PHYSICAL THERAPY MODALITIES:
HOW THEY WORK AND THEIR EFFECTIVENESS IN THE TREATMENT OF
SHOULDER PAIN

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ABSTRACT

The purpose of this paper is to explain the parts, administration, mechanism of action, and beneficial effects of four different physical therapy modalities: Ultrasound, Transcutaneous Electric Nerve Stimulation, Dry Needling, and Cupping. Ultrasound, and Transcutaneous Nerve Stimulation have been used in physical therapy clinics for many years, whereas dry needling and cupping are newer to the physical therapy practice. All four of these modalities are commonly used in treatment, which begs the question of whether they are effective. This paper presents the research and findings from multiple sources on the effectiveness of these different modalities in regards to shoulder pain.
A common occurrence in life is becoming injured, such as falling and spraining your ankle or having a compressed spine that leads to chronic low back pain. These two injuries are different, but they can both be treated by physical therapy. Physical therapy is the gold standard of treatment for musculoskeletal injuries and disorders, post operational healing to regain mobility and functionality, and reducing pain. Physical therapists utilize manual work, exercise, and modalities in the treatment process of their patients. Every treatment is specifically tailored to the individual to meet their specific needs and reach their personal goals. Physical therapy commonly starts with manual work to loosen the injury sight to allow for better mobility with exercise. Next, the patient works on exercises geared toward increasing range of motion and strength and reducing pain. Lastly, the use of modalities, such as ice and heat, are used to help reduce pain and further promote healing. Modalities are assistive devices in the treatment and management of pain.

There are a variety of modalities typically utilized in physical therapy, such as electrical stimulation and ultrasound, and there are modalities that are less typically found in the practice, such as dry needling and cupping. The main purpose of all four of these modalities is to decrease pain and help improve strength and range of motion. The shoulder joint is a common area of injury due to it having the largest range of motion of all joints. There are a variety of causes of shoulder pain including, but not limited to, strains, tendinitis, bursitis, rotator cuff tear, trigger points, etc. Shoulder pain is the 3rd leading musculoskeletal disorder and is most commonly treated by physical therapists. In the treatment of shoulder disorders, modalities may be utilized in order to enhance the treatment procedure. These modalities are often used in the treatment of shoulder pain, but do they truly promote healing and reduce pain as they are thought to do? The
The purpose of this paper is to explain, physiologically, how modalities reduce pain and promote healing and to present the research and findings about the effectiveness of these modalities in shoulder pain management and promotion of healing.

**ULTRASOUND**

Ultrasound is a frequently used physical therapy modality that was first introduced in the 1950s. Ultrasound therapy is designed to safely and effectively heat the layers of tissue underneath the skin that are not easily heated by a hot pack, which is typically layered on the treatment area superficially. Even though ultrasound is regularly used in treatments it is one of the most misunderstood modalities in the physical therapy practice.

**Parts, Settings, and Administration**

In order to understand ultrasound, it is important to understand the parts and their function. A therapeutic ultrasound machine is made up of four components: the generator, the crystal, the sound head, and the applicator. The generator is the base of the machine that controls all the settings of the ultrasound, these setting will be discussed later. The crystal, typically made of lead zirconated or titanate, works as a transducer converting electric energy, output from the generator, into acoustic energy. The sound head is placed directly against the injury site during treatment and transfers the acoustic energy created by the crystal to the tissue of the body. The transfer of acoustic energy (sound waves), causes the tissue to vibrate. The last part of the ultrasound is the applicator which...
is the part of the device that is attached to the generator and stores the crystal and sound head. The applicator is what the therapist holds and allows them to perform the treatment. Figure 1 is a picture of the different parts of an ultrasound.

Another important part to understanding ultrasound is to understand the settings. As mentioned above, the generator typically has all the buttons for determining the settings, sometimes these buttons can be found on the applicator. The different settings of an ultrasound are mode (duty cycle), frequency, and intensity. In addition, time Ultrasounds typically have two modes, continuous and pulsed. If set to the continuous mode the energy from the ultrasound is produced during 100% of the treatment time, this is best used when thermal effects are desired\(^4\) (p.261). Pulsed mode reduces the average intensity of the ultrasound over time and can be set at either 20% or 50%. Pulsed mode is best used when non-thermal effects are trying to be achieved\(^4\) (p.261). The frequency of the ultrasound is the rate at which the sound waves are being produced. For treatment, the frequency best represents the depth of tissue penetration and rate of heating. There are two frequency settings on an ultrasound machine: 1 MHz and 3 MHz. A setting of 1 MHz is best used when trying to target deep structures like the piriformis or when a patient has a large layer of subcutaneous fat\(^4\) (p.262). The setting of 3 MHz is best used when targeting superficial areas like the Achilles tendon\(^4\) (p. 262). Intensity is the rate at which energy is being delivered per unit area and should be set no higher than 3.0 W/cm\(^2\). Any higher can cause damage to the underlying tissue\(^4\) (p.263). In order to determine the intensity, the therapist must first determine the treatment
time and how “warmed up” they want the tissue to get. Below is a table showing the changes in temperature in the tissue per minute at different intensities for the two different frequencies.

**Table 1. Temperature increase in muscle at 1MHz and 3 MHz for various Intensities**

<table>
<thead>
<tr>
<th>Intensity (W/cm²)</th>
<th>1MHz</th>
<th>3 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5</td>
<td>.07⁰F</td>
<td>.54⁰F</td>
</tr>
<tr>
<td>1.0</td>
<td>.36⁰F</td>
<td>1.08⁰F</td>
</tr>
<tr>
<td>1.5</td>
<td>.54⁰F</td>
<td>1.62⁰F</td>
</tr>
<tr>
<td>2.0</td>
<td>.72⁰F</td>
<td>2.52⁰F</td>
</tr>
</tbody>
</table>

Determining the correct treatment time and intensity depends on the desired effect of the treatment. If the tissue is heated to 1.9⁰F, this will increase the tissues metabolism and help reduce mild inflammation⁴ (p.624). If the tissue is heated between 3.6⁰F and 5.4 ⁰F, this will help reduce pain, reduce muscle spasms, and increase blood flow⁴ (p.264). If the tissue is heated to 7.2⁰F, this will help increase range of motion and increase tissue extensibility⁴ (p.264). For example, if a patient comes in with non-specific shoulder pain, with most of the pain in the trapezius muscle, the main goal of the physical therapist is to reduce the patient’s pain. The physical therapist may decide to use ultrasound in order to help achieve this goal. The trapezius is a superficial muscle, so the ultrasound would be set to 1MHz. In order to achieve the desired effect, the therapist needs to heat the muscle to about 5.4⁰F. Looking at the intensity table above, a therapist would want to heat the trapezius for 7.5 minutes at an intensity of 2.0W/cm².

