Comparison of the Effects of Extracorporeal Shock Wave Therapy and Dry Needing on Spasticity in Poststroke Patients

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Abstract

Previous studies have suggested either shockwave therapy or dry needling is an effective method for the treatment of spasticity. However no previous study compared these two treatments on spasticity in poststroke patients. This study was performed to compare the effects of extracorporeal shock wave therapy and dry needing on upper limb spasticity. Twenty voluntaries to the stroke patients with upper extremity spasticity were randomly assigned in two groups of treatment A and B. Patients in group A received one session of extracorporeal shock wave therapy on biceps brachii muscle in which 6,000 impulses were given at 0.06–0.07 mJ/mm2 (1.2–1.4 bar) at 18 Hz on the biceps brachii muscle bulk. Patients in group B received one session of dry needling on biceps brachii muscle trigger points with the rapid entry and rapid exit for one minute. Demographic information of the patients was recorded. The modified Ashworth Scale was used to evaluate the spasticity of the patients. Individuals with an average age of 77.70 and 15.25 years participated in group A, and individuals with an average age of 72.40 and 12.47 years in group B. While the affected side on the upper extremity was 4 people in group A, it was recorded as 5 people in group B. According to the results of the study MAS score (P= 0.003) decrease significantly after extracorporeal shock wave therapy and dry needling. there was no significant differences between these two groups in term of change in MAS score. Dry needling and extracorporeal shock wave therapy can significantly decrease spasticity but There is no significant differences between shock wave therapy and dry needling in decreasing elbow flexor spasticity in post stroke patients.

Key words: spasticity, shockwave, dry needling, stroke

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1. Introduction

Stroke is a very common neurological disease that causes permanent disability, especially in advanced populations, with 13.7 million new cases worldwide each year. Stroke and related disability can affect living activities and cause different effects on daily life. One of these side effects of stroke is pain and spasticity , which often occur after stroke (1). Spasticity is a characteristic component of upper motor neuron syndrome. It means increased neural activity and sensitivity (2). Spasticity is defined as a velocity-dependent increase in muscle tone as a result of an increase in the stretch reflex (3). Spasticity may cause activity limitation and/or participation limitation, and ultimately increase dependency by limiting hand functions, especially fine hand movements, and accordingly increase the cost of direct post-stroke care (4). There are studies showing that spasticity occurs in approximately 38% of patients after stroke (5). 48% and 77% of stroke survivors have upper extremity impairment, thus affecting function and wellness and quality of life. This is especially true of the extremities . due to the presence of spasticity . Wissel et al . observed that spasticity develops most frequently in the elbow (79%) (6), therefore, they should consider the spasticity of the upper extremity muscles , especially the biceps . elbow flexors such as brachii It is very important to reduce spasticity.

Post-stroke spasticity is a very important and serious problem. Some of the therapeutic approaches include physiotherapy (7, 8) and drug therapy (9, 10). In recent years, extracorporeal shock wave therapy (ESWT) and dry needling have been widely used in the treatment of post-stroke spasticity and pain (1, 11-15). Based on a systematic review, ESWT, both alone and in combination therapy, is used in the upper extremity . states that it reduces spasticity (16). Shock waves consist of sound waves that have a physical effect due to the energy these sounds impose on the tissue. These sounds are non-linear and have high peak pressure and low stress amplitude, short rise time and short duration (10 µs). The shock wave has 2 phases: negative and positive phase. The positive phase is when there is direct mechanical compression on the tissue and the negative phase is when there is cavitation that explodes at high velocities and creates the second shock wave during a shock (17). gaiyan Lit (5) and Junyi In the studies of Guo (18), the upper extremity after ESWT showed that spasticity was significantly reduced. ESWT has two physical effects on tissue: a primary effect, which is a direct mechanical effect at the treatment point due to sound waves, and a secondary cavitation effect, ie an indirect mechanical effect of bubble gas (5).

Extremity of dry needling shows that it significantly reduces spasticity (14). In studies , the mechanisms of dry needling in reducing spasticity are that it can change the properties of spastic muscles by changing the fascia length and pennation angle, decrease the fluctuation in the dysfunctional endplate and positively affect regional brain activity (15).

Despite many studies on the effectiveness of ESWT and dry needling on spasticity , there are no studies comparing these two modalities on pain, upper extremity function, and spasticity . Therefore, the aim of this study is to determine the upper extremity of dry needling with ESWT Spasticity is a comparison between its effectiveness on function and pain.

2. Literature Review

2.1. Stroke

Cerebral circulation consists of the internal carotid system and the vestibular system , called the circle of Willis . The internal carotid artery provides blood supply to the anterior part of the brain and the vertebrobasilar system to the posterior part of the brain (19).

Stroke is a neurological disease that usually occurs in two forms: ischemic stroke and hemorrhagic stroke (Fig. 1).

Ischemic stroke involves a blockage in the blood vessels. A blockage occurs in the arteries that send blood to the brain. This blockage causes damage to blood vessels and ultimately reduced blood flow and oxygen to the brain, resulting in damage or death of brain cells. Ischemic stroke includes 85% of stroke survivors (19).

Another type of stroke is a hemorrhagic stroke . Hemorrhagic stroke is caused by rupture of cerebral arteries and leakage of blood flow and ultimately a lack of oxygen, and bleeding causes damage to brain cells (19)

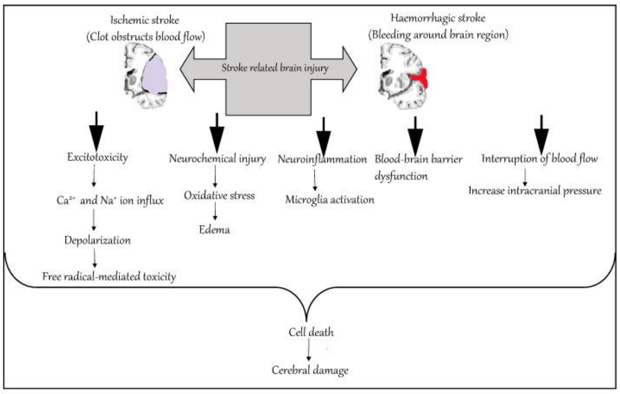

Figure 1. Stroke types(19)

2.2. Epidemiology

Stroke is a very common neurological disease that causes permanent disability, especially in advanced populations, with 13.7 million new cases worldwide each year (1) Approximately 87% of strokes are ischemic infarction and approximately 10-25% of strokes are hemorrhagic infarction. The prevalence of stroke is increasing significantly today due to decreased mortality and increased clinical interventions between 1990 and 2016. While the incidence and prevalence of stroke are increasing in low-income countries, the prevalence of stroke is decreasing in developed countries. The incidence of stroke increases with increasing age, and this rate doubles after the age of 55 (20).

