (TJE) did not significantly reduce the symptoms or clinical indicators of temporomandibular disorders (TMD) in individuals with chronic whiplash-associated disorders (WAD).[17] TJE has demonstrated efficacy in reducing symptoms of TMD and increasing maximal active mouth-opening capacity in certain earlier trials.[18] Though these changes did not achieve statistical significance, there were some differences in this research between the groups that benefited the treatment group (JEG). [19] These results might have been caused by a number of factors: Small Sample Size: There weren't many participants in this study. In the JEG, the dropout rate was 20%, whereas in the control group (CG), it was 13%. The decreased sample size may have reduced the statistical power to identify significant changes, even if the baseline data of the dropouts and those who finished the research did not differ substantially.

Generalized and Chronic Pain: Conditions characterized by prolonged pain can affect how people perceive their pain and cause maladaptive responses in the sensory input and output systems.[20] The patients in this research may have experienced widespread pain in addition to persistent WAD, which might have impacted how well they responded to therapy. General co-morbidity is frequently not disclosed in other controlled trials; therefore, it is unknown how the degree of participants' levels of generalized pain compare to those from previous studies subjects are contrasted with those in other researches.[21, 22]

According to the study, individuals who have extensive pain or other chronic pain problems could not react to TJE the same manner as other patient groups. Self-administered exercise compliance can be impacted by a number of variables, including as the patient-therapist dynamic, empowerment, and symptom alleviation. These factors emphasize how difficult it may be to manage chronic pain disorders and how crucial it is to customize treatment plans to meet the needs of each patient.[23]

Compared to patients in prior research who had temporomandibular disorders (TMD) and abnormalities of the cervical spine, the patients in this study had a greater prevalence of broad pain. This implies that a significant portion of the study's participants were experiencing chronic discomfort. The input neuro systems may have been significantly impacted by this persistent pain, which may have consequences for the efficacy of therapeutic jaw exercise (TJE) in treating TMD in this particular patient population. The neurological system and pain sensations frequently interact intricately in patients with chronic pain problems.[24,25]

It is typically advised against causing discomfort during or following TJE performance. Physical therapists monitored the patients for four weeks to make sure they were able to endure the exercise. If any discomfort developed during or after TJE, the patients were advised to skip particular aspects of the training program. At the follow-up evaluations, the study did not demonstrate a statistically significant decrease in TMD symptoms and clinical indications in spite of these measures.[26] It's important to note, nevertheless, that a sizable proportion (95%) of patients in the jaw exercise group (JEG) said they maintained TJE at home. The following variables might account for this high compliance: Patient's Perception of Relief: During TJE, patients may have felt a brief alleviation of their jaw pain.[27] Though the exercises did not result in any improvement in their symptoms over the long run, this brief alleviation may have encouraged individuals to stick with them.[28] Empowerment and Control: Patients may have adhered to the exercise program if they felt more in control of their symptoms and had a better understanding of their pain condition. Individuals may be more motivated to stick with therapeutic exercises if they believe they can actively regulate their symptoms. Relationship between the Patient and the Therapist: Patients could have felt a duty of allegiance to the therapists who gave them their first training in TJE. It's possible that this link contributed to the participants' continued exercise compliance. Recall Bias: Recall bias may have affected patients' reports of compliance, where they had a more positive memory of their devotion to TJE than what actually happened.

Complex variables affecting both somatic (body) and psychogenic (mental and emotional) aspects might be involved in chronic pain problems. In order to ascertain whether the pain in the patients' drawings was primarily caused by physical tissue disturbances (organic factors, or somatic factors) or by psychological or emotional factors (non-organic factors, or psychogenic factors), it was necessary to analyze the patients' pain drawings.[29, 30]

Low ratings on questionnaires measuring overall health and well-being, including the Short Form 36, have been linked to non-organic pain drawings. Additionally, these illustrations have been connected to psychological traits that indicate bad prognosis in individuals with illnesses like low back pain. About 60% of the patients in this research drew non-organic pain patterns, indicating that chronic pain may have a major impact on these individuals' output nerve systems. When developing pain management techniques, it is important to take into account the potential detrimental impact of mental dysfunction on treatment outcomes for patients suffering from chronic pain. Nevertheless, the TMD therapy in this trial did not really address this issue.[31]