After a clinician determines the parameters they want to use and selects all the specific settings, it is time to apply the ultrasound. First, a treatment area is determined. Research has shown, to get effective heating the treatment area should only be two to three times the area of the sound head⁴ (p.265). If one is trying to heat a larger area, it is better to use a heat pack. After the treatment area is determined, a water based gel is placed on the area. The gel is used because the ultrasound acoustic energy from the sound head doesn’t travel through air. The gel creates better
contact between the sound head and skin and decreases the impedance due to air. When gel isn’t used the acoustic energy bounces back before reaching the body at about 100%, but when the gel is used the amount of energy bouncing back decreases to 0.1%\(^5\). The gel is also helpful as it serves as a lubricant making it easier for the sound head to glide around the treatment area.

During the treatment the sound head is continuously moved over the treatment area, usually in a small circular motion. If the sound head is not continuously moving it can cause damage to the soft tissue and create pain for the patient.

**How Ultrasound Works**

The sound head emits sound waves that are transmitted through the gel and then through the skin. After the sound waves pass through the skin and reach tissues that have a higher density one of three things can happen: the waves can be absorbed, refracted, or reflected\(^5\). When a sound wave is absorbed it causes the molecules to vibrate creating kinetic energy which is then transformed into thermal energy creating heating of the tissue\(^5\). If a wave is refracted it will pass through the tissue but be bent in the process and no longer travel on its original path\(^5\). When a wave is reflected the wave bounces back in the direction it came from. Sound energy is able to travel through most soft tissues and isn’t highly absorbed until it reaches tissue that has a high collagen content; like ligaments, bone, tendons, fascia, and scar tissue\(^5\). With this difference in absorption you see differences in heating. Less dense muscle and fat will not heat up as much as tissues with a high density of collagen, such as tendons. Bone highly absorbs sound waves. Therefore, if an ultrasound is done directly over bone it will cause an increase in temperature of the periosteum and cause discomfort for the patient.
**Beneficial Effects**

Ultrasound is believed to produce two main types of benefits: thermal effects and non-thermal effects. As previously stated, it is believed that ultrasound produces sound waves that are transformed into thermal energy when they cause molecules in certain tissues to vibrate, thereby heating the tissue. The thermal effects include increasing extensibility of collagen fibers, blood flow and metabolism, and decreasing stiffness of joints, muscle spasms, and pain\(^4\text{(p.267)}, 5\text{(p.100)}\). There are also non-thermal effects thought to be due to ultrasound. Besides heating, ultrasound causes of cavitation, the creation of gas bubbles and acoustic streaming, and the movement of fluid caused by sound waves\(^5\text{(p.101)}\). These two effects of ultrasound are believed to increase histamine release, calcium influx, protein synthesis, tissue regeneration, attract immune cells to the injured area, and increased vascular regeneration\(^4\text{(p.268)}, 5\text{(p.101)}\).

**Research on Effectiveness of Treatment Shoulder Pain**

Ultrasound was found to be the most widely used therapeutic modality in 1998\(^6\). Ultrasound was first used in the 1950s as a therapeutic modality; research concluded at that time that ultrasound was able to heat tissues high in collagen and yielded better stretch and this bolstered the modalities popularity as a therapeutic assistive device immensely\(^3\). Wong et al.\(^3\) surveyed physical therapists and found that 84% of therapists indicated that they were most likely to use ultrasound to decrease soft tissue inflammation, 70% to increase extensibility of the tissues, 52% to increase soft tissue healing, and 50% to decrease pain. Five studies were compiled for this paper to show the effectiveness of ultrasound for the treatment of shoulder pain. All studies included happened after the year 2000 and were mentioned in multiple systematic reviews of research in this field. Effectiveness of shoulder improvement was measured by changes in pain, disability, range of motion (ROM), and strength. Pain is measured...
using a 0-10 visual analogue scale (VAS), where zero is no pain and 10 is extreme amounts of pain (figure 3). Disability is measured using a disability questionnaire. There are multiple questionnaires that can be used to assess shoulder disability, one example being the Shoulder Pain and Disability Index is pictured (figure 4). Range of motion is measured using a goniometer. Common shoulder range of motion movements are shown in figure 5 and their typical values are shown in table 2. Strength is measured by the physical therapist and assigned a number (0-5).

<table>
<thead>
<tr>
<th>Please rate your overall pain level with activity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

![Figure 3. Pain Scale](image)

<table>
<thead>
<tr>
<th>SHOULDER PAIN AND DISABILITY INDEX – INITIAL VISIT</th>
</tr>
</thead>
</table>

**Pain Scale**

**How severe is your pain?**
Circle the number that best describes your pain where 0 = no pain and 10 = the worst pain imaginable.

<table>
<thead>
<tr>
<th>At its worst?</th>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>When lying on the involved side?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Reaching for something on a high shelf?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Touching the back of your neck?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Pushing with the involved arm?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

**Disability Scale**

**How much difficulty do you have?**
Circle the answer that best describes your experience where 0 = no difficulty and 10 = so difficult it requires help.

<table>
<thead>
<tr>
<th>Washing your hair?</th>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing your back?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Putting on an undershirt or jumper?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Putting on a shirt that buttons down the front?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Putting on your pants?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Placing an object on a high shelf?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Cutting a heavy object of 10 pounds?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>Removing something from your back pocket?</td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

![Figure 4. Shoulder Pain and Disability Index](image)
Table 2. Normal Values for Shoulder Range of Motion measured in Physical Therapy

<table>
<thead>
<tr>
<th>Range of Motion Measured</th>
<th>Normal Values for Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>180°</td>
</tr>
<tr>
<td>Behind the Back (Internal Rotation)</td>
<td>Level of T7</td>
</tr>
<tr>
<td>Abduction</td>
<td>180°</td>
</tr>
<tr>
<td>External Rotation</td>
<td>90°</td>
</tr>
</tbody>
</table>

Summary of all the study’s findings are below in table 2. Four of the five studies found that ultrasound is not effective in reducing patient pain, range of motion, or strength compared to groups that did not receive ultrasound. Shomoto et al.\(^8\) found that ultrasound was effective in
decreasing the amount of calcification and decreasing pain compared to a placebo for patients with calcified tendonitis. This is consistent with the Philadelphia Clinical Practice Guidelines, which states ultrasound is only effective for calcified tendonitis of the shoulder and has not been found effective for other shoulder disorders.