2.3. Risk Factors for Stroke

There are many risk factors for stroke. The most important risk factor is hypertension. Studies close to half of the incidence of stroke are related to hypertension. Diabetes mellitus, cardiovascular disease defined as a metabolic disorder Hyperlipidemia, defined as diabetes mellitus (DM) and increased cholesterol, is another risk factor. Demographic characteristics such as sedentary lifestyle, obesity, poor physical activity, poor diet (fruits, vegetables, fiber, omega -fatty acids and monounsaturated fats, especially vitamin B12 deficiency), smoking, gender, age are also risk factors for stroke (21). .

Depending on gender, the incidence of stroke is higher in younger women, but the incidence of stroke increases with age in men . It is stated that the high incidence of stroke in women is due to pregnancy-related factors such as preeclampsia and hormonal therapy, contraceptive use, and migraine with aura (22).

2.4. Problems After Stroke

Motor disorders seen after stroke are classified as deterioration in body functions such as muscle strength, endurance, deficiency and muscle tone disorders, body structure, as well as the structure of nerves and/or muscles. It can cause activity limitation and disability as a result of motor disorders. Motor disorders are the result of stroke, such as hyperkinetic syndrome (dystonia , tremor, ataxia) and hypokinetic syndrome (vascular parkinsonism , laxity, paralysis…). Motor adefects and movement disorders can impair function as a result. Motor impairment interferes with activities of daily living, walking, swallowing, talking, etc. (23).

Spasticity is one of the consequences of stroke. There are studies showing that spasticity occurs in approximately 38% of patients with paralysis (5). 48% and 77% of stroke survivors have upper extremity therefore, it affects function and healthy life and quality of life. This is mainly due to the presence of spasticity. Wissel et al . observed that spasticity developed most frequently in the elbow (79%) (6).

The sense of touch, proprioceptive , 2-point discrimination etc. Sensory disturbances are another complication of stroke. More than half of stroke patients suffer from sensory impairment . Depending on the location of the disorder, different sensory disturbances may occur. These disorders are also due to the lack of signal transmission (24)

2.5. Stroke Recovery Phase

Stroke recovery is possible but difficult. It needs a lot of effort and family support and especially patient motivation. Many patients fear not being able to fully recover from the elasticity and are concerned about the healing process and the time to be independent and active.

Brunnstrom healing phases. This approach includes 6 phases (Table 1). This classification was created from clinical observations of a large number of hemiplegic patients based on the degree of spasticity , synergy, and involuntary movements . The first stage is the flaccid state where there is no movement in the limbs and the patient cannot initiate movement . In this approach, increasing muscle tone occurs over time, and later on, spasticity disappears and extremity movements become voluntary (Table 1). The physiotherapist uses this process to aid rehabilitation and make movements voluntary. Stroke patients can use spasticity and involuntary movements to increase performance and independence in daily life (25).

Table I. Brunnstrom recovery stages.

Stages	Description
Stage 1	Flaccidity is present and no movements of the limbs can be initiated.
Stage 2	The basic limb synergies or some of their components may appear as associated reactions or minimal voluntary movement responses may be present. Spasticity begins to develop.
Stage 3	The patient gains voluntary control of the movement synergies, although full range of all synergy components does not necessarily develop. Spasticity is severe.
Stage 4	Some movement combinations that do not follow the synergies are mastered and spasticity begins to decline.
Stage 5	More difficult movement combinations are possible as the basic limb synergies lose their dominance over motor acts.
Stage 6	Spasticity disappears and individual joint movements become possible.

2.6. Spasticity

Spasticity was first described by Lance in 1980 as a motor disorder characterized by increased muscle tone due to the stretch reflex. muscle spindle Hyperexcitability causes an increase in Ia as a component of the motor neuron syndrome, as well as motor neuron activity and ultimately hyperexcitability of the stretch reflex. This definition characterizes spasticity during passive movement , but cannot explain its effect on voluntary movements. In 1994 , Young describes the neurophysiological mechanism that defines spasticity , which is independent of the type of movements : an increase in the tonic stretch reflex due to abnormal intraspinal processing of velocity-dependent primary afferent inputs (26). Upper motor neuron syndrome, which defines increased activity, may have a positive or negative effect (26).

Spasticity, in neurological disorders of the descending corticospinal system, spasticity dystonia (restriction of muscle activity in the absence of voluntary movements), spasticity co It is a positive sign of neurological disorders in the descending corticospinal system , such as muscle contraction . Contraction, extensor or flexor muscle contraction in the joint, agonist and antagonist muscles due to abnormal pattern commands in the supraspinal tracts. spasticity , increase in stretch reflex or tendon reflex, clonus and related reactions occur (27).

Post-stroke spasticity occurs in the stage after the elasticity stage. In the upper extremity, Spasticity can affect upper extremity function and functioning, thus leading to activity limitation, participation restriction, and lower dependency, ultimately leading to increased direct care costs during the first year after stroke (4).

Lundstrom defined spasticity as an effect on movement function, activity performance, or participation in social life, accompanied by positive symptoms of upper motor neuron (UMN) syndrome. So it can lead to impairment, activity restriction, participation restriction and ultimately disability. Sometimes spasticity can have a positive effect on function and the physiotherapist can benefit from spasticity especially for upper extremity function (28).

2.6.1. Spasticity Epidemiology

Spasticity is more common in the upper extremities than in the lower extremities in stroke patients . In the upper extremity, the frequency of spasticity varies between 7% and 38% in the first 12 months, and it is reported to be 46% on average in patients with impaired upper extremity function at baseline.

Spasticity after stroke its prevalence varies between 4% and 46% in 1 month, 4.16%-48% in 1-3 months, 6.9-63% in 3-6 months, and 7.6-49% after 6 months. It is stated that 2–2.6% of the patients develop disabling or severe spasticity within 1 month, 5% at 1-3 months, 8–15.6% at 6 months, and 12.5–18% after 6 months. (29).

Spasticity in paralysis stroke the incidence is 35.7% within 1 month, 34.6% within 1-3 months, 42.3% between 3-6 months, and 45.4% after 6 months. Meta-analysis, generally disabling spasticity and severe spasticity It has been shown that the incidence is 9.4% in 1 month, 5% in 1-3 months, 12% in 6 months, 14.9% in 12 months. severe spasticity its incidence was 10.3% (29).

2.6.2. Etiology of Spasticity

Spasticity is induced by the dissociation or fragmentation of motor responses from sensory input, It causes excessive excitability of the central nervous system (CNS) .

