Turk J Phys Med Rehab 2025;71(x):i-x
DOI: 10.5606/tftrd.2025.15454
Available online at www.turkishjournalpmr.com

Original Article

# Comparison of the short-term effectiveness of myofascial dextrose injection and radial extracorporeal shockwave therapy in myofascial pain syndrome: A prospective, randomized clinical study

Mehmet Arslan[1], Halil Ogut[1], Mehmet Karadag[2], Hayal Guler[1], Ayse Dicle Turhanoglu[1]

[1]Department of Physical Medicine and Rehabilitation, Hatay Mustafa Kemal University Faculty of Medicine, Hatay, Türkiye
[2]Department of Biostatistics, Hatay Mustafa Kemal University Faculty of Medicine, Hatay, Türkiye

*ABSTRACT*

**Objectives:** The aim of this study was to compare the effectiveness of myofascial dextrose injection (MDI) and extracorporeal shock wave therapy (ESWT) in the treatment of myofascial pain syndrome (MPS).

**Patients and methods:** Between July 2022 and December 2022, a total of 70 patients (8 males, 62 females; mean age: 38.8±11.1 years; range, 18 to 61 years) with MPS in the upper and/or middle trapezius muscle were included in this prospective, randomized clinical study. The patients were randomly divided into two groups as the MDI group (n=35) and the ESWT group (n=35). The first group received MDI with 5% dextrose, while the second group received radial ESWT. Both groups received three sessions of treatment with one-week intervals. An exercise program was provided for all patients. Both groups were assessed using the Visual Analog Scale (VAS) for activity-related pain, Pressure Pain Threshold (PPT), Neck Disability Index (NDI), and Nottingham Health Profile (NHP) at baseline (pre-treatment), and at Weeks 2 and 4 (post-treatment).

**Results:** Following treatment, both groups exhibited significant improvements in VAS, PPT, NDI, and NHP scores ($p<0.001$). However, the MDI group demonstrated a higher improvement in the VAS scores at both Weeks 2 and 4 ($p<0.001$). The NDI scores were significantly more favorable in the MDI group at Weeks 2 and 4 ($p=0.044$ and $p=0.011$, respectively). In terms of PPT and NHP scores, the MDI group showed a significantly greater improvement at Week 4 ($p=0.005$ and $p=0.013$, respectively).

**Conclusion:** Both MDI and ESWT treatments have positive effects on pain and functionality in MPS patients, while MDI seems to yield more favorable results compared to ESWT.

***Keywords:*** Dextrose, extracorporeal shockwave therapy, injection, myofascial pain syndrome, neck pain, pain threshold.

Myofascial pain syndrome (MPS) is a non-inflammatory regional pain condition characterized by the presence of taut fibrous bands within muscles, palpable trigger points within these bands, and associated symptoms such as referred pain, tenderness, muscle spasms, stiffness, movement restriction, fatigue, and weakness.[1,2] The primary goals of treatment are to restore the shortened and tightened muscles to their normal length, deactivate trigger points, alleviate pain and movement limitations. Various approaches, including posture training, exercise, manual therapies, physical therapy modalities, pharmacological treatments and trigger point injections can be employed to achieve these objectives.[3]

Extracorporeal shockwave therapy (ESWT) exerts its analgesic effects through multiple mechanisms, including the acceleration of cytokine transfer from the vascular region to the application site, thereby stimulating angiogenesis; promoting neovascularization in the bone-tendon interface to facilitate healing; activating serotonergic pathways in the brainstem, inhibiting descending pain pathways in the spinal cord, and reducing the release of

**Corresponding author:** Mehmet Arslan, MD. Hatay Mustafa Kemal Üniversitesi Tıp Fakültesi, Fiziksel Tıp ve Rehabilitasyon Anabilim Dalı, 31001 Alahan, Hatay, Türkiye.
**E-mail:** dr.arslan.mehmet@gmail.com

**Received:** July 13, 2024 **Accepted:** March 19, 2025 **Published online:** April 24, 2025

***Cite this article as:*** Arslan M, Ogut H, Karadag M, Guler H, Dicle Turhanoglu A. Comparison of the short-term effectiveness of myofascial dextrose injection and radial extracorporeal shockwave therapy in myofascial pain syndrome: A prospective, randomized clinical study. Turk J Phys Med Rehab 2025;71(x):i-x. doi: 10.5606/tftrd.2025.15454.