**Table 3. Summary of Ultrasound Research on Treatment of Shoulder Pain.**

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Diagnosis of Shoulder Pain</th>
<th>Study</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shomoto et al. <strong>8</strong></td>
<td>2002</td>
<td>Calcified Tendonitis</td>
<td>- Ultrasound applied 3 times per week for 5 minutes</td>
<td>- There was statistically significant improvement in Pain and Calcification in the US group.</td>
</tr>
<tr>
<td>Kurtais et al. <strong>9</strong></td>
<td>2004</td>
<td>Soft tissue disorders of the shoulder</td>
<td>- Ultrasound for 10 minutes 5 days a week for 3 weeks</td>
<td>- No statistically significant difference between group with US and group without</td>
</tr>
<tr>
<td>Ainsworth et. al <strong>6</strong></td>
<td>2007</td>
<td>Non-specific shoulder pain</td>
<td>- 6 week study with an ultrasound group and a placebo group</td>
<td>- No statistically significant improvement in disability score between the two groups</td>
</tr>
<tr>
<td>Thiruvasagar <strong>1</strong></td>
<td>2013</td>
<td>Sub Acromial Impingement Syndrome</td>
<td>- Ultrasound group and placebo groups 15 day treatment period</td>
<td>- No statistical difference between control group and US group for all measurements</td>
</tr>
<tr>
<td>Analan et. al <strong>10</strong></td>
<td>2015</td>
<td>Rotator Cuff Disease</td>
<td>- Ultrasound group and a placebo group</td>
<td>- No statistically significant improvement difference between the two groups for all measurements</td>
</tr>
</tbody>
</table>
Ultrasound is a commonly used modality for shoulder disorders, even though the research doesn’t show that it is effective. It is difficult to determine if ultrasound is effective due to many limitations of the studies and the limited amount of research in this field. In the Ainsworth et al. study, 50% of the patients figured out which group they were in, which may have biased the results. The settings of ultrasound treatments are not consistent across the various research studies. Thiruvasagar concluded from his study that modalities that are used improperly may actually hinder the patients healing process because the patient believes that the modalities are enough of a treatment and the patient chooses not to complete their exercise outside of therapy. Another problem is that the research doesn’t compare the different parameters of the ultrasound, like frequency, treatment area size, and time of treatment to determine the most effective settings. Many of the studies included the use of multiple modalities, making it difficult to assess if ultrasound is effective. The combination of multiple modalities without ultrasound may be just as effective with ultrasound, but just using ultrasound may provide a different result. Alexander et al. said that future research should focus on determining which populations benefit most from ultrasound and not just focused on testing effectiveness. Albright et al. determined from a systematic review of the research that ultrasound is a rehabilitation technique that should be used for specific conditions and shouldn’t be a one size fits all type of treatment like other modalities are, and also further research needs to be conducted in order to determine the best parameters of ultrasound for specific conditions. However, most clinicians rely on their personal experience with ultrasound to determine its effectiveness and ignore research.
Transcutaneous Electric Nerve Stimulation (TENS) is another frequently used modality in Physical Therapy for pain control. TENS was designed to alter a person’s perception of pain using electric current. The use of electric current dates back to 2500BC. The ancient Egyptians attached electric eels to patients in order to reduce their pain\textsuperscript{12(p.3)}. TENS is non-invasive and has less side effects than other pain reducing treatments, like opioids. TENS works through the gate control theory of pain mechanism which was first discovered by Melzack and Wall. This modality is commonly used at the end of treatment to relieve a patient of pain from their injury.

**Parts, Settings, and Administration**

TENS has three components: the TENS unit, the lead wires, and the electrodes. The TENS unit is the power generator and has the buttons for the settings to be adjusted, which will be discussed later. The lead wires are used to connect the electrodes to the TENS unit. A TENS unit usually has two lead wire ports and each lead wire has a positive and a negative end. The last part are the electrodes, which allow for electric current, created by the TENS unit, to pass through the body tissue. There are two different types of electrodes. The first type is self-adhesive electrode, and the second type are non-adhesive electrodes which requires a conducting gel to be placed between the electrodes and the skin\textsuperscript{5(p.342)}. There are also two different sizes of electrodes: small and large. Small electrodes are
used best when trying to stimulate superficial nerves or over thin layers of fat\textsuperscript{5}(p.342). Large electrodes are better used when trying to stimulate deep nerves, go through thicker layers of fat, or when trying to stimulate a larger treatment area (like the low back)\textsuperscript{5}(p.342). The placement of the electrodes depends on the patient. Electrodes are usually placed around the central location of pain or on certain pain trigger points. Four electrodes can be used to create an “X” current by placing two electrodes from one lead wire above and below the point of pain and the other two electrodes on the other lead wire on each side of the point of pain. This creates a current that will cross, like and “X”, through the point of pain (figure 8). Four electrodes can also be used to bracket two separate areas of pain. For example, if a patient has upper trapezius pain and medial shoulder blade pain, then two electrodes connected to one lead wire are placed on the trapezius and the other two electrode on the other lead wire are placed on the medial shoulder blade (figure 9). These are just two examples of electrode placement for shoulder pain. There is no one correct placement. It all depends on the patient and where there pain is located.

\begin{figure}[h]
\centering
\includegraphics[width=0.45\textwidth]{figure8}
\caption{Cross, "X", electrode configuration for shoulder pain.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.45\textwidth]{figure9}
\caption{Bracket configuration for trapezius and medial shoulder pain.}
\end{figure}
TENS units have five settings: frequency, amplitude, pulse duration, mode, and treatment time. Frequency is the rate at which the electric current is being fired in pulses per second (HZ). The frequency can be set from 1 Hz – 150Hz, and is determined based on the type of TENS that is planned to be used. Amplitude is the intensity, or magnitude, of the electric current, usually measured in mV. This setting is determined by the patient. Pulse duration is the length of time a pulse of electric current lasts, measured in μsec. Pulse Duration can be set from 50-300 μsec, and is determined based on the type of TENS that is planned to be used. Most TENS units have three modes: continuous/normal, burst, and modulation. When the TENS unit is set to continuous mode the electric current is continuously supplied. This is the typical mode used\(^5\)\(^{(p.337)}\). If a TENS unit doesn’t have a mode setting then the unit is set in continuous mode. When the unit is set to burst mode the electric current is supplied in low frequency bursts (0.5—5Hz) of high frequency (100Hz)\(^5\)\(^{(p.337)}\). When the Unit is set to modulation mode the electric current’s pulse duration and frequency are cycled throughout the treatment. Both frequency and pulse duration are decreased by 50% of their original setting in half a second and then increased back to their original setting in the next half second. Therefore, the cycle time is one second. Modulation mode was created to decrease patient habituation to the stimulus and to be more comfortable for the duration of the treatment time\(^5\)\(^{(p.337)}\). The last setting, treatment time, can vary greatly. In the clinical setting treatment time for TENS is usually 15-20 minutes, but if a patient is using TENS at home the device can be worn all day, except when driving or showering. Although a patient can wear a TENS unit all day, it is recommended to use TENS in one hour increments to avoid skin irritation\(^5\)\(^{(p.345)}\).

The application of TENS in a clinical setting goes as follows. First, the skin is cleaned and excess hair may be removed. The electrodes are attached to the leads and placed in such a
way that they bracket the pain, or desired treatment area. The frequency, pulse duration, mode, and treatment time are set. The amplitude is slowly turned up by the clinician/technician. The patient is informed that they are going to feel a “tingling sensation” as the amplitude is increased. The patient is instructed to pick an amplitude that is intense but comfortable, and they don’t want the amplitude so high that it causes pain. Certain precautions should be taken with the administration of TENS. TENS may not be administered to the patient if they have a pace maker close to the site of stimulation, are pregnant, have a carotid sinus, damaged skin, lack of sensation, or cancer (tumors)\(^5\)\(^{(p.350)}\).