Density of sensory input from muscle spindles and afferent It depends on the tension (stretching rate) of Ia and the location of the lesion. As the stretch rate increases, sensory input from la increases and eventually muscle tone increases. When there is an imbalance between inhibitory and excitatory inputs , it can cause different upper extremity syndromes such as hypotonia , spasticity or dyskinesia . Depending on the location of the lesion, muscle tone disorders may be different. Spasticity , hyperreflexia , and sometimes clonus may develop when there is a lesion in the cortex or sometimes in the brainstem (27).

On the basis of their studies, they stated that reticulospinal system and/or vestibulospinal system hyperactivity may be the mechanism of spasticity . After stroke, the reticulospinal tract is activated and spreads downward. A hemiplegic patient has hyperexcitability only in the reticulospinal tract on the hemiplegic side . So there is motor neuron excitability on this side . According to Brunnstrom 's theory, post-stroke patients may experience post- flatulence spasticity , which may disappear at the latest during the recovery phase . However, some stroke patients may not experience spasticity during the recovery phase (30).

According to Magnetic Resonance Imaging (MRI) studies, the location of the lesion is important for the emergence of spasticity . Based on studies of the inner capsules, basal ganglia , insula , thalamus , putamen and premotor cortex, and others.

lesion in the insula causes disorders in the vestibulospinal system, resulting in disorders in the vestibular system and spasticity accordingly . Damage to the basal ganglia can cause incoordination and impaired balance of movements, as well as weakness and eventually muscle spasticity and overactivity.

The most common injury site in hemorrhagic stroke is the putamen / globus . pallidus (56%) and inner capsule (51%).

Basal ganglia , inner capsule and corticospinal system are important regions in the development of spasticity (29).

2.7. Treatment

2.7.1. Stretching

Based on the systematic review, stretching is one of the effective treatments for spasticity in physiotherapy. Static stretching, such as orthotics , is more effective than intermittent stretching. Muscle spindles in the static method is inhibited , thus reducing the motor unit activity of the muscles. Stretching combined with other treatment modalities can improve the mobility of the joints and the viscoelastic properties of the muscle- tendon unit and reduce spasticity (8).

2.7.2. Transcutaneous Electrical Stimulation (TENS)

modalities such as TENS It can reduce spasticity and improve upper extremity function. The mechanism of action of this modality is reciprocal inhibition , presynaptic increase inhibition , decrease stretch reflex excitability , corticomotor of the stimulated regions. It is based on reducing the excitability of the brain, ultimately modulating brain plasticity , and increasing sensory input and secretion of Beta endorphins due to the excitability of large-diameter AB fibers . TENS can be applied on the spastic muscle, on the antagonist muscle, along the nerve and distal to the spastic muscle as well as at acupuncture points (27).

2.7.3. EMG Biofeedback (EMG BF)

myoelectric signals obtained from the muscles in order to inform the individual about the activity of the muscles by converting them into visual and auditory signals. Based on this feedback, the patient learns how to alter the physiological characteristics of the activities and can minimize voluntary muscle tone to achieve cortical control in this method. Another method is to use EMG BF to activate antagonist muscles, thereby reducing muscle tone by reciprocal inhibition (37).

2.7.4. Massage

a simple and inexpensive method to reduce muscle tone . The mechanism of this method may be that manipulation stretches the muscle - tendon complex and Golgi, which may inhibit alpha motor neurons and reduce spasm. It stimulates the tendon organ. Supra, which can reduce the patient's stress and relax, eventually reduce spasticity . sensory input with spinal effect (38).

2.7.5. Cold Application

an easy and inexpensive method to reduce spasticity when used for a long time . As the effect of cold , it reduces the sensitivity of skin mechanoreceptors , decreases the conduction velocity of sensory and motor nerve fibers (alpha), or decreases neuromuscular It is a decrease in the tension sensitivity of the spindles and thus a decrease in motor nerve activity. Fibers (alpha) and gamma increase motor neuron activity and eventually reduce spasticity . On the other hand, the maximum amplitude of the H response increases according to the maximum amplitude of the M wave (Hmax / Mmax), so reflex excitability decreases and thus spasticity decreases (36, 39).

2.7.6. Hot Application

Hot application is commonly used to reduce spasticity . Heat can significantly reduce the F-wave parameters, thus reducing spasticity and causing local relaxation of the muscles (40). Heat may also increase the effect of stretching technique on spasticity due to increased collagen response to stress (41).

2.7.7. Extracorporeal Shock Wave Therapy (ESWT)

Based on a systematic review, ESWT, both alone and in combination therapy, is used in the upper extremity . states that it reduces spasticity (16). Shock waves consist of sound waves that have a physical effect due to the energy these sounds impose on the tissue. These sounds are non-linear and have high peak pressure and low stress amplitude, short rise time and short duration (10 μs).

The shock wave consists of 2 phases. Negative and positive phase. The positive phase is when there is direct mechanical compression on the tissue and the negative phase is when there is cavitation that explodes at high velocities and creates the second shock wave wave during a shock (17).

Based on studies, there are two shockwave modes : focused and radial shockwave. Waves from focused shock wave therapy are generated from the probe and focused on the target area. In contrast, radial shock wave devices develop their maximum energy at the probe tip and distribute it radially into the tissue (42).

ESWT on spasticity due to central nervous system damage are not clearly known. Mariotto et al. He stated that ESWT can induce nitric oxide (NO) synthesis and NO plays a role in the improvement of variable tendon disease. NO is involved in neuromuscular junction formation in the peripheral nervous system and in neurotransmission and synaptic It is involved in the physiological functions of the central nervous system, including plasticity (43).

Considering the therapeutic effects of ESWT on bones and tendons , Manganotti and Amelio suggested that reduction of spasticity may be caused by improving connective tissue stiffness by directly acting on fibrosis of chronic hypertonic muscles (44). Hojjat radinmehr et al. In the study, the radial ESWT of single session applied on the gastrocnemius and soleus muscles. Spasticity scores improved for both the gastrocnemius and soleus muscles, and they stated that the effect on spasticity continued one hour after ESWT, but had no effect on alphamotor neuron excitability (45).

gaiyan Li et al. examined the effect of ESWT on elbow spasticity in a randomized , single-blind clinical trial . The control groups (A) were divided into three groups as the group in which they applied ESWT to the agonist muscles (B) and the group (C) that they applied to the antagonist muscles. They concluded that ESWT is an effective treatment for post-stroke spasticity , with lasting effects on both agonist and antagonist muscles after 4 weeks . They also stated that ESWT reduced pain, but had no effect on upper extremity function and edema (5).

Yan Leng et al. aimed to evaluate the neural and peripheral contribution after spasticity in their study . They combined the biomechanical modeling method with knowledge of muscle composition from mechanical muscle properties and electrical impedance measurement. They applied one session of ESWT treatment to the intervention group, followed by routine treatment with the same frequency and intensity as the control group. In this study, the effect of spasticity in terms of changes in muscle mechanical properties of ESWT intervention. It was concluded that it may be more effective in dealing with the peripheral component (46).