substance P and calcitonin gene-related peptide from the dorsal root.[4] Additionally, it alleviates muscle stiffness by enhancing metabolism and circulation at the application site, which contributes to the dissolution of calcium deposits. Due to these effects, ESWT is used for therapeutic purposes in conditions such as calcific tendinitis, epicondylitis, calcaneal spur, spasticity, and MPS.[4] To date, several studies have demonstrated the beneficial effects of ESWT in patients with MPS.[5,6]

In MPS, algesic and inflammatory mediators accumulate at trigger points, leading to pain and dysfunction. The primary goal of treatment is to reduce these mediators and provide analgesia. Various therapeutic approaches, including dry needling and local anesthetic injections, have been employed to achieve this effect. Additionally, myofascial dextrose injections (MDIs) have been proposed as a potential treatment modality. Studies have demonstrated that dextrose can provide analgesia in painful muscle syndromes, even at low concentrations in animal models.[7] Moreover, it has been hypothesized that MDI may help alleviate the energy crisis associated with MPS.[8,9] While hypertonic dextrose injections are commonly utilized in classical prolotherapy to promote tissue regeneration and symptom relief, hypotonic 5% dextrose has been shown to exert an analgesic effect without triggering an inflammatory response.[10] Also, MDI is believed to contribute to pain reduction and functional improvement by addressing the metabolic imbalance at trigger points, reducing local algesic mediators, and exerting direct analgesic effects. In recent years, several studies have investigated the therapeutic efficacy of MDI in MPS.[9,11,12]

In the present study, we aimed to compare the therapeutic effectiveness of MDI and ESWT in MPS patients in terms of pain, pressure pain threshold, disability, and quality of life.

## PATIENTS AND METHODS

This single-center, prospective, randomized clinical study was conducted at Hatay Mustafa Kemal University Faculty of Medicine, Department of Physical Medicine and Rehabilitation between July 2022 and December 2022. Initially, a total of 76 patients aged between 18 and 65 years with MPS localized in the upper and/or middle trapezius muscle were screened. The diagnosis of MPS was established based on the criteria recommended by Simons and Travell.[1] Additionally, supplementary criteria, including referred pain, local twitch response, movement limitation and the absence of neurological deficits, were applied. Only patients with symptoms persisting for at least one month who did not receive any prior pharmacological or non-pharmacological treatment were enrolled. Patients under 18 and over 65 years of age, those with signs of cervical radiculopathy or myelopathy, a history of cervical surgery, diagnosed with fibromyalgia, with open wounds or skin diseases at the application site, pregnant, with bleeding disorders or malignancy were excluded from the study. Finally, a total of 70 patients (8 males, 62 females; mean age: 38.8±11.1 years; range, 18 to 61 years) who met the inclusion criteria were included. The study flowchart is shown in Figure 1. A written informed consent was obtained from each patient. The study protocol was approved by the Hatay Mustafa Kemal University Faculty of Medicine Ethics Committee (date: 27.06.2022, No: 2022/69). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Before the study, all patients were informed and underwent systemic examinations. Data including age, sex, height, weight, occupation, marital status, symptom duration, dominant side and treatment area were recorded. An independent researcher utilized computer-generated randomization software (randomizer.org) to randomly assign patients into two groups, using a block randomization method with a 1:1 allocation ratio. The patients were divided into two groups as the MDI group (n=35) and the ESWT group (n=35).

### Interventions

In the MDI group, injections were administered into the trigger points using a 5% dextrose solution. Each trigger point received 0.3 to 0.5 mL of 5% dextrose, with a total volume of 5 to 10 mL. Polifleks® (Polifarma İlaç San. ve Tic. AŞ., Tekirdağ, Türkiye) 100 mL 5% dextrose solution was used for the injections. After appropriate skin antisepsis, the needle was advanced perpendicular to the skin until the trigger point in the muscle was reached. Hemostasis was checked, and 0.3 to 0.5 mL of 5% dextrose solution was injected into each trigger point using a multi-needling technique. The needle was, then, retracted to the subcutaneous tissue without exiting the skin, and the surrounding areas of the initial point were also needled. This technique aimed to inactivate latent and satellite trigger points. Genject (Genject Sağlık Ürünleri AŞ., Ankara, Türkiye) 2.5 mL, 27-gauge, 50 mm syringes with luer