**Types of TENS**

There are three different types of TENS that can be used: conventional TENS, acupuncture like TENS, and burst train TENS. Conventional TENS, which is the most commonly used form of TENS, is when the TENS unit is set to a high frequency (80-110Hz) and a low pulse duration (50-100μsec). This type of TENS is used to decrease pain perception via the gate control theory of pain\(^5\)\(^{(p.337)}\). Acupuncture like TENS is when the TENS unit is set to a low frequency (1-10HZ) and a long pulse duration (100μsec). This type of TENS is used to decrease pain, and create muscle twitches, which helps increase blood flow to the injured tissue\(^5\)\(^{(p.338)}\). Burst Train TENS is a combination of conventional TENS and acupuncture like TENS. Burst Train TENS is when the TENS unit is set to a high frequency burst (100Hz) at a low frequency (1-4Hz) with a long pulse duration (200μsec). This type of TENS is thought to create a more comfortable type of muscle twitch while still able to decrease pain\(^5\)\(^{(p.338)}\). For this paper the focus will be on the mechanism and research on the effectiveness of conventional TENS.
How TENS Works: Gate Control Theory of Pain

The nervous system is broken down into two parts: the central nervous system and the peripheral nervous system. The central nervous system is composed of the spinal cord and the brain. The peripheral nervous system is composed of the nerves and ganglia that are outside of the brain and spinal cord. Different nerves lead from the body to the spinal cord. For the gate control theory there are two types of nerves we need to know about. There are small nerve fibers (Aδ and C fibers) which are responsible for nociception (pain), and large fibers which are responsible for normal touch perception. Both of these fibers synapse on projection cells and inhibitory neurons. Projection cells send pain signals to the brain. Inhibitory neurons, when activated, inhibit the projection cells from sending signals to the brain. When there is no input from the small or large nerves, then the inhibitory nerve is active and inhibits the projection cells from sending pain signals to the brain. When there is normal input like touch, the large neurons synapse on both the inhibitory neuron and the projection cell, but since the inhibitory neuron is active it stops the projection cell from sending signals to the brain. This is also the case when there is more input from the large neuron than the small neurons. When the small neurons are stimulated, with a painful stimulus, they activate the projection cells and inhibit the inhibitory neurons. When the inhibitory neurons are inhibited it no longer blocks the projection cell from sending pain signals to the brain\textsuperscript{12}(p.6).
Beneficial Effects

Continuous TENS is used to decrease a patient’s perception of pain. The research suggests that the two main mechanisms for decreased pain are the gate control theory of pain and the endogenous opioid release theory\textsuperscript{12}(p.7). The two other types of TENS can also be used to increase blood flow by causing muscle twitches. These two types of TENS aren’t used as often.
clinically because NMES, another type of electric stimulation, is more effective in increasing blood flow via muscle twitches.

**Research on Effectiveness in the Treatment of Shoulder Pain**

TENS is a very common modality used for pain modulation. Research in this area is very difficult because measuring pain is challenging. Every patient perceives pain differently. Some may have high pain tolerances and others low, and this difference in perception makes comparing patients to one another problematic. Five studies were compiled for this paper to show the effectiveness of TENS for treating shoulder pain. All studies included happened after the year 2000 and were mentioned in systematic reviews regarding the research on TENS effectiveness for treating shoulder pain. Changes in pain, strength, blood flow, range of motion, and strength were measured. Pain, disability, and strength were measured in the same manner as in the ultrasound research, except in Likar et al.’s\(^\text{13}\) study where pain was measured based on opioid drug consumption.

A summary of all the studies’ findings can be seen in table 4. The results of the study were as expected. Three of the five studies determined that TENS is more effective in reducing pain than placebo or lack of treatment. One study found that low frequency TENS can be used to increase blood flow to the area being stimulated, but high frequency TENS did not. The last study compared TENS to ultrasound and concluded that TENS was more effective than ultrasound in reducing patient pain and increasing range of motion.
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Diagnosis of Shoulder Pain</th>
<th>Study</th>
<th>Results</th>
</tr>
</thead>
</table>
| Likar et al.¹³       | 2001 | Post-Operative shoulder                      | -Patient post-operative shoulder were given tens plus pain medication or only pain medication  
-Amount of medication consumption were measured | -Patients with tens plus pain medication consumed significantly less pain medication than the patients without tens  
-This shows that TENS is effective in reducing post-operative pain |
| Sandberg et al.¹⁴    | 2007 | Trapezius muscle based shoulder pain         | -Three different modes of TENS were tested to determine if blood flow would be increased to the Trapezius Muscle  
-ROM was measured before and after treatment | -High frequency and the control TENS did not increase blood flow  
-Low Frequency TENS that induced muscle contraction increased blood flow to the muscle |
| Ekim et al.¹⁵         | 2008 | Hemiplegic patients with Shoulder /pain      | -One group was given TENS for 20 minutes 5 times a week for three weeks and the other group a placebo treatment | -The TENS group has significant improvement in passive range of motion and external rotation |
| Moniruzzaman et al.¹⁶| 2010 | Post stroke shoulder pain                    | -One group was given TENS treatments and the other Ultrasound  
-Pain, strength, and ROM were assessed before and after treatment | -The TENS group had significant improvement in pain free range of motion and improvement in muscle strength  
-Concluded that TENS is more effective than Ultrasound in the treatment of shoulder pain |
| Kocyigit et al.¹⁷     | 2012 | Sub Acromial Shoulder Syndrome              | -Patients were either given TENS or placebo and given a painful stimulus well under an MRI  
-Stimulation of pain centers were watched with the MRI  
-Pain was assessed before and after treatment | -There was a significant decrease in self-reported pain perception and reduced stimulation of pain centers in the brain |
TENS is a commonly used modality for chronic pain and musculoskeletal disorders. All of the research in the area of TENS varies greatly for shoulder conditions. Kocyigit et al.\textsuperscript{17} used a low-frequency TENS on half the patients and sham TENS on the other patients. The researchers then used a painful stimuli on the patients while in an MRI. In the group with TENS there was a significant decrease in perceived pain and also decreased pain-specific activation of pain pathways in the brain. This was a key study showing that TENS decreases pain perception for patients with shoulder pain. Likar et al.\textsuperscript{13} showed that patient’s pain was reduced with TENS because they used less pain killers than patients who didn’t have any TENS. Sandberg et al.\textsuperscript{14} showed that high frequency TENS, which is what is typically used, doesn’t increase blood flow, but most literature doesn’t suggest this to be an effect of high frequency TENS. The same study showed that low frequency TENS does increase blood flow. Monirussaman et al.\textsuperscript{16} showed that TENS is more effective than ultrasound, but this research isn’t very beneficial because ultrasound has been found not effective in the treatment of shoulder pain. Ekrim et al.\textsuperscript{15} showed that TENS improved passive range or motion and external rotation, most likely due to decreased pain.