Li et al., in their study, aimed to determine the long-term effect and functional status of ESWT in patients with post -stroke spasticity . There are 3 groups in this study; group A: 1 session per week for 3 weeks , group B: a single session of ESWT, group C: a sham session per week for 3 consecutive weeks. In this study, it was concluded that ESWT may be effective in reducing hand and wrist spasticity and improve wrist control and hand function in patients with chronic stroke (47).

aimed to examine the effects of ESWT on upper extremity muscle tone in chronic stroke patients . In the intervention group, twice a week for eight weeks, the flexor of the hand carpi on the ulnaris and radialis , the intrinsic muscles of the hand and the flexor digitorum applied ESWT on the tendon , and sham - ESWT on the control group in the same way. In this study , they concluded that ESWT is effective in improving muscle tone reduction in patients with chronic stroke (13).

2.7.8. Dry needling

According to studies performed after spasticity , there is a change in muscle thickness, pennation angle and fascicle length of the spastic muscle. It is stated that dry needling applied to the spastic muscle changes the muscle thickness, pennation angle and fascicle length of the spastic muscle (48).

Irritability of the trigger point (MTRP) of a muscle , the end plate in the MTRP region was highly correlated with the prevalence of fluctuation. Relatedly , the mechanism of action of dry needling is based on mechanical disruption of the associated dysfunctional end plate region . In addition, dry needling has been shown to increase blood flow and oxygen saturation in the stimulated region (49).

Dry needling produces a local twitch response so it can alter the spontaneous electrical activity (SEA) of the muscles . The local twitch response that occurs when the needle is inserted into the end plate region reduces Acetylcholine (ACH) storage and results in lower SEA . Another mechanism of dry needling at the endplate is that dry needling causes muscle fiber discharge, thereby producing a local twitch response, resulting in changes in fascicle length, muscle thickness, and angle of pennation . Another mechanism is that it increases blood flow and decreases ACH and opioid or analgesic secretion, increases metabolism in the region, and accelerates its repair (50).

Alternatively, stimulation of Aδ- nerve fibers can also activate the serotonergic and noradrenergic descending inhibitory system. Although there are no known specific experimental or clinical studies supporting the proposed serotonergic and noradrenergic mechanisms of dry needling, it is assumed that dry needling may have an effect on both systems (50).

Zacarias Sánchez-Mila et al., in their study, aimed to investigate the effects of dry needling . They applied the Bobath concept on motor function and post-stroke postural control in subsequent treatment sessions. There are 2 groups in this study; They applied treatment based on the Bobath concept to the control group , and dry needling was applied to the intervention group in addition to the Bobath concept . In this study, the effects of dry needling in a treatment session following the Bobath concept. concluded that it is effective in reducing spasticity and improving balance, range of motion and stability in stroke patients (51).

Fakhari et al., in their study, found that dry needling is effective in post-stroke wrist flexor They aimed to investigate the effects on spasticity . Evaluation was performed 3 times in this study: baseline before treatment, immediately after dry needling , and one hour after dry needling. flexor in the affected arm carpi radialis (FCR) and flexor carpi A single session of dry needling was applied for the ulnaris , one minute per muscle . In this study, the effects of dry needling on the wrist flexor in paralyzed patients were investigated. concluded that it reduced spasticity and alpha motor neuron excitability , and that improvements continued for one hour after dry needling (52).

Ana Mendigutia-Gómez et al., in their study, aimed to investigate the effects of dry needling . They applied spastic shoulder muscles on spasticity , pain sensitivity and shoulder range of motion in stroke patients . The intervention was applied once a week for 3 weeks. In this study , they concluded that dry needling was effective in reducing localized pain sensitivity and improving shoulder range of motion in stroke patients, but they stated that there was no significant reduction in muscle spasticity (53).

2.8. Upper Extremity Function

spasticity and weakness can be seen in the muscles after stroke . It negatively affects the quality of life of stroke patients. In the first stage of stroke, there is elasticity and weakness. Therefore, the patient cannot control movement in the affected extremity, especially dexterity functions such as grasping, reaching, and manipulating objects. On the other hand, since patients tend to use the unaffected arm, the affected arm is neglected and the function of the hand deteriorates further and the patient becomes dependent. Eventually, the patient is unable to perform dexterity functions such as grasping or manipulating objects, especially small objects, in a coordinated pattern (54).

Independence in activities of daily living is closely related to proficiency in dexterity and functions, which refers to the ability to grasp and manipulate objects with correct and coordinated hand and finger movements. Although strongly related, hand and finger control is generally more impaired after stroke than proximal upper extremity control and is more difficult to rehabilitate . ipsilateral cortico-spinal and reticulospinal tracts, extremity It has been suggested that they can better compensate for motor defects in the proximal rather than the distal muscles (55).

Somatosensory disturbances such as touch, temperature, pain, and proprioception are common in stroke patients. It has been reported that some sensory modalities are impaired in 85% of chronic stroke patients , but the observed prevalence varies between studies (55).

2.9. Effect of Sensory Disorder on Function

Somatosensory impairment impairs control of movements and upper extremity function, and may also impair selective and goal-directed movements. Therefore, the patient may have activity limitation and participation limitation (56).

Sensory input is impaired when there is somatosensory impairment. This impairment affects the ability to function in activities of daily living and participate in social life. Therefore , somatosensory recovery is clinically very important to aid rehabilitation (56).

Functionally, problems arising from sensory deficits after stroke can be summarized as impaired perception of sensory information, impaired performance of motor tasks that require somatosensory information, and decreased rehabilitation results for the upper extremity . Sensation is important for safety, even with adequate motor function. The development of secondary complications such as wounds, abrasions and shoulder-hand syndrome has been associated with sensory impairment. It has been found to be directly related to the development of shoulder pain and subluxation in sensory disorders (57).

Impairment in sensory input and processing can disrupt the relationship between the patient and the environment. Van der Lee et al. According to the study, stroke patients with sensory impairment neglect their arm and do not use the affected arm in daily life, so the upper extremity functions and dexterity of the patient are impaired. of the upper extremity Spontaneous use has been noted to be significantly reduced. This lack of sustained use of the affected limb leads to a further reduction in dexterous movements, especially for functional activities that require sustained muscle contraction. This further adds to the model of learned disuse (58). In the presence of sensory disorders, the functional capacity of upper extremity movements is also impaired.