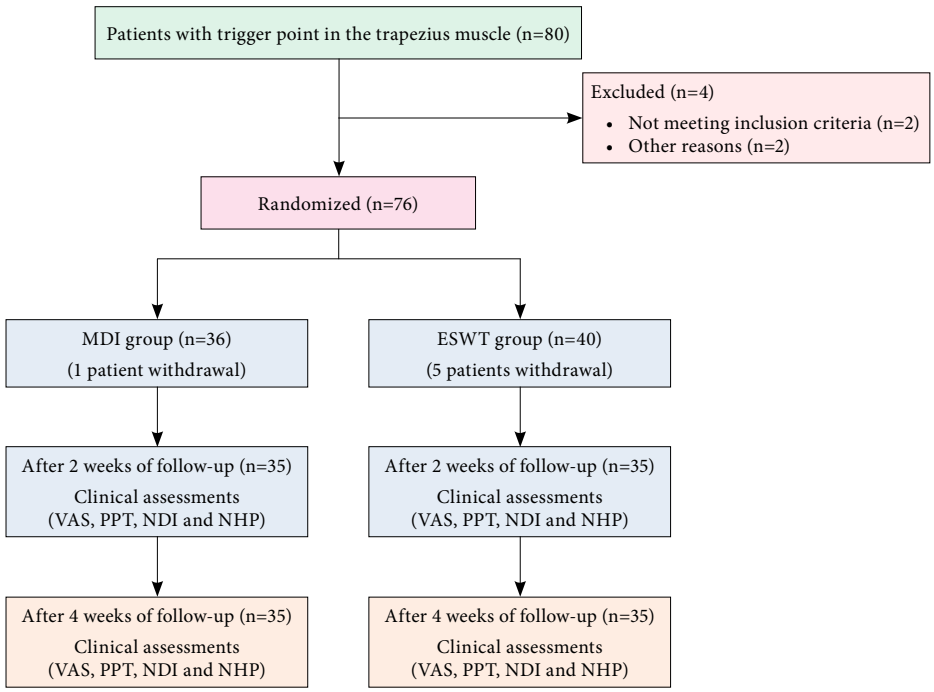


**Figure 1.** Study flowchart.

MDI: Myofascial dextrose injection; ESWT: Extracorporeal shock wave therapy; VAS: Visual Analog Scale; PPT: Pressure pain threshold; NDI: Neck disability index; NHP: Nottingham health profile.

lock feature were used for the injections. The use of thinner gauge needles aimed to reduce post-injection pain and increase patient comfort. The MDIs were administered once a week for a total of three sessions.

In the ESWT group, the patients received one session per week for a total of three sessions. Before each application, the same physician examined the patients and marked the trigger points for treatment. Radial ESWT was applied at a frequency of 10 Hz and a pressure of 2 to 3 bar. Each session included 500 pulses to the trigger points and 500 pulses around the trigger points, totaling 1,000 pulses per session and 3,000 pulses throughout the treatment. This protocol was applied in accordance with the recommendations of the International Society for Medical Shockwave Treatment. The Elmed™ Vibrolith (Elmed Medical Systems, Ankara, Türkiye) ESWT model, produced in 2015, was used in the study. The calibration of the device was regularly performed by the authorized company.

Interventions were assigned to the participants by a single researcher. The ESWT and MDI procedures were applied to both groups by another researcher. Outcome assessments were made. The patients were instructed not to use anti-inflammatory or muscle relaxant medications. In case of severe pain, they were advised to take paracetamol 500 mg tablets up to a maximum of 3 g per day. Both groups received range of motion exercises including neck flexibility exercises, trapezius muscle stretching exercises, and posture and ergonomics education. Participants were asked to do home exercise programs regularly every day from the beginning of treatment until the fourth week follow-up. The patients were encouraged to comply with the exercises during the follow-up visits. Patients were observed for half an hour after the application for any complications such as bruising, bleeding, hypotension, or local allergic reactions, and were discharged if no complications developed.