The problem with TENS research is it is very inconsistent. There are a limited number of research studies in the area of TENS and shoulder pain. Most clinicians rely on clinical experience over research, and clinically, patients report decrease in pain with the use of TENS. The other problem with research is that it is unethical to not fully treat the patient, therefore a lot of research is deemed inconclusive because it is not certain which part of the treatment is reducing the patient’s pain. Another problem is that every patient perceives pain differently and there is no one fits all treatment for patients when it comes to physical therapy. Therefore, what is found effective for one patient may be completely ineffective for another patient.
**DRY NEEDLING**

Acupuncture has been a part of Traditional Chinese Medicine for thousands of years and the first description of acupuncture dates back to second century BC\(^{18}(p.15)\). The use of acupuncture first came to America in 1971 after Henry A. Kissinger visited China and observed the practice. Since then, the use of acupuncture in the United States has grown substantially\(^{18}(p.32)\). In 1994, 1,000,000 people reported using acupuncture and that number doubled by 2002\(^{19}\). Traditional Chinese acupuncture has been westernized for medical use in the physical therapy profession and is typically referred to as dry needling or western acupuncture. This modality is not as commonly seen in physical therapy as ultrasound or TENS, but it is becoming increasingly more popular. The growth in the use of dry needling in physical therapy offices has been difficult because acupuncturists don’t believe that physical therapists should be able to utilize this technique in their practice and there has even been legislation passed in certain states that prohibit physical therapists from practicing Dry Needling\(^{18}(p.134)\). The argument for the use of dry needling in physical therapy is that acupuncture and dry needling are not the same.

**Tradition Chinese Acupuncture Vs. Dry Needling**

Tradition Chinese acupuncture and dry needling are based on different principles. In Traditional Chinese Medicine they believe that a person becomes sick when their Yin and Yang, the body’s energy, are no longer in balance. The goal of acupuncture is to rebalance a patient’s Yin and Yang\(^{18}(p.20)\). Acupuncture points are determined by the twelve channels of the body. These channels are believed to each be connected to one of the body’s vital organs. There are also an additional eight channels, called extra-points, which are used when the twelve main channel points don’t have the desired effects\(^{18}(p.21)\). Dry needling, on the other hand, is mainly used to inactivate myofascial trigger points and is based on the physiology and pathology of the
muscles. Dry needling is commonly used to reduce myofascial pain caused by trigger points. Although acupuncture and dry needling are considered different, when using acupuncture to treat myofascial pain it is similar to treating it with dry needling. A comparison of the two treatments showed 70% of muscle trigger points correspond to traditional acupuncture points in the treatment of musculoskeletal pain\textsuperscript{18}(p.39).

**Trigger Points and the Local Twitch Response**

Myofascial trigger points are one of the most common musculoskeletal disorders. A trigger point is a “a hypersensitive spot, usually within a taut band of skeletal muscle or in the muscle’s fascia, they can have strong focal points of tenderness, are a few millimeters in diameter, and can be found at multiple sites in the muscle tissue”\textsuperscript{18}(p.38). A taut band is a contracture of muscle fibers within the muscle but doesn’t involve the whole muscle. There are two types of trigger points: active and latent. Active trigger points are spontaneously painful and are more sensitive to pressure. Inactive trigger points are not painful unless pressure is applied and are not as sensitive to pressure. Latent trigger points can turn into active trigger points\textsuperscript{20}. Trigger points also cause dysfunction at the motor end plate causing abnormal depolarization of the post junction membrane\textsuperscript{21(ch.1)}. Trigger points can be caused by a variety of things such as: trauma to the muscle, prolonged submaximal use, overuse of a muscle, or stress\textsuperscript{22}. These factors cause damage to the muscle fiber and the sarcoplasmic reticulum or the membrane, which leads to an increase in calcium, shortening of the actin myosin cross bridge leading to a shortage of ATP and an impaired calcium pump so the damaged part of the muscle fiber remains in a contracture\textsuperscript{21(ch.1),22}. Trigger points can cause muscle weakness, irritability with activity, muscle imbalances, and altered motor recruitment of a muscle\textsuperscript{21(ch.1)}. 
When a trigger point is needled it can elicit a local twitch response. A local twitch response is a sudden visible contraction of the muscle fiber after a needle is inserted into the trigger point\textsuperscript{21} (ch.1). Some believe that a local twitch response is necessary to reap the benefit from the needling treatment. The most common trigger points that cause shoulder pain are found in the infraspinatus, deltoid, and upper trapezius\textsuperscript{21(ch.6)}. Other muscles that may have trigger points related to shoulder pain are the supraspinatus, teres minor, subscapularis, teres major, coracobrahialis, rhomboid, pectoralis minor, pectoralis major, latissimus dorsi, biceps brachii, triceps brachii, and subclavian muscle.

**Beneficial Effects**

There is a lot of research on the effectiveness of dry needling for myofascial trigger points but little research of the underlying mechanism of dry needling. There have been a few proposed hypothesis about the pain reducing mechanism of dry needling. The first is that the insertion of the needle into the muscle fiber causes mechanical stretch and elicits a local twitch response. This local twitch response then detangles the actin and myosin allowing the muscle to return to resting length and therefore deactivating the trigger point\textsuperscript{22}. If the needle is rotated, the stretch response will be greater. The second hypothesis is that when the needle is inserted into the fiber it activates A\textbeta{} mechanoreceptors which inhibit nociception\textsuperscript{22}. The third hypothesis is that the needle insertion through the skin causes activation of the cutaneous A\textbeta{} fibers which stimulate inhibitor neurons that cause the release of opioid-like peptides which inhibit c-fibers, and therefore the transmission of pain\textsuperscript{22}. The last hypothesis is that the local twitch response changes the chemical environment of the muscle. Trigger points decrease local oxygen saturation of the muscle by 5\%\textsuperscript{23}. This decrease in oxygen causes a drop in local pH and the release of several nociceptive chemicals. The local twitch response is believed to increase blood flow and
therefore oxygen to the trigger point. The increase in blood flow decreases nociceptive chemical concentration at the site of the trigger point\textsuperscript{21(ch.2, 22}. Dry needling also may have effects on the connective tissue and fascia, but more research of its effect on these structures needs to be done.

**Parts and Administration**

The needles used for dry needling are filiform needles, made of steel with a diameter of about $300\mu\text{m}\textsuperscript{21(ch.3).}$ The needle comes in a plastic guide tube so the clinician doesn’t have to touch the tip of the needle before it enters the patient, therefore the needle remains sterile. The guide tube also assists in guiding the needle at the proper angle into the muscle. Needles can only be used once and are disposed of in a sharps container after removal from the patient. Acupuncture needles were not always made of steel. The first needles depicted in Traditional Chinese Medicine were made of stone, bone, and bamboo. Throughout history acupuncture needles have been made of other various materials including: bronze, silver, gold, and even jade\textsuperscript{18 (p.25).}

For the administration of dry needling, the patient is first described the procedure and must consent. The patient is then positioned in a comfortable position but also a position that the clinician will be able to needle the targeted muscle. The patient is then instructed to relax. The area is cleaned with alcohol and the clinician wears gloves.