3. Methodology

This study investigated the effects of dry needling and ESWT on the elbow flexor after stroke. It is a two-group, pretest-posttest clinical study with repeated measures to evaluate its effects on spasticity . This study aimed to evaluate the use of extracorporeal shock wave therapy and dry needling in patients with post-stroke hemiplegia in the elbow flexor compared ts effectiveness on spasticity , upper extremity functions and pain. Twenty patients with post-stroke hemiplegia were included in this study. The researcher started working after this study was approved by the training and development center in Karbala Health Directorate and an ethics committee report (code 560) was received on 2021/8/21. Written informed consent form was obtained from those who agreed to participate in the study.

This study is a randomized controlled single-blind clinical trial. elbow flexor after stroke 20 individuals with spasticity were randomly divided into two groups as the group receiving ESWT and the group receiving dry needling treatment. Randomization was done using Microsoft Excel. The procedure was designed by a researcher who was not involved in other aspects of the protocol. All participants were assigned to groups using pre-numbered, sealed, opaque envelopes.

3.1. Inclusion criteria for the study:

1- Being over 65 years old

2-Diagnosis of stroke by a specialist

3- Having a stroke for the first time

4-elbow flexor spasticity

5- Ability to understand commands

6- Stable vital signs

7-Unchanged drug doses that may affect its spasticity (5)

8- Not taking antispastic drugs (45)

9- Modified Ashworth scale (MAS) upper extremity score greater than 1 and less than 4 for flexor strain (18)

Exclusion criteria in the study

Botox , alcohol or phenol block treatments

Having had elbow joint surgery

History of epilepsy, severe mental disorders, malignant tumors; and limb vein history of thrombosis (5)

Presence of any other neurological disorder

Being receiving other treatments

ESWT contraindications (pregnancy, On major vessels and nerves, Pacemaker or other implanted devices, Open wounds, Joint replacements , Pineal , Blood clotting disorders including thrombosis , Infection and cancer) (45).

exhibit fear of needles (51)

3.2.Exclusion Criteria:

1. Those who could not complete the tests

2. Persons whose data is missing or lost during registration

After the participants were included according to the inclusion criteria, the data collection process was started. After each participant who voluntarily participated in this study filled out the demographic information questionnaire, each test was evaluated by the researcher. First sensory tests, then functional tests were completed. Before starting, the researcher briefed each participant about the tests.

Dry needling were applied in a single session to individuals who had post-stroke hemiplegia and were older than 65 years and accepted treatment . The following tests were applied to all patients who accepted to participate in the study.

The study group was determined according to the following criteria.

3.3. Evaluations

ESWT and dry needling were applied to individuals over 65 years of age with post-stroke hemiplegia who accepted treatment . ESWT was applied to one group and dry needling was applied to the other group. All measurement indicators will be evaluated before treatment and immediately after one session of treatment. Individuals were informed about the test and time was given to practice before each test. After making sure that they understood, it was put into practice. The following tests were applied to all patients who accepted to participate in the study.

3.3.1. Demographic Information

Demographic information, age, gender, height, weight and BMI were recorded.

3. 3.2. Sensory Evaluation of Upper Extremity

- Sense of Touch

semmen winstone The sense of touch was tested with the monofilament test (SWMT). In this test, monofilaments of different diameters are used. The patient is in the supine position, with the upper extremity on the side. The patient's eyes are closed, the filament is bent by half its length, and the filament is pressed against the skin at a 90º angle. The first step was to start with the thickest filament (6.65), and then the patient was asked if he could feel the filament . If the patient could feel this filament, another less thick filament was tested (5.58). This process was continued until the patient could not feel a filament . The first value that was not felt from the applied filament thickness values was recorded. This test was performed on the arm, forearm, hand, and finger (59) .

- Light Touch

In the light touch test, a cotton swab was used to touch each area, including the arm, forearm, hand, and finger. In each test, the patient was asked to say yes or no according to the feeling of the cotton swab in the supine position with the upper extremity eyes closed. “0 point” was given if there was no loss of light touch sensation, and “1 point” was given if there was. The score of each area was then summed up for the total grade. (59) .

- Sense of Pain

For the pain sensation test, the patient should be in the supine position, the upper extremity at the side, and the eyes closed. A pointed and blunt - headed separator was then used. Pointed or blunt pressure changed randomly. The patient was asked to answer blunt if it felt " blunt " and "pointy" if it felt pointed. This test was examined on the arm, forearm, hand and finger. “0 point” was given if there was no loss in the sense of pain, and “1 point” was given if there was. The score of each region was then summed up for the total grade (46).

- 2 Point Discrimation

For 2-point discrimination, the patient should be in the supine position with the upper extremity sideways, eyes closed. In the first step, the researcher used the widest discriminator range [100 millimeters (mm)]. The patient was asked to say whether he felt one or two points. If the patient felt a point, the test was stopped, but if he felt 2 points, he reduced the distance and was questioned again. By continuing these processes, the distance is reduced and finally the narrowest gap (1mm) is advanced. The narrowest gap felt as a single point is recorded as the measured value. This test was examined on the arm, forearm, hand and finger (46) .

3.3.4. spasticity

Elbow flexors of individuals with post-stroke hemiplegia modified to test spasticity Ashworth scale (MAS) was used. The MAS rating is as follows:

0.No increase in muscle tone .

muscle tone , when the affected part (lara) is flexed or extended , stiffness and relaxation are felt or minimal resistance is seen at the end of the range of motion.

1+ There is a slight increase in muscle tone , first with stiffness, followed by minimal resistance in the remainder (less than half) of the range of motion.

There is a more pronounced increase in muscle tone over most of the range of motion , but the affected part(s) is easily moved.

There is a significant increase in muscle tone , passive movement is difficult.

4. Affected part(s) in flexion or extension rigid (33) .

3.3.5. Pain

To assess pain Visual analog scale (VAS) was used. Pain is assessed using a 10 cm horizontal axis. 0: no pain, 10: the worst possible pain (74).

3.4. Treatment procedure

After completing the informed consent form, individuals are reviewed by the investigator for inclusion criteria. The procedure was designed by a researcher who was not involved in other aspects of the protocol. Group distributions were made using numbered, sealed, opaque envelopes prepared for all participants. That is, all participants have an equal chance of being in group A or B. ESWT to the first group; Dry needling was applied to the second group .

biceps The brachii muscle was subjected to an ESWT session in which 6,000 pulses were delivered at 0.06-0.07 mJ /mm2 (1.2-1.4 bar) at 18 Hz (5).

Needling was applied to the lateral arm using disposable, flawless steel sterile needles in the supine position of the subjects in the group . 0.25×0.30. Dry needling was applied to the patients in the supine position, with the arm away from the trunk and the forearm in supination . With the rapid entry and rapid exit cone shape technique, each muscle is pricked for one minute (23).