### Clinical assessments

All patients were evaluated at three time points: baseline (before treatment), at Week 2, and at Week 4 (post-treatment). The second-week evaluation was conducted before the second treatment, while the fourth-week evaluation took place one week after the last treatment. The assessment tools included the Visual Analog Scale (VAS), Pressure Pain Threshold (PPT) Algometry, Neck Disability Index (NDI), and Nottingham Health Profile (NHP).

The VAS score during activities of daily living used a 10-cm VAS ranging from 0 to 10, where 0 indicates no pain and 10 indicates the most severe pain. The patients were asked to mark their pain intensity on this scale, and the marked point was measured and recorded.

The PPT measurements with algometry were performed on all patients, with the algometer tip perpendicular to the skin at the most painful active trigger point in the trapezius muscle. The patients were asked to indicate when they first felt pain. The applied pressure was increased during the procedure until the patient first felt pain, and the measurement was recorded in Newton/cm$^2$. Three measurements were taken at the same point with sufficient time intervals, and the average value was calculated. The Baseline Dolorimeters model of Fabrication Enterprises Inc. (NY, USA) was used in the study.

The NDI includes questions about the severity of neck pain, personal care activities such as dressing and bathing, lifting heavy loads, reading, associated headaches, concentration, work ability, driving, sleep quality, and leisure activities. The patients were asked to mark the option that best described their current condition. This index score aimed to determine the extent to which neck pain affected daily living activities. The NDI consists of 10 questions, each scored between 0-5, with a maximum score of 50. Higher scores indicate more severe disease. The Turkish validity and reliability of the NDI were conducted by Aslan et al.[13] in 2008.

The NHP questionnaire consists of two parts. The first part assesses pain, energy, emotional state, sleep, social situation, and physical activity. The second part evaluates problems in work, home chores, social activities, relationships with other people at home, sexual life, hobbies, and vacation time. The questions in each section are answered with 'Yes' or 'No'. The first part has 38 questions, and the second part has seven questions. The patients were asked to complete this questionnaire themselves. The first part scores up to 600, and the second part up to 7. Higher values indicate more severe disease. The Turkish validity and reliability of the NHP were conducted by Küçükdeveci et al.[14] in 2000.

### Statistical analysis

Study power analysis and sample size calculation were performed using the G*Power version 3.1.9.2 software (Heinrich-Heine-Universität, Düsseldorf, Düsseldorf, Germany). The effect size was determined to be 0.9, based on the mean VAS obtained from patients receiving ESWT treatment, using the difference between two independent means in accordance with Aktürk et al.'s[15] study. For a statistical power of 0.80 and an alpha (α) level of 0.05, a total sample size of 64 patients (32 participants in each group) was necessary. Considering a 10% dropout rate, it was decided to include at least 70 participants in total in the study.

Statistical analysis was performed using the IBM SPSS for Windows version 23.0 software (IBM Corp., Armonk, NY, USA). The normal distribution of variables was checked using the Shapiro-Wilk test, skewness, and kurtosis values. Descriptive data were presented in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. Variance analysis with repeated measures and the least significant difference (LSD) post-hoc tests were used within the groups. The chi-square test was used for categorical variables. Comparisons between groups at repeated time points were made using the Student t-test and the Mann-Whitney U test. The data requiring comparison between groups at repeated times were evaluated with two-way repeated measures analysis of variance (ANOVA) and subsequent LSD multiple comparison tests. A $p$ value of <0.05 was considered statistically significant.

## RESULTS

Of a total of 76 patients, one patient from the MDI group and five patients from the ESWT group discontinued treatment due to transportation and scheduling issues. All patients who withdrew from the study stopped treatment before the second week follow-up. A total of 70 patients were included in the statistical analysis, with 35 in the MDI group and 35 in the ESWT group. The general characteristics of patients are presented in Table 1. There was no significant difference in the age between the two groups (p=0.534). The distribution of sex and other demographic variables was also similar between the groups (p>0.05), except for symptom duration (p=0.04).

Significant improvements in VAS scores were observed in both groups following treatment (p<0.001). At Weeks 2 and 4, the MDI group showed greater improvements in VAS scores compared to the ESWT group (p<0.001, Table 2).