The needle is inserted and angle of insertions depends on the muscle. The needle can be removed quickly after insertion or may be left in place for an extended period of time
(10-20 minutes). Table 5 gives examples of patient position and needle insertion for three different muscles of the shoulder. These three muscles are the most common muscles with trigger points that cause shoulder pain.

Table 5. Referred Pain, Position of Patient, and Needle Insertion for Three Different Muscle of the Shoulder

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Site of Referred Pain</th>
<th>Position</th>
<th>Needle Insertion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infraspinatus</td>
<td>Front of Shoulder, and Deltoid region</td>
<td>Prone, or side lying with a pillow between arm and body</td>
<td>Needle inserted into the muscle directed toward the scapula</td>
</tr>
<tr>
<td>Deltoid</td>
<td>None</td>
<td>Anterior: Supine Posterior: Prone Middle: Supine, prone or side lying with a pillow between arm and body</td>
<td>Needle inserted perpendicular to skin into taunt band, directed toward humorous</td>
</tr>
<tr>
<td>Upper Trapezius</td>
<td>Up neck to temporal region, may cause tension headaches</td>
<td>Prone or side lying with a pillow between arm and body</td>
<td>Pincher method used, needle is then inserted perpendicular to the skin</td>
</tr>
</tbody>
</table>

There are multiple precautions that need to be taken into consideration before administering dry needling to a patient. Unlike most modalities, dry needling is an invasive technique so more needs to be considered before administration. A patient should never be given dry needling if they have a needle phobia or are fearful of the procedure because they may tense up during the treatment which could do more harm than good. They shouldn’t be given dry needling if they have increased lymphedema in the area or a decreased function of the immune system, as these increase a patient’s risk of infection. Other precautions should be taken with patients who have abnormal bleeding, diabetes, or are pregnant. Along with these precautions there are also anatomical precautions that need to be taken. The clinician needs to have an extensive knowledge of anatomy in order to avoid blood vessels, nerves, and organs, especially the lungs. Special precautions are taken around muscles of the lungs so that pneumothorax
Research on Effectiveness in the Treatment of Shoulder Pain

Surveys showed that 85% of the United States population reported pain caused by trigger point\textsuperscript{22}. In patients with shoulder pain it was found that 77% had trigger points in the infraspinatus muscle, 58% had trigger points in the upper trapezius muscle, 49% in the teres minor muscle, and 38% in the deltoid muscle\textsuperscript{22}. Trigger points are a common occurrence and dry needling has been strongly recommended for relieving myofascial trigger point related pain. Traditional acupuncture has been used for many years, but dry needling is a new tool used by physical therapists. Eight studies were compiled for this paper to show the research on effectiveness of dry needling for treating shoulder pain. All studies included happened after the year 2000 and were highlighted in systematic reviews and books about dry needling. Pain, disability, strength, and range of motion were measured in the same manner as the ultrasound studies. Another measure used in the dry needling studies is the pressure pain threshold (PPT). The pressure pain threshold is measured using a pressure threshold algometer. The algometer is placed over the trigger point and pressure is increased until the patient reports pain and the pressure at that point is recorded. An increase in pressure tolerance from before treatment to after signifies improvement\textsuperscript{23}.

A summary of all the studies’ findings are in table 6. All eight studies found statistically significant decreases in pain after dry needling. Four studies assessed range of motion and three found a statistically significant improvement with dry needling and the other one did not. Of the three studies that measured pain pressure threshold one found a statistically significant improvement with dry needling, one found a clinically important but not a statistically significant improvement.
improvement, and the third didn’t find a statistically significant improvement. Two other studies reported improvements in strength and sleep in patients that received dry needling over those who did not. In two studies over-all function and mood were found to improve in patients who received dry needling over those without, but one study found that function did not improve more with dry needling.

Table 6. Summary of Dry Needling Research on Treatment of Shoulder Pain

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Diagnosis of Shoulder Pain</th>
<th>Study</th>
<th>Results</th>
</tr>
</thead>
</table>
| Dilorenzo et al. 25 | 2004 | -Post Stroke Hemiparetic Pain Syndrome | - Patients were treated with dry needling every 5-7 days for a total of 4 treatments  
- The control group did not receive dry needling  
- Pain was assessed before and after treatment | -Patients that received the dry needling treatment had statistically significant decrease pain, and better sleep  
- Significant correlation was found between pain and mobility |
| Hsieh et al. 26    | 2007 | -Bi-lateral infraspinatus trigger points | -Patients had trigger points in the infraspinatus muscle on both side, one was treated with dry needling and the other side was not  
- Pain, ROM, PPT were measured before and after treatment for both sides | -ROM and PPT statistically significant increased on the treated side compared to the untreated side  
- Pain was statistically significant decreased on the treated side |
| Osborne and Gatt 27 | 2010 | -Anterior lateral shoulder pain in elite volleyball players | -Dry needling was performed on trigger points in the infraspinatus and teres minor  
- Pain, ROM, and strength were assessed before and after treatment | -ROM and strength were improved following treatments  
- Pain and pain with activity were decreased after treatment |
<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Pain Type</th>
<th>Intervention 1</th>
<th>Intervention 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itoh et al. 28</td>
<td>2013</td>
<td>Chronic Shoulder Pain</td>
<td>One group received dry needling and the other group received sham dry needling</td>
<td>Needle left in place for 10 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pain and disability were measured before and after treatment</td>
<td></td>
</tr>
<tr>
<td>Ziaeifar et al. 23</td>
<td>2014</td>
<td>Upper Trapezius Trigger Point</td>
<td>One group of patients received standard manual treatment, and the other group received Dry Needling</td>
<td>Pain, PPT, and disability were assessed before and after treatment</td>
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<tr>
<td>Gerber et al. 29</td>
<td>2015</td>
<td>Neck and shoulder girdle pain</td>
<td>Three single weekly dry needling treatments of a single trigger point in the upper trapezius muscle</td>
<td>Status of trigger point, pain, ROM, PPT, CMS, and disability were assessed before and after treatments</td>
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<tr>
<td>Arias-Buria et al. 30</td>
<td>2015</td>
<td>Post-operative shoulder pain</td>
<td>One session of dry needling was performed using the fast in out technique</td>
<td>Control group did not receive dry needling with their physical therapy treatment</td>
</tr>
</tbody>
</table>
Three needling treatments were given (8 days) apart to one group, the other didn’t receive any dry needling. Pain, ROM, and disability were measured at start, after treatment, and 3 months after treatment. Both groups of patients significantly improved, but there was no difference between the needling group and the control. Pain was reduced significantly right after treatments in patients who received dry needling.  