3.5. Statistical analysis

In this study, the G* Power 3.1.9.2 package program was used to determine the number of individuals to be included in the study. Accordingly, 10 people were included in each group in order to obtain 80% power from the study at a significance level of $p<0.05$ (7).

Obtained data were analyzed with IBM SPSS 22 program. Distribution of data obtained in the study Kolmogrov It was tested with the Smirnov test and the skewness- kurtosis values were checked, and as a result, since the skewness-kurtosis values of the data were in the range of ±1, parametric analysis tests were performed. Descriptive analysis for background variables between the two groups and independent t-test for quantitative variables were used. Repeated measures ANOVA were used to analyze differences between groups before and after the intervention.

4. Findings

It was observed that the individuals in the ESWT and dry needling groups were similar in terms of demographic information (age, height, weight, body mass index, gender, affected side and spasticity status) ($p>0.05$, Table 2 and Table 3).

Table 2. Mean and standard deviation values of age, height, weight, body mass index of individuals in ESWT and dry needling groups

Parameters	ESWT (n=10)		Dry needling (n=10)		p
	Average	Standard deviation	Average	Standard deviation	
Length (m)	**167.90**	**10.04**	**166.80**	**10.32**	**0.812**
Age (years)	**77.70**	**15.25**	**72.40**	**12.47**	**0.710**
Weight (kg)	**56.00**	**13.68**	**57.90**	**8.08**	**0.406**

p <0.05 n: Number of individuals, ESWT: extracorporeal shock wave therapy, dry needling : Dry needling

Table 3. Examination of gender, affected side and spasticity parameters of individuals in the ESWT and dry needling groups

Parameters		ESWT (n=10)		DRY NEEDLING (n=10)		
		n	%	n	%	p
Gender	**Male**	**8**	**57.14**	**6**	**42.86**	**0.329**
	Woman	**2**	**33.33**	**4**	**66.67**	
Affected party	**Right**	**4**	**44.44**	**5**	**55.56**	**0.651**
	Left	**6**	**54.55**	**5**	**45.45**	
modified Ashwort Scale	**one**	**-**	**-**	**2**	**one hundred**	**0.17**
	2	**2**	**one hundred**	**-**	**-**	
	3	**2**	**66.67**	**one**	**33.33**	
	1+	**6**	**54.55**	**5**	**45.45**	
	2+	**-**	**-**	**2**	**one hundred**	

p <0.05 n: Number of individuals, ESWT: extracorporeal shock wave therapy, dry needling : Dry needling

It was observed that the individuals in the ESWT and dry needling groups were similar in terms of sensory parameters, functional parameters and pain values (p>0.05, Table 4). Information on sensory parameters, measurement values of upper extremity functions and pain status of individuals are shown in Table 4.

Table 4. Examination of sensory parameters, functional parameters and pain values of individuals in the ESWT and dry needling groups

Parameters	ESWT (n=10)		Dry needling (n=10)		P
	Average	Standard deviation	Average	Standard deviation	
JTEFT-write	45.70	21.79	28.80	13.41	0.051
JTEFT- page turn	41.00	39.16	24.90	11.41	0.228
JTEFT-Collecting and dropping small objects	31.70	26.63	27.40	12.74	0.651
JTEFT-Nutrition	36.60	29.51	22.10	5.34	0.144
JTEFT-Moving light objects	20.50	14.80	24.00	8.93	0.530
JTEFT- Moving heavy objects	24.40	20.10	18.80	7.91	0.423
JTEFT-Arranging the checkers	26.60	21.38	21.20	12.52	0.499
light touch	2.70	1.89	1.80	1.81	0.291
sense of touch	9.90	7.81	15.80	5.03	0.060
pain sensation	0.80	1.69	0.50	1.27	0.658
2PD- Hand	14.75	10.77	17.80	10.41	0.551
2PD- Finger	13.75	8.50	15.00	10.10	0.784
2PD-Front arm	28.75	9.72	28.10	6.59	0.868
2PD- Arm	33.88	11.33	30.90	9.67	0.556
Purdue Peg Board Test	20.56	5.25	17.90	5.97	0.320
9-HPT- Right	89.70	72.98	90.60	80.48	0.979
9-HPT- Left	98.70	76.79	79.90	62.75	0.556
Jebsen taylor hand function test (Total)	202.00	105.62	167.00	50.25	0.357
VAS	1.56	1.59	1.80	.92	0.683

$p < 0.05$ n: Number of subjects, ESWT: extracorporeal shock wave therapy, dry needling : Dry needling, JTEFT: Jebsen Taylor Hand Function Test, 9-(HPT): 9 Hole Peg Test, VAS: Visual Analog Scale, 2PD: 2 Point Discriminatio

-way for comparing two groups in terms of score changes Statistical analysis was performed with mixed ANOVA and the results are presented in Table 4.

4.1 Statistical Analysis Results of the Sense of the Upper Extremity

4.1.1. Light touch: According to the statistical analysis results of the study, it was determined that the effect of time was not significant for the light touch sense, and the results of the two measurements were not significantly different (p=0.09). It was determined that there was no significant difference between the two groups in terms of light touch sense, and the effect of the group was not significant (p=0.084). In addition, it was determined that the interaction between time and group was not significant, and there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement (F=1.97, p=0.17, $\eta 2$ p=0.1), (Table 5).

4.1.2. Tactile Sense: According to the results of the statistical analysis of the study, it was shown that the effect of time was not significant in terms of the Touch Sense Score, and the results of the two measurements were not significantly different (p=0.053). It was determined that there was no significant difference between the two groups in terms of tactile sense score, and the effect of the group was not significant (p=0.05). It was determined that there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement , and the interaction between time and group was not significant (F=1, p=0.33, η2 p=0.054), (Table 5).

4.1.3. Pain Sense: According to the statistical analysis results of the study, it was determined that the results of the two measurements in terms of pain sensation score were not significantly different, the effect of time was not significant (p=0.55), it was determined that the two groups were significantly different in terms of pain sensation score, and the effect of the group was significant (p=0.016). In addition, the interaction between time and group was not significant, and the two groups were not significantly different in terms of initial measurement and post-intervention measurement (F=1, p=0.35, η2 p=0.053), (Table 5).

4.1.4. Two-point discrimination:

Hand: According to the statistical analysis results of the study, it was shown that the effect of time was not significant and the results of the two measurements were not significantly different (p=0.39). It was seen that the effect of the group was not significant (p=0.47). It was determined that the interaction between time and group was not significant (F=2.13, p=0.16, η2 p=0.118). In other words, the two groups were not significantly different in terms of initial measurement and post-intervention measurement (Table 5).