Given that every patient in this trial had neck discomfort, it's plausible that the therapeutic jaw exercises' (TJE) limited efficacy was influenced by referred neck pain. Referred pain is pain that originates in one part of the body but manifests in another. In this instance, neck discomfort may be causing or aggravating the symptoms of TMD. This study and a prior one observed a significant incidence of clinical symptoms in the stomatognathic system among TMD patients who also had cervical spine abnormalities, therefore this finding alone might not be sufficient to explain the full picture. This implies that TMD may coexist with neck trauma in patients, while the precise nature of the link between the two disorders is unclear and may differ from patient to patient.[32, 33]

Patients were asked to complete a questionnaire on their use of jaw exercises (TJE) throughout the 6-month follow-up. It was discovered that between the 3-week and 6-month follow-up evaluations, 10 of the 26 participants in the control group (CG) had received instructions from other therapists to engage in some kind of jaw exercises. The patients self-reported this information in the questionnaire, but it was not examined further.

Because neither group shown a discernible improvement throughout the course of the trial, the researchers chose not to investigate this further, even in spite of the extra exercises that some patients in the control group completed. Therefore, it was thought improbable that the extra workouts added by a portion of the patients in the control group had a significant effect on the overall findings of the research.

5. Conclusion

Cell transplantation, specifically using Bone Marrow-Derived Mesenchymal Stem Cells (BMSCs) in combination with Platelet-Rich Plasma (PRP) gel and β-TCP granules, is a viable and safe approach for sinus floor augmentation and alveolar ridge augmentation. Despite variations in cell proliferation, differentiation, and bone regeneration outcomes among individuals, the procedure showed promising integration and stability, as evidenced by CT imaging, histological analysis, and successful dental implant integration. The long-term follow-up of approximately 66 months revealed no side effects or health concerns, supporting the overall efficacy and biocompatibility of the cell transplantation method for bone regeneration in dental applications.

References

1- Maini K, Dua A. Temporomandibular Syndrome. [Updated 2023 Jan 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551612/
2- Pastakia, K., & Kumar, S. (2011). Acute whiplash associated disorders (WAD). Open access emergency medicine : OAEM, 3, 29–32. https://doi.org/10.2147/OAEM.S17853
3- Montemurro, N., Trilli, I., Bordea, I. R., Ferrara, E., Francesco, M., Caccamo, F., Malcangi, G., & Rapone, B. (2023). Are Whiplash-Associated Disorders and Temporomandibular Disorders in a Trauma Related Cause and Effect Relationship? A Review. Medicina (Kaunas, Lithuania), 59(8), 1482. https://doi.org/10.3390/medicina59081482
4- Alrizqi, A. H., & Aleissa, B. M. (2023). Prevalence of Temporomandibular Disorders Between 2015-2021: A Literature Review. Cureus, 15(4), e37028. https://doi.org/10.7759/cureus.37028
5- Al-Khotani, A., Naimi-Akbar, A., Albadawi, E. et al. Prevalence of diagnosed temporomandibular disorders among Saudi Arabian children and adolescents. J Headache Pain 17, 41 (2016). https://doi.org/10.1186/s10194-016-0642-9
6- Arribas-Pascual, M., Hernández-Hernández, S., Jiménez-Arranz, C., Grande-Alonso, M., Angulo-Díaz-Parreño, S., La Touche, R., & Paris-Alemany, A. (2023). Effects of Physiotherapy on Pain and Mouth Opening in Temporomandibular Disorders: An Umbrella and Mapping Systematic Review with Meta-Meta-Analysis. Journal of clinical medicine, 12(3), 788. https://doi.org/10.3390/jcm12030788