Dry needling isn’t a commonly used modality in physical therapy but is becoming increasingly popular. Based on the research, dry needling is an important tool in decreasing patient’s pain caused by trigger points. Pain associated with trigger points may have detrimental effects on a patient’s quality of life, mood, and make certain activities painful. Any treatment that is effective in reducing pain should be implemented in patient’s treatment program to increase their quality of life and overall mood. All studies found that dry needling significantly reduced patient’s pain. Itoh et al.\textsuperscript{28} showed that dry needling immediately reduces the pain associated with trigger points. Osborne and Gatt\textsuperscript{27} showed that the biggest reduction in pain was within 24 hours of the treatment and lasted about seven days after the treatment. They also reported that after three dry needling sessions the patients never return to the level of pain reported before the treatment for two years following the dry needling. Gerber et al.\textsuperscript{29} measured changes in the trigger points from active to latent or complete reduction. This study showed a significant correlation in decrease in pain with change in the trigger point status. Arias-Buría\textsuperscript{30} found that just one treatment of dry needling at the start of treatment significantly improved the function of the patient and may assist in a faster recovery. Most of the studies assessed changes in pain as their primary determinant of effectiveness and found that dry needling is effective in reducing pain. Other outcomes measured in studies included range of motion, pressure pain.
threshold, disability, strength, sleep, mood, and function. The results of these outcomes were not consistent between studies. Further research needs to be conducted to determine the effectiveness of dry needling on these secondary measurements.

**CUPPING**

Cupping has been around for over 5000 years and was first used in ancient Egypt and is now a popular component of Traditional Chinese Medicine\(^{(ch.1)}\). Cupping is not typically used in western medicine but has started to be used more in the physical therapy profession to relieve musculoskeletal pain and help increase blood flow to the site of injury. In the summer of 2016, Olympic swimmer Michael Phelps competed with strange circular bruises on his shoulder, which were caused by cupping. His appearance sparked the interest of many fans, spectators, and athletes alike\(^{(ch.3)}\). This modality, just like dry needling, isn’t as commonly seen in physical therapy practice but is slowly increasing in popularity.

**Parts and Administration**

The first used cups were made of hollowed out animal horns. The clinician used their mouth to suck from the top of the horn to create the suction effect\(^{(ch.10)}\). Cups are now typically made of glass, plastic, or silicone. The cups are suctioned to the body either using heat or a pump gun. When using heat, a cotton ball is lit on fire inside the cup to heat the air. The cup is then placed on the skin, as the air cools it creates a vacuum effect and pulls the skin up into the cup\(^{(ch.2)}\). When using a pump gun, the gun is attached to a valve at the top of the cup and the gun is pumped to remove air inside the

![Different Sized Cups Placed on Patients Shoulder](image)
cup creating a vacuum effect to pull the skin into the cup. In physical therapy clinics the pump gun method is typically used. Cups come in a variety of sizes, and different sizes can be utilized for different purposes. Small cups are typically used on smaller areas, like the arms, and have a more intense suctioning effect. Big cups are typically used on larger areas, like the lower back, and are not as intense but can cup more skin at a time\textsuperscript{32(ch.2)}. The cups are left on the body for 5-20 minutes and once removed patients may develop a bruise. These bruises are not painful and are beneficial to the clinicians because their color can tell the clinician where the main problem is\textsuperscript{32(ch.2)}. The darker the bruise means that that area is lacking the most blood flow and most likely causing pain for the patient\textsuperscript{34(ch.1)}. A lighter bruise or no bruise at all means that the area already has sufficient blood flow and most likely isn’t causing pain for a patient. Bruises are likely to clear up in 3 to 4 days but can last for up to two weeks\textsuperscript{32(ch.3)}.

The administration of cupping in a physical therapy office goes as follows. The patient is first instructed to remove clothing if it is blocking the area to be treated. The patient is instructed to sit or lay in such a way that the treatment area is easily assessable. Next, the area is cleaned and lotion may be applied. Different size cups are selected based on the body part being treated. The cups are placed on the skin and the vacuum pump is used to suction the skin into the cup. The cups are left on the patient for 5-20 minutes. The cups are then removed by pulling the valve on the top of the cup to release the air. If the patient is receiving massaging cupping, once a cup is suctioned on the therapist slowly moves the cup around the treatment area. Bruising may occur in the area that was treated, and these bruises can last for at least three days.
days and up to two weeks. It is suggested to only perform cupping once previous bruising has mostly returned to normal\(^{32}(\text{ch. } 3)\). Cupping is performed usually once or twice a week with about three days between sessions. If cupping is done too often it can potentially cause capillary expansion, rupture of blood vessels, fluid accumulation, skin inflammation, or an Indian rope burn\(^{32}(\text{ch. } 5)\).

There are few precautions when it comes to cupping. A clinician should not cup over any open skin ulcers or wounds\(^{32}(\text{ch. } 3)\). A clinician should also be cautious when cupping someone who is pregnant. It is suggested that a pregnant woman gets the okay from her doctor before undergoing a cupping treatment. Also, the clinician should avoid cupping over arteries, especially the pulse taking arties in the wrist and neck\(^{35}(\text{ch. } 3)\).

**Types of Cupping**

There are multiple types of cupping: dry cupping, wet cupping, and moving cupping. Dry cupping is what was described previously using heat or the pump gun. The second type, wet cupping, or bloodletting, is when incisions are made in the skin prior to performing the cupping procedure and draws blood into the cup when the suction is applied\(^{35}(\text{ch. } 1)\). This type of cupping is not used in physical therapy. Moving cupping is when dry cupping is performed and then the cup is moved around instead of left in one area. The focus of this paper will be on the mechanism and research on the effectiveness of dry cupping.

Cupping, very much like acupuncture, utilizes a point system, where different points on the body correspond to the treatment of different ailments\(^{32}(\text{ch. } 9)\). Cupping has three levels: weak,
medium, and intense. The different levels correspond to different amounts of suction, so weak cupping is the least amount of suction and intense suction is the strongest amount of suction. The level is determined by what type of ailment is being treated. Weak cupping is used for relaxation, increasing blood flow, and relieving colds and allergies\(^\text{32(ch.8)}\). Medium cupping is used for relieving headaches, sports injuries, and musculoskeletal disorders\(^\text{32(ch.8)}\). Intense cupping is used for chronic pain conditions\(^\text{32(ch.8)}\). Both medium and intense cupping are used in physical therapy, but weak cupping is not typically used.