**TABLE 1**
Baseline characteristics of patients

| | MDI group (n=35) | | | ESWT group (n=35) | | | |
|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | n | % | Mean±SD | *p* |
| Age (year) | | | 38.24±10.51 | | | 39.40±11.71 | 0.665* |
| Sex | | | | | | | 0.999µ |
| Female | 31 | 88.6 | | 31 | 88.6 | | |
| Male | 4 | 11.4 | | 4 | 11.4 | | |
| Body mass index (kg/m²) | | | 25.94±4.71 | | | 26.99±6.80 | 0.453* |
| Job | | | | | | | NC |
| Housewife | 17 | 48.6 | | 20 | 57.1 | | |
| Student | 5 | 14.3 | | 4 | 11.4 | | |
| Official | 7 | 20.0 | | 3 | 8.6 | | |
| Worker | 6 | 17.1 | | 8 | 22.9 | | |
| Marital status | | | | | | | 0.771µ |
| Married | 27 | 77.1 | | 28 | 80.0 | | |
| Single | 8 | 22.9 | | 7 | 20.0 | | |
| Symptom duration (month) | | | 1.30±1.13 | | | 1.86±1.10 | **0.040*** |
| Dominant hand | | | | | | | 0.555µ |
| Right | 33 | 94.3 | | 34 | 97.1 | | |
| Left | 2 | 5.7 | | 1 | 2.9 | | |
| Treatment area | | | | | | | 0.053µ |
| Right | 24 | 68.6 | | 16 | 45.7 | | |
| Left | 11 | 31.4 | | 19 | 54.3 | | |

MDI: Myofascial dextrose injection; ESWT: Extracorporeal shock wave therapy; SD: Standard deviation; NC: Non computed, * *p* was obtained from Student t test (intergroup evaluation), µp value was obtained from Chi-square test.

Both groups demonstrated significant increases in PPT values after treatment (p<0.001). The MDI group exhibited better results in PPT measurements at Week 4 compared to the ESWT group (p=0.005).

The NDI scores improved significantly in both groups following treatment (p<0.001). The MDI group showed a higher improvement in the NDI scores at Weeks 2 and 4 compared to the ESWT group (p=0.044 and p=0.011, respectively) (Table 2).

Significant improvements were seen in NHP scores in both groups after treatment (p<0.001). The MDI group had better outcomes in NHP scores at Week 4 compared to the ESWT group (p=0.013) (Table 2).

In the ESWT group, two patients reported increased pain, and three patients experienced mild skin redness after the first treatment. These complaints improved rapidly during follow-up. In the MDI group, five patients experienced nausea and dizziness following the first treatment; however, these symptoms were not severe enough to require intervention. No adverse effects were observed in either group during subsequent treatment sessions.

## DISCUSSION

In the present study, we investigated the clinical efficacy of MDI and ESWT in the treatment of myofascial trigger points in patients with MPS. Both interventions resulted in statistically significant improvements during and after treatment. Notably, VAS and NDI scores showed significant improvements in favor of MDI at all stages. Additionally, PPT and NHP demonstrated a higher improvement in favor of MDI at the end of the treatment.

The MPS primarily affects the muscles of the neck and back, although it can involve any muscle in the body. The trapezius muscle is the most commonly affected in the neck, while the quadratus lumborum muscle is frequently involved in the lower back.[1,16] A wide range of treatment options are available for MPS, including monotherapy and combination therapies. Both pharmacological and non-pharmacological approaches, as well as interventional treatment modalities, have been utilized. The effectiveness of trigger point injections and ESWT has been demonstrated in various studies.[17-19]