7- Idáñez-Robles AM, Obrero-Gaitán E, Lomas-Vega R, Osuna-Pérez MC, Cortés-Pérez I, Zagalaz-Anula N. Exercise therapy improves pain and mouth opening in temporomandibular disorders: A systematic review with meta-analysis. Clin Rehabil. 2023 Apr;37(4):443-461. doi: 10.1177/02692155221133523. Epub 2022 Oct 20. PMID: 36263523.
8- Hindle, K. B., Whitcomb, T. J., Briggs, W. O., & Hong, J. (2012). Proprioceptive Neuromuscular Facilitation (PNF): Its Mechanisms and Effects on Range of Motion and Muscular Function. Journal of human kinetics, 31, 105–113. https://doi.org/10.2478/v10078-012-0011-y
9- Dietz V, Horstmann GA, Berger W. Significance of proprioceptive mechanisms in the regulation of stance. Prog Brain Res. 1989;80:419-23; discussion 395-7. doi: 10.1016/s0079-6123(08)62238-4. PMID: 2634280.
10- Zhang L, Xu L, Wu D, Yu C, Fan S, Cai B. Effectiveness of exercise therapy versus occlusal splint therapy for the treatment of painful temporomandibular disorders: a systematic review and meta-analysis. Ann Palliat Med. 2021 Jun;10(6):6122-6132. doi: 10.21037/apm-21-451. Epub 2021 May 10. PMID: 33977737.
11- Asquini G, Rushton A, Pitance L, Heneghan N, Falla D. The effectiveness of manual therapy applied to craniomandibular structures in the treatment of temporomandibular disorders: protocol for a systematic review. Syst Rev. 2021 Mar 8;10(1):70. doi: 10.1186/s13643-021-01623-7. PMID: 33685496; PMCID: PMC7941703.
12- Shergill, Y., Côté, P., Shearer, H., Wong, J. J., Stupar, M., Tibbles, A., & Cassidy, J. D. (2021). Inter-rater reliability of the Quebec Task Force classification system for recent-onset Whiplash Associated Disorders. The Journal of the Canadian Chiropractic Association, 65(2), 186–192.
13- Visscher CM, Lobbezoo F, de Boer W, van der Meulen M, Naeije M. Psychological distress in chronic craniomandibular and cervical spinal pain patients. Eur J Oral Sci 2001;109: 165-71.
14- Turp JC, Kowalski CJ, Stohler CS. Temporomandibular disorders pain outside the head and face is rarely acknowledged in the chief complaint. J Prosthet Dent 1997;78:592-5.
15- Mann NH 3rd, Brown MD, Hertz DB, Enger I, Tompkins J. Initial-impression diagnosis using low-back pain patient pain drawings. Spine 1993;18:41-53.
16- Al-Moraissi EA, Conti PCR, Alyahya A, Alkebsi K, Elsharkawy A, Christidis N. The hierarchy of different treatments for myogenous temporomandibular disorders: a systematic review and network meta-analysis of randomized clinical trials. Oral Maxillofac Surg. 2022 Dec;26(4):519-533. doi: 10.1007/s10006-021-01009-y. Epub 2021 Oct 21. Erratum in: Oral Maxillofac Surg. 2021 Nov 5;: PMID: 34674093.
17- Asquini G, Pitance L, Michelotti A, Falla D. Effectiveness of manual therapy applied to craniomandibular structures in temporomandibular disorders: A systematic review. J Oral Rehabil. 2022 Apr;49(4):442-455. doi: 10.1111/joor.13299. Epub 2022 Jan 17. PMID: 34931336.
18- Chęciński M, Chęcińska K, Turosz N, Brzozowska A, Chlubek D, Sikora M. Current Clinical Research Directions on Temporomandibular Joint Intra-Articular Injections: A Mapping Review. J Clin Med. 2023 Jul 13;12(14):4655. doi: 10.3390/jcm12144655. PMID: 37510770; PMCID: PMC10380303.
19- Minervini G, Franco R, Marrapodi MM, Crimi S, Badnjević A, Cervino G, Bianchi A, Cicciù M. Correlation between Temporomandibular Disorders (TMD) and Posture Evaluated trough the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): A Systematic Review with Meta-Analysis. J Clin Med. 2023 Apr 2;12(7):2652. doi: 10.3390/jcm12072652. PMID: 37048735; PMCID: PMC10095000.
20- Yang, S., & Chang, M. C. (2019). Chronic Pain: Structural and Functional Changes in Brain Structures and Associated Negative Affective States. International journal of molecular sciences, 20(13), 3130. https://doi.org/10.3390/ijms20133130
21- Dueñas, M., Ojeda, B., Salazar, A., Mico, J. A., & Failde, I. (2016). A review of chronic pain impact on patients, their social environment and the health care system. Journal of pain research, 9, 457–467. https://doi.org/10.2147/JPR.S105892
22- Sterling M. (2011). Whiplash-associated disorder: musculoskeletal pain and related clinical findings. The Journal of manual & manipulative therapy, 19(4), 194–200. https://doi.org/10.1179/106698111X13129729551949
23- Roditi, D., & Robinson, M. E. (2011). The role of psychological interventions in the management of patients with chronic pain. Psychology research and behavior management, 4, 41–49. https://doi.org/10.2147/PRBM.S15375