Fingers: According to the statistical analysis results of the study, the effect of time was found to be significant (p=0.046). It has been shown that the results of the two measurements in terms of Finger Score are significantly different. The effect of the group was not significant (p=0.77). In other words, it was determined that there was no significant difference between the two groups. The interaction between time and group was not significant (F=0.13, p=0.911, η2 p=0.001), and the two groups were not significantly different in terms of initial measurement and post-intervention measurement (Table 5).

Forearm: According to the statistical analysis results of the study, it was seen that the effect of time was significant (p<0.001), and the results of the two measurements were significantly different in terms of the 2PD score of the forearm. It was determined that the effect of the group was not significant (p=0.835), and there was no significant difference between the two groups in terms of the 2PD score of the forearm. It was determined that the interaction between time and group was not significant (F=0.056, p=0.816, η2 p=0.003), and it was observed that there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement (Table 5).

Arm: According to the statistical analysis results of the study, it was shown that the effect of time was significant (p=0.004), and the results of the two measurements were significantly different in terms of the 2PD score of the arm. The effect of the group was not found significant (p=0.801). There was no significant difference between the two groups in terms of the 2PD score of the arm. It was determined that the interaction between time and group was not significant (F=2.42, p=0.139, η2 p=0.13), and there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement (Table 5).

4.2. Statistical Analysis Results for Pain: According to the statistical analysis results of the study, it was determined that the effect of time was significant (p=0.001), while the results of the two measurements for VAS were significantly different. It was determined that the effect of the group was not significant (p=0.745), and there was no significant difference between the two groups in terms of VAS score. The interaction between time and group was not significant (F=0.26, p=0.62, η2 p=0.015). It was determined that there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement (Table 5).

4.3. Statistical Analysis Results for Spasticity: According to the statistical analysis results of the study, it was determined that the effect of time was significant (p=0.003), in other words, the results of the two measurements in terms of MAS were significantly different. It was determined that the effect of the group was not significant (p=0.449), and there was no significant difference between the two groups in terms of MAS score. In addition, the interaction between time and group was not significant (F=0, p=1, η2 p=0), and it was determined that the two groups were not significantly different in terms of initial measurement and post-intervention measurement (Table 5).

Table 5. Comparison of first and last measurement scores using 2-way mixed ANOVA

Parameters	Groups	First Measurement		Final Measurement		Within-Group change Scores *	Main Effect (time) p	Main Effect (Group) p	Group *Time interaction f/p value	η 2 p (effect size)
		mean	SD	mean	SD					
JTEFT-write	ESWT	45.70	21.79	38.70	15.61	-7(-9.28,-4.71)	0.004	0.051	1.4/0.252	0.072
	DRY NEEDLING	28.80	13.41	25.50	13.62	-3.3(-5.58,-1.01)				
JTEFT- page turn	ESWT	41.00	39.16	32.70	30.59	-8.3(-14.76 , -1.83)	0.002	0.252	2.43/0.136	0.12
	DRY NEEDLING	24.90	11.41	21.50	10.61	-3.4(-6.34,-0.45)				
JTEFT-Collecting and dropping small objects	ESWT	31.70	26.63	27.40	20.45	-4.3(-8.87,0.275)	0.002	0.635	0.07/0.793	0.004
	DRY NEEDLING	27.40	12.74	23.70	10.22	-3.7(-5.96,-1.43)				
JTEFT-Nutrition	ESWT	36.60	29.51	37.90	29.40	1.3(-4.95,4.75)	0.56	0.092	2.25/0.151	0.111
	DRY NEEDLING	22.10	5.34	19.10	5.04	-3(-4.68,-1.31)				
JTEFT-Moving light objects	ESWT	20.50	14.80	24.40	20.10	3.9(-0.29,8.09)	0.66	0.86	9.47/0.006	0.345
	DRY NEEDLING	24.00	8.93	18.80	7.91	-5.2(-10.41,-0.01)				
JTEFT- Moving heavy objects	ESWT	24.40	20.10	21.50	18.98	-2.9(-4.04,-1.76)	<0.001	0.489	8.62/0.009	0.324
	DRY NEEDLING	18.80	7.91	17.70	7.82	-1.1(-1.88,-0.31)				
JTEFT-Arranging the checkers	ESWT	26.60	21.38	20.00	18.83	-6.6(-15.18,1.98)	0.04	0.684	1.53/0.23	0.078
	DRY NEEDLING	21.20	12.52	19.40	12.69	-1.8(-3.61,0.01)				
light touch	ESWT	2.70	1.88	2.85	1.88	0.15(-0.33, 0.34)	0.099	0.084	1.97/0.17	0.10
	DRY NEEDLING	1.80	1.81	1.5	1.77	-0.30(-0.65, 0.046)				
sense of touch	ESWT	9.90	2.47	15.80	1.59	0(-1.65,1.65)	0.053	0.05	1/0.331	0.054
	DRY NEEDLING	9.90	2.64	16.60	1.64	0.80(0.061, 1.54)				
pain sensation	ESWT	0.8	1.68	0.8	1.69	0(-0.33,0.28)	0.55	0.016	1/0.35	0.053
	DRY NEEDLING	0.5	1.27	0.4	0.96	-0.1 (-0.39,0.36)				
2PD- Hand	ESWT	14.75	10.77	12.63	11.16	-2.12(-4.33,0.084)	0.394	0.476	2.13/0.16	0.118
	DRY NEEDLING	17.80	10.41	17.00	10.77	-0.8(-1.53,-0.06)				
2PD- Finger	ESWT	13.75	8.50	12.75	8.58	-1(-2.48,0.48)	0.046	0.77	0.013/0.911	0.001

	DRY NEEDLING	15.00	10.10	14.10	10.41	-9(-2.27,0.47)				
2PD-Front arm	ESWT	28.75	9.72	25.50	10.84	-3.25(-6.56,0.057)	<0.001	0.835	0.056/0.816	0.003
	DRY NEEDLING	28.10	6.59	24.50	6.29	-3.60(-5.22,-1.97)				
2PD- Arm	ESWT	33.88	11.33	28.25	12.81	-5.62(-10.73,-0.51)	0.004	0.801	2.42/0.139	0.13
	DRY NEEDLING	30.90	9.67	28.80	7.22	-2.1(-4.52,0.32)				
Purdue Peg Board Test	ESWT	20.56	5.25	21.67	4.92	-1.11(0.3,1.92)	0.001	0.403	1.57/0.226	0.085
	DRY NEEDLING	17.90	5.97	20.10	5.47	2.2(0.49,3.91)				
9-HPT- Right	ESWT	89.70	72.98	73.20	68.70	-16.5(-44.31,11.30)	0.085	0.855	0.684/0.419	0.037
	DRY NEEDLING	90.60	80.48	84.40	74.84	-6.2(-10.7,-1.69)				
9-HPT- Left	ESWT	98.70	76.79	107.90	67.55	9.2(-30.07,48.47)	0.920	0.33	1.29/0.27	0.067
	DRY NEEDLING	79.90	62.75	68.90	56.38	-11(-19.35,-2.65)				
Jebsen Taylor Hand Function Test (Total)	ESWT	202.00	105.62	189.60	105.05	-12.4(-33.29,8.49)	0.004	0.307	0.47/0.502	0.025
	DRY NEEDLING	167.00	50.25	148.00	47.42	-19(-25.12,-12.87)				
VAS	ESWT	1.56	1.59	.44	1.01	-1.11(-1.82,-0.39)	<0.001	0.745	0.26/0.62	0.015
	DRY NEEDLING	1.80	.92	.50	.53	-1.3(-1.78,0.817)				
MAS	ESWT	1.60	.84	1.20	.42	-0.4(-0.77,-0.03)	0.003	0.449	0/1	0
	DRY NEEDLING	1.40	.70	1.00	.47	-0.4(-0.77,-0.03)				