**TABLE 2**
Comparison of VAS, PPT, NDI and NHP values in groups

| | MDI group | ESWT group | | |
|---|---|---|---|---|
| | Mean±SD | Mean±SD | *p*# | *p*§ |
| VAS[1] | 7.74±1.09[A] | 7.03±1.58[A] | 0.055 | **<0.001** |
| VAS[2] | 3.49±1.52[B] | 5.26±1.69[B] | **<0.001** | |
| VAS[3] | 2.37±1.93[C] | 4.4±1.91[C] | **<0.001** | |
| Difference[1-3] | 5.37±2.26 | 2.63±2.09 | **<0.001** | |
| *p*⋆ | **<0.001** | **<0.001** | | |
| PPT[1] | 1.69±0.4[A] | 1.58±0.63[A] | 0.356 | **<0.001** |
| PPT[2] | 2.3±0.44[B] | 2.05±0.74[B] | 0.091 | |
| PPT[3] | 2.65±0.54[C] | 2.2±0.73[B] | **0.005** | |
| Difference[1-3] | −0.95±0.63 | −0.62±0.62 | **0.031** | |
| *p*⋆ | **<0.001** | **<0.001** | | |
| NDI[1] | 20.8±6.38[A] | 20.06±8.2[A] | 0.674 | **<0.001** |
| NDI[2] | 11.26±7.3[B] | 14.63±6.41[B] | **0.044** | |
| NDI[3] | 8.14±5.97[C] | 12.2±6.9[C] | **0.011** | |
| Difference[1-3] | 12.66±6.39 | 7.86±6.25 | **0.002** | |
| *p*⋆ | **<0.001** | **<0.001** | | |
| NHP-1[1] | 244.26±109.98[A] | 225.09±113.45[A] | 0.475 | **<0.001** |
| NHP-1[2] | 141.13±110.75[B] | 176.14±118.47[B] | 0.206 | |
| NHP-1[3] | 107.49±88.12[B] | 171.69±121.38[B] | **0.014** | |
| Difference[1-3] | 136.78±104.29 | 53.40±65.66 | **<0.001** | |
| *p*⋆ | **<0.001** | **<0.001** | | |
| NHP-2[1] | 2.71±2.33[A] | 2.91±1.72[A] | 0.685 | **<0.001** |
| NHP-2[2] | 1.57±1.84[B] | 2.14±1.83[B] | 0.197 | |
| NHP-2[3] | 1.29±1.74[B] | 2.29±1.99[B] | **0.029** | |
| Difference[1-3] | 1.43±2.34 | 0.63±1.80 | 0.114 | |
| *p*⋆ | **<0.001** | **0.019** | | |
| NHP-t[1] | 246.98±111.02[A] | 228.01±114.64[A] | 0.484 | **<0.001** |
| NHP-t[2] | 142.7±111.92[B] | 178.28±119.84[B] | 0.204 | |
| NHP-t[3] | 108.77±89.16[B] | 173.98±122.93[B] | **0.013** | |
| Difference[1-3] | 138.105.18 | 54.03±66.64 | **<0.001** | |
| *p*⋆ | **<0.001** | **0.001** | | |

VAS: Visual Analog Scale; PPT: Pressure pain threshold; NDI: Neck disability index; NHP: Nottingham health profile; MDI: Myofascial dextrose injection; ESWT: Extracorporeal shock wave therapy; SD: Standard deviation; NHP-1: Nottingham health profile part 1; NHP-2: Nottingham health profile part 2; NHP-t: Nottingham health profile total; * Analysis of variance in repeated measurements (evaluation within the group); # Student t test (evaluation between groups); § Two-way analysis of variance in repeated measurements; each different sign (A, B, C) indicates a statistically significant difference according to LSD (Least Significant Difference) post hoc test. 1: Pre-treatment; 2: 2nd week; 3: 4th week; 1-3: Difference between 4th week and pre-treatment.

Lai et al.[20] conducted a study on 57 MPS patients presenting with shoulder pain. In their study, 10 cc of a 15% dextrose solution mixed with lidocaine was administered, resulting in a significant reduction in VAS scores at the four-week follow-up. The injections were performed as perimysial dissections under the guidance of ultrasound. In contrast, in the current study, injections were administered

directly into and around the trigger points, using a lower concentration of dextrose. Similarly, Chou et al.[12] investigated 45 MPS patients and reported a significant decrease in VAS scores at the one-month follow-up following the administration of 10 mL of a 15% dextrose solution. Furthermore, Sirh et al.[21] studied 17 MPS patients, administering a 12.5 to 15% dextrose solution mixed with 0.5% lidocaine into the quadratus lumborum muscle and enthesis regions, which also led to a significant reduction in VAS scores.