24- Silveira, A., Gadotti, I. C., Armijo-Olivo, S., Biasotto-Gonzalez, D. A., & Magee, D. (2015). Jaw dysfunction is associated with neck disability and muscle tenderness in subjects with and without chronic temporomandibular disorders. BioMed research international, 2015, 512792. https://doi.org/10.1155/2015/512792
25- Braido, G. V. D. V., Campi, L. B., Jordani, P. C., Fernandes, G., & GonÇalves, D. A. G. (2020). Temporomandibular disorder, body pain and systemic diseases: assessing their associations in adolescents. Journal of applied oral science : revista FOB, 28, e20190608. https://doi.org/10.1590/1678-7757-2019-0608
26- Alami, S., Desjeux, D., Lefèvre-Colau, M. M., Boisgard, A. S., Boccard, E., Rannou, F., & Poiraudeau, S. (2011). Management of pain induced by exercise and mobilization during physical therapy programs: views of patients and care providers. BMC musculoskeletal disorders, 12, 172. https://doi.org/10.1186/1471-2474-12-172
27- Lindfors E, Hedman E, Magnusson T, Ernberg M, Gabre P. Patient Experiences of Therapeutic Jaw Exercises in the Treatment of Masticatory Myofascial Pain: A Qualitative Study. J Oral Facial Pain Headache. 2017 Winter;31(1):46-54. doi: 10.11607/ofph.1623. PMID: 28118420.
28- Karlsson, O., Karlsson, T., Pauli, N., Andréll, P., & Finizia, C. (2021). Jaw exercise therapy for the treatment of trismus in head and neck Cancer: a prospective three-year follow-up study. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer, 29(7), 3793–3800. https://doi.org/10.1007/s00520-020-05517-7
29- Okur Güney, Z. E., Sattel, H., Witthöft, M., & Henningsen, P. (2019). Emotion regulation in patients with somatic symptom and related disorders: A systematic review. PloS one, 14(6), e0217277. https://doi.org/10.1371/journal.pone.0217277
30- Meints, S. M., & Edwards, R. R. (2018). Evaluating psychosocial contributions to chronic pain outcomes. Progress in neuro-psychopharmacology & biological psychiatry, 87(Pt B), 168–182. https://doi.org/10.1016/j.pnpbp.2018.01.017
31- Dahl B, Gehrchen PM, Kiaer T, Blyme P, Tøndevold E, Bendix T. Nonorganic pain drawings are associated with low psychological scores on the preoperative SF-36 questionnaire in patients with chronic low back pain. Eur Spine J. 2001 Jun;10(3):211-4. doi: 10.1007/s005860100266. PMID: 11469731; PMCID: PMC3611502.
32- Mathers J. J. (2012). Differential diagnosis of a patient referred to physical therapy with neck pain: a case study of a patient with an atypical presentation of angina. The Journal of manual & manipulative therapy, 20(4), 214–218. https://doi.org/10.1179/2042618612Y.0000000011
33- Durall C. J. (2012). Therapeutic exercise for athletes with nonspecific neck pain: a current concepts review. Sports health, 4(4), 293–301. https://doi.org/10.1177/1941738112446138