5. Discussion

In this study, both dry needling and ESWT were used to improve the biceps It has been found that it can significantly reduce spasticity in the brachii muscle , and that these two treatments can improve upper extremity function tests.

Our study also determined that both dry needling and ESWT can significantly improve 2PD in the forearm, arm, and finger, but not for the hand. No significant improvement was observed in tactile sense, pain sensation and light touch in either group.

VAS score decreased significantly in both groups.

When we compared these two treatment groups for all measures, the differences were not significant.

Spasticity or muscle tone and improve upper extremity sensation and function in stroke patients is a serious concern.

Spasticity refers to hypertonia in the muscles due to the change in the central nervous system and the change in the viscoelasticity of the soft tissue around the muscle . In this study, elbow flexor (biceps brachii) was used to assess spasticity . MAS is an assessment scale that can quantitatively measure spasticity in patients. MAS is widely used in studies to evaluate spasticity in post-stroke patients . As in our study, Hamza et al.' The MAS score (75) used for subacute stroke with moderate and severe upper extremity impairment in the study of Li et al. It was also used to evaluate spasticity in the study of .

It was determined that ESWT treatment significantly reduced spasticity in the MAS score . Li et al. Although they stated in their study that applying more than one session of ESWT treatment (47) would be better , previous studies showed that one session of ESWT can reduce spasticity immediately after the treatment session, and this effect persists weakly (47). We used one session of ESWT treatment, similar to the literature.

Our study is in agreement with previous studies. Park et al. stated in their study that ESWT treatment was effective in reducing spasticity in the wrist flexors (13). Yan Leng et al. also showed in their study that there was a decrease in spasticity after ESWT (46). Radinmehr et al., a session of radial found that extracorporeal shock wave therapy reduced spasticity scores (45).

ESWT therapy on spasticity is the physical effect of negative and positive phase-forming waves. The positive phase is when there is direct mechanical compression on the tissue and the negative phase is when there is cavitation that explodes at high velocities and creates the second shock wave wave during a shock (17). This physical effect, which can reduce muscle stiffness and connective tissue stiffness by affecting fibrosis tissue, is based on studies (43).

Dry needling has an effect on reduced pain inhibition . There are Sensory receptors in the skin and in different tissues. Two of these receptors are pain receptors. A δ is one of these receptors that stimulate with strong mechanical stimuli, the other type of pain receptors are C fibers and chemical stimuli etc. with warn. Dry needling is a stimulant for Aδ. A δ periaqueductal It has a connection with gray (PAG). Descending neurons pass through this space and terminate in encephalin -containing gelatinosa spaces in the posterior horn of the spinal cord. Encephalin inhibitor C fibers give a transmission signal to the central nervous system (80).

In our study, it was shown that there was no significant difference in improving function between the dry needling and ESWT groups. Since there was no significant difference between the two groups in reducing spasticity and pain, the decrease in pain and spasticity was associated with an increase in upper extremity function, which seems to be an expected result from our study.

Another possible reason to improve upper extremity function is proximal is the theory of stability or core stability concept. Proximal muscle stability , distal It is essential for mobility , coordination and strength building.

6. Conclusion

1. It was determined that there was no significant difference between the two groups in terms of JTEFT score. The interaction between time and group was not found to be significant.
2. Purdue It was determined that there was no significant difference between the two groups in terms of pegboard test score. The interaction between time and group was not significant, and it was shown that the two groups were not significantly different in terms of initial measurement and post-intervention measurement.
3. It was determined that there was no significant difference between the two groups in terms of the 9-HPT right extremity score. It was shown that there was no significant difference between the ESWT group and the Dry needling group in terms of initial measurement and post-intervention measurement.
4. the 9-HPT left extremity score, it was shown that there was no significant difference between the two groups. It was determined that the interaction between time and group was not significant, and the two groups were not significantly different in terms of initial measurement and post-intervention measurement.
5. It was determined that there was no significant difference between the two groups in terms of light touch sense ($p=0.084$). It was determined that there was no significant difference between the ESWT group and the dry needling group in terms of initial measurement and post-intervention measurement.
6. tactile sense score. It was determined that there was no significant difference between the ESWT group and the Dry needling group in terms of initial measurement and post-intervention measurement, and the interaction between time and group was not significant.
7. It was determined that the two groups were significantly different in terms of pain sensation score, and the effect of the group was significant. In addition, the interaction between time and group was not significant, and the two groups were not significantly different in terms of initial measurement and post-intervention measurement.

8. It was seen that the effect of the group was not significant for the 2PD, hand region. It was determined that the two groups were not significantly different in terms of initial measurement and post-intervention measurement.
9. It has been shown that the results of the two measurements differ significantly in terms of 2PD, finger score. It was determined that there was no significant difference between the two groups. The interaction between time and group was not significant, and it was determined that the two groups were not significantly different in terms of initial measurement and post-intervention measurement.
10. It was seen that the results of the two measurements differed significantly in terms of the 2PD score of the forearm. It was determined that there was no significant difference between the two groups in terms of the 2PD score of the forearm.
11. It showed that the results of the two measurements differed significantly in terms of the 2PD score of the arm. The effect of the group was not found significant.
12. The results of the two measurements for VAS were found to differ significantly. It was determined that the effect of the group was not significant and there was no significant difference between the two groups in terms of VAS score. The interaction between time and group was not significant.
13. It was determined that the results of the two measurements in terms of MAS were significantly different. It was determined that the effect of the group was not significant and there was no significant difference between the two groups in terms of MAS score. In addition, the interaction between time and group was not significant, and it was determined that the two groups were not significantly different in terms of initial measurement and post-intervention measurement.

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