Absence of a control group in these three studies investigating the effect of dextrose injection in MPS constitutes a disadvantage. As a result, it becomes difficult to ascertain which variable (dextrose, injection, lidocaine, exercise, etc.) the efficacy of the procedure depends on. Controlled studies are needed in this area. All of the aforementioned studies used a 15% dextrose concentration and found improvements in VAS values as an assessment measure. In this study, a 5% dextrose concentration was used, and statistically significant improvements in VAS values were found during and after treatment. While a 15% dextrose injection promotes tissue regeneration and improves symptoms, it is known that hypotonic 5% dextrose does not stimulate the inflammatory cascade.[10]

Navarro-Santana et al.[22] conducted a meta-analysis comparing studies on dry needling and wet needling for myofascial trigger points. While wet needling was found to be more effective in providing short-term pain relief, no significant differences were observed in terms of cervical range of motion, PPT or psychiatric factors. Jacob and Sankaran[23] conducted a study on 200 patients with myofascial trigger points, where one group received 0.5% bupivacaine injections, and the other group received a combination of 0.5% bupivacaine and 25% dextrose solution injected into the myofascial trigger points. Although both groups demonstrated significant improvements at one month in terms of VAS, Oswestry Disability Index (ODI) and Clinical Global Impression (CGI), the group receiving dextrose showed significantly greater improvements at three and 24 months. Gibaly et al.[24] conducted a study on 40 patients with anterior disc displacement of the temporomandibular joint, comparing dry needling and dextrose prolotherapy groups. Although both groups were effective, the dextrose prolotherapy group demonstrated significantly better outcomes in terms of VAS scores and maximum mouth opening compared to the dry needling group. Although the dry needling group demonstrated significant improvements in treatment outcomes in these studies, the dextrose injection group yielded more effective results. In our study, although there was no dry needling group, it can be suggested that the observed improvement in patients is not solely due to the needle effect but also attributable to the application of dextrose.

Considering the theory that MPS is associated with deficient energy metabolism, it is thought that injecting dextrose into myofascial trigger points may help alleviate the associated pain syndrome by stimulating energy production.[8,9] Han et al.[7] investigated the effectiveness of dextrose injection in painful muscle syndromes in mice. The authors concluded that, for dextrose to produce analgesia, there must be an increase in acid-sensing ion channel (ASIC) 1a, neural activation, and substance P in the surrounding environment. It was proposed that a dextrose concentration of ≥5% would be sufficient to achieve this analgesic effect. Energy crisis and hypoxia occur in myofascial trigger points. Consequently, the increased ambient pH activates transient receptor potential cation channel subfamily V member (TRPV) and ASIC channels, leading to pain and hyperalgesia. Additionally, it is known that substance P, along with various mediators, is elevated in active trigger points.[1] Based on this, it is considered that the 5% dextrose solution used in our study contributed to analgesia. Although it is thought that a lower concentration dextrose solution may be beneficial for MPS patients, controlled studies are needed on this subject.

Pain is the main complaint in MPS patients. In studies of dextrose injection in the literature, pain is often evaluated based on VAS scores. In addition, MPS patients frequently experience symptoms such as limited movement, stiffness, weakness, depression, sleep disorders, and autonomic dysfunction.[1,2] In this study, in addition to VAS score, PPT algometer was used as an objective assessment tool for pain, and NDI was used for disability assessment. The evaluations were conducted using NHP, which assesses factors such as emotional stress, sleep disorders, social life, physical activity, energy level, hobbies, lifestyle, and daily living activities, in addition to pain. Significant improvements were detected in VAS, PPT, NDI, and NHP values in patients receiving 5% dextrose injections. Consequently, while the results in the

dextrose injection group are consistent with the literature, this study also provides novel findings to the body of the literature.

Park et al.[6] conducted a study involving 30 patients with MPS in the trapezius muscle. In their study, they compared the high-energy form of ESWT with the low-energy form. Significant differences in VAS, PPT, NDI, and neck range of motion were observed in both groups compared to pre-treatment. In the intergroup evaluation, significant improvements were found in favor of high-energy ESWT in terms of NDI and neck flexion range of motion. No significant differences were observed between the groups in terms of VAS, PPT, and other neck range of motion measurements. In our study, we found significant improvement in VAS, PPT, and NDI with low-energy radial ESWT application, and the results consistent with the literature were obtained.