**How Cupping Works**

The exact mechanism of the pain reducing effects of cupping is unknown, but there are a few hypotheses out there as to how cupping helps reduce pain in musculoskeletal disorders. One hypothesis is that when an area of skin is cupped it puts a stress on the skin and underlying tissue. This suction stress causes the capillaries to vasodilate and potentially rupture and this then stimulates inhibitory neural pathways, and therefore, helps reduce pain perception in that area\(^\text{32(ch.13)}\). Another hypothesis is that when the capillaries vasodilate there is an increase in blood flow to that area; the local metabolites and toxins are flushed out of the area and the area is re-oxygenated which helps reduce pain\(^\text{35(ch.1)}\). Overall, the increased blood flow due to cupping is believed to improve circulation, tissue perfusion, cellular oxygenation, venous drainage and blood clearance.\(^\text{36}\)

**Beneficial Effects**

There are many perceived benefits to cupping. Cupping increases blood flow to the injured area, and this increase in blood flow directs nutrients and oxygen to that area. This increased blood flow to the area can also help reduce lactic acid build up, therefore reducing
muscle soreness\textsuperscript{32(ch.5)}, and detoxifies the body by stimulating the release of buildup toxins in the tissues. Cupping is also believed to reduce stiffness, improve range of motion, relieve muscle cramps and joint pain, and help break up scar tissue\textsuperscript{35(ch.1)}. Massaging cupping is believed to increase blood flow by drawing stagnant blood, which then stimulates the lymphatic system, to remove the waste and toxins from the body\textsuperscript{32(ch.13)}. Unrelated to musculoskeletal disorders, cupping is believed to be beneficial in treating a wide range of disorders including but not limited to: skin conditions, weight loss, digestion, relieve a cough, herpes, hypertension, and many others\textsuperscript{32(ch.13)}.

**Research on Effectiveness in the Treatment of Shoulder Pain**

Michael Phelps’s strange shoulder spots turned the public’s attention toward the phenomenon of cupping for musculoskeletal injury. The “new” technique has since gained popularity. Prior to 2016, only a select few had heard of the use of cupping for treating musculoskeletal disorders, but like many trends, once a celebrity is seen doing it everyone wants to do it\textsuperscript{33}. With cupping’s new found popularity, this creates the question of whether cupping is actually effective. Cupping, like dry needling, is a new modality being used in the physical therapy profession. Four studies were compiled for this paper to show the research on the effectiveness of cupping for shoulder pain. All studies included happened after the year 2000. Changes in shoulder pain were measured in the same manner as the ultrasound studies. Pain and disability were the only two measurements assessed in the research compiled.

A summary of all the studies’ findings are below in table 7. All four of the studies found that there was a significant decrease in pain compared to pre-treatment pain. Two of the studies had a control group and found that pain decreased significantly more in the cupping group compared to the control group. Only one of the four studies measured disability along with pain
and found that there was statistically significant decrease in pain and disability with the use of cupping.

Table 7. Summary of Cupping Research on Treatment of Shoulder Pain

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Diagnosis of Shoulder Pain</th>
<th>Study</th>
<th>Results</th>
</tr>
</thead>
</table>
| Sohn et al. 37   | 2011 | Shoulder pain in nurses    | -Nurses received four dry cupping treatments over a period of two weeks  
-Measured changes in pain and level of fatigue | -Statistically significant decrease in pain in fatigue after dry cupping therapy |
| Arslan et al. 36 | 2015 | Shoulder and neck pain in office workers | -Dry cupping was given to office workers twice a week for five weeks, control group received no therapy  
Pain was assessed before treatments began and reassessed three days after the treatments were finished | -Decreases in pain was statistically significant in the dry cupping group and there was not a significant decrease in pain in the control group |
| Ali and Rehman 38 | 2015 | Non-specific shoulder pain | -Three cycles of dry cupping were performed on participants (4 cups for 20 minutes)  
Pain and disability were measured pre and post treatment | -There was a statistically significant reduction in and pain in disability after dry cupping was performed |
| Chi et al. 39    | 2016 | Work related non-specific shoulder pain | -Dry cupping group received three treatments of cupping therapy (heated cups), the control group didn’t receive any thing  
Pain was measured pre and post treatment | -There was a significant decrease in pain in the dry cupping group compared to the control group |
Cupping isn’t commonly found in the practice of physical therapy but has gained recent popularity and is being considered as a treatment option more and more. Research in the effectiveness of cupping for shoulder pain is limited. There are few studies, and none of the studies found were done in the scope of the physical therapy practice. In these studies, cupping was done as a separate treatment on patients without the combined effects of physical therapy. All four studies showed that cupping is successful in reducing pain, but none of the studies’ research assessed if adding cupping to physical therapy reduces the pain more than patients in physical therapy that don’t receive cupping. Chi et al.\textsuperscript{39} determined cupping to be a suitable method of pain relief and its potentially better for being used instead of certain pain reducing methods, because cupping has no adverse side effects. Sohn et al.\textsuperscript{37} used cupping to treat shoulder pain and fatigue of nurses and found that cupping helped reduce both of those factors. Arslan et al.\textsuperscript{36} found cupping to be an effective treatment for office workers whom had shoulder pain, most likely due to sitting at a desk and being on a computer most of the day. Ali and Rehman\textsuperscript{38} found cupping to significantly reduce pain and disability. The biggest problem with all these studies is the limited number of patients and lack of control. Chi et al.\textsuperscript{39} concluded that even with their findings further studies are needed to understand the long term effects of cupping. Arslan et al.\textsuperscript{36} concluded that more large scale clinical trials need to be done in order to make a more conclusive conclusion of cuppings effectiveness. A large amount of physical therapy practice is based on evidence based practices. In order for cupping to become more widely used and accepted in the physical therapy field more research needs to be done in the use of cupping in the scope of physical therapy treatments.
CONCLUSION

Shoulder pain is a common occurrence affecting people every day. The gold standard of treating nonspecific shoulder pain is physical therapy. Physical therapy utilizes the use of exercise, hands on work, and modalities in the treatment of patients. This paper examined the mechanisms of ultrasound, transcutaneous nerve stimulation, dry needling, and cupping. These modalities are commonly used in physical therapy offices. All these modalities are believed to have analgesic effects, help improve range of motion, and increase blood flow to areas, among other benefits. This paper analyzed the use of these modalities and their effectiveness in treating shoulder pain.

The research in the area of modalities and their effectiveness on shoulder pain is very limited. All the Ultrasound research was conclusive in that ultrasound is not effective in the treatment of shoulder pain. Although, it is still used commonly in physical therapy. The other three modalities had positive results in that they were all found effective in reducing pain in patients. Most of the studies focused on the reduction of pain and less focused on the secondary factors (ROM, disability, strength, etc) believed to be caused by these modalities. Physical therapy claims to be an evidence-based practice, but the evidence in the area of modality treatments is limited. More research needs to be done on the effectiveness in the treatment of shoulder pain with these modalities to conclusively state weather they are effective. Most of the research done had limited participation. It is also difficult in physical therapy to discern what is helping the patient. With many of the patients, they were receiving multiple modalities, exercises, and hands on work, making it difficult to discern what was helping the most. It is also hard to make a conclusion about effectiveness of a modality because everyone responds differently to treatments, and this causes physical therapy to be more of a trial and error type of
treatment. Therapists prefer to rely on their own experiences with the modalities rather than research. Ultrasound should be excluded in these trials due to the conclusive results that it is ineffective, especially with the restraints placed on it by insurance companies. Otherwise, I think all modalities should be tested to find the best one for a patient. There is no one size fits all treatment and finding something to help a patient reduce their pain, even if it is not enough to be considered statistically significant, is still clinically significant for the therapist and makes a world of difference to the patient.
References