Anwar et al.[25] conducted a study involving 45 patients with MPS in the trapezius muscle, with symptom duration exceeding three months. They compared patients into groups of radial ESWT treatment, ESWT combined with 0.5% lidocaine injection, and a control group. Compared to the control group, both the ESWT group and the combination group showed significant improvements in VAS, NDI, skin temperature measured by thermometer, and tissue stiffness measured by sonoelastography at Week 4. The combination group showed significant improvements in VAS and sonoelastographic tissue stiffness compared to the ESWT group at Week 4. No significant difference was found between the ESWT and combination groups regarding NDI. In our study, significant improvements were observed in both groups in terms of VAS and NDI, consistent with the literature. Additionally, significant improvements in NDI were detected in the MDI group compared to the ESWT group, indicating more effective results in the injection group.

In a retrospective study including 262 MPS patients in the trapezius muscle with symptom duration exceeding three months, Yalçın[26] compared ESWT and kinesiotape (KT) with a control group. Significant improvements were observed in VAS, NDI, PPT, and neck contralateral flexion angle in both the ESWT and KT groups compared to the control group. In the intergroup comparison, significant improvements were found in VAS, PPT, and NDI in favor of ESWT. Although the prospective nature of our study, its inclusion of patients with symptom duration less than three months, and its observation of short-term treatment effects are the main strengths, the significant improvements observed in VAS, PPT, and NDI in both groups are consistent with the literature.

Manafnezhad et al.[27] conducted a study involving 70 patients with MPS in the trapezius muscle, with symptom duration exceeding three months. They compared ESWT and dry needling treatments in their study. Significant improvements in VAS, PPT, and NDI were observed in both groups compared to pre-treatment, with no significant difference between groups. In our study, however, more favorable results were found in the MDI group compared to the ESWT group. It is thought that the difference between the groups in our study can be explained by the dilution effect of dextrose injections on pain mediators and the hyperpolarization effect of dextrose on nerve cells via $K^+$ and $Ca^{++}$ channels.[28,29]

Exercise is an integral part of treatment programs for MPS patients. Stretching the muscles with tight bands and strengthening the surrounding weak muscles are very effective in reducing pain.[30] In addition, a meta-analysis found that exercise increased PPT values and decreased disability in MPS patients.[31] In our study, the groups were given an exercise program in addition to ESWT and MDI applications. It is considered that the exercise program provided to our patients may have positively influenced our results. However, it should be kept in mind that the same exercises were given to both groups, and the exercise applications were evaluated during the control sessions.

Despite its strengths, this study has certain limitations, such as the lack of an untreated control group and the short follow-up period. To fully observe the primary effect of dextrose injections, comparative studies should be conducted, such as dry needling with the same needle without injecting dextrose solution. Longer-term follow-up studies with untreated control groups are needed. It is also important to note that the difference in symptom duration between groups may have contributed to the differences in the results of our study.

To date, no prospective, randomized clinical trial comparing the therapeutic efficacy of MDI and ESWT in the treatment of MPS has been found in the literature. We believe that this study is useful to bridge this gap in the literature. Additionally, previous studies on dextrose injections in the treatment

of MPS have mostly focused on pain through VAS scores. In this study, more comprehensive evaluations were made using the VAS scores, PPT, NDI, and NHP, providing a more holistic assessment of pain and functionality. This aspect of the study contributes to the literature. The results of this study show similarities with previous studies on ESWT. In many studies in the literature, patients with a symptom duration of less than three months were excluded. This study includes patients with symptom durations of less than three months, suggesting that the treatment methods used in the study may benefit patients with shorter symptom durations.

In conclusion, both MDI and ESWT treatments provide significant improvements in pain and function in the short term in MPS patients. Moreover, MDI treatment produces more effective results compared to ESWT. It is of utmost importance to emphasize that the results of this study should be validated through multi-center, large-scale, long-term randomized-controlled studies.

**Data Sharing Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Author Contributions:** Idea/concept, data collection and/or processing, literature review, writing the article, references and funding: M.A.; Idea/concept, design, control/supervision, literature review, writing the article, critical review: H.O.; Control/supervision, analysis and/or intervention, critical review: M.K.; Design, control/supervision, critical review, literature review: H.G, A.D.T.

**Conflict of Interest:** The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

**Funding:** The authors received no financial support for the research and/or authorship of this article.

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