Clinical Practice Guideline: **Deep Heating Modalities (Therapeutic Ultrasound and Diathermy)**

Date of Implementation: **June 16, 2016**

Product: **Specialty**

Related Policies:
CPG 121: Passive Physiotherapy (Therapeutic) Modalities
CPG 135: Physical Therapy Medical Policy/Guideline
CPG 155: Occupational Therapy Medical Policy/Guideline
CPG 278: Chiropractic Services Medical Policy / Guideline

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GUIDELINES

I. American Specialty Health – Specialty (ASH) considers use of therapeutic ultrasound (not mist/low frequency) as medically necessary for patients requiring deep heat to a specific area for reduction of pain, spasm, and joint stiffness, and to increase the flexibility of muscles, tendons, and ligaments. Specific indications for the use of ultrasound application include but are not limited to the patient having neuromas, symptomatic soft tissue calcification or tightened structures limiting joint motion that require an increase in extensibility.

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Deep Heating Modalities (Therapeutic Ultrasound and Diathermy)
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II. ASH considers use of diathermy medically necessary for the delivery of heat to deep tissues such as skeletal muscle and joints for the reduction of pain, joint stiffness, and muscle spasm. It has been determined that high energy pulsed wave diathermy machines produce the same therapeutic benefit as standard diathermy; therefore, these treatments are considered reasonable and necessary for the same indications as standard diathermy.

Diathermy or therapeutic ultrasound application is not considered medically necessary for the treatment of asthma, bronchitis, or any other pulmonary condition.

Notes Related to Guidelines

Use of the term "ultrasound" in this document refers to therapeutic ultrasound and not diagnostic ultrasound.

ASH peer review clinical committees recommend the following guidelines for the use of passive therapeutic modalities:

- Generally used to manage the acute inflammatory response, pain, and/or muscle tightness or spasm in the early stages of musculoskeletal and related condition management (e.g., short term and dependent upon patient condition and presentation; a few weeks). When the symptoms that prompted the use of certain passive therapeutic modalities begin to subside (e.g., reduction of pain, inflammation, and muscle tightness) and function improves, the medical record should reflect the discontinuation of those modalities, so as to determine the patient's ability to self-manage any residual symptoms.
- Use in the treatment of sub-acute or chronic conditions beyond the acute inflammatory response time frame requires documentation of the anticipated benefit and condition-specific rationale (e.g., exacerbation, inclusion with active care as an alternative for pharmacological management of chronic pain) to be considered medically necessary. Passive therapeutic modalities can be appropriate in these situations when they are preparatory and essential to the safe and effective delivery of other skilled therapeutic procedures (e.g., chiropractic manipulation, therapeutic exercise, acupuncture) that are considered medically necessary.
- Used as a stand-alone treatment is rarely therapeutic, and thus not required or indicated as the sole treatment approach to a patient's condition. Therefore, a treatment plan should not consist solely of passive therapeutic modalities but should also include skilled therapeutic procedures (e.g., chiropractic manipulation, therapeutic exercise, acupuncture).
- Should be selected based on the most effective and efficient means of achieving the patient's functional goals. Seldom should a patient require more than one (1) or two (2) passive therapeutic modalities to the same body part during the therapy session. Use of more than two (2) passive therapeutic modalities on a single visit date and

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for a prolonged period is unusual and should be justified in the documentation for consideration of medical necessity.

General Medical Necessity Criteria that must be met in addition to criteria above.

- The patient's condition has the potential to improve or is improving in response to this therapy service
- This therapy service is intended to improve, adapt or restore functions which have been impaired or lost as a result of illness, injury, loss of a body part, or congenital abnormality
- The use of this therapy service is applied only for a brief period in the early stages of treatment or during the acute period of an exacerbation/flare-up of the patient's condition(s) and is used as preparatory to other skilled treatment procedures or is necessary in order to provide other skilled treatment procedures safely and effectively
- The use of this therapy service (e.g., dosage, frequency) corresponds with the current nature, status, and severity of the patient's condition(s)
- The use of this therapy service is decreased as the patient displays improvement and the plan of care transitions into other skilled treatment procedures that can safely and effectively restore, adapt or improve the patient's impaired function(s)
- The use of this therapy service is safe and effective for the patient's condition, and the patient is able to properly provide the necessary feedback for its safe application
- The use of this therapy service is not redundant with other therapy services used on the same body part during the same session and is not duplicative with another practitioner's treatment plan

CPT® Codes and Descriptions

CPT® Code	CPT® Code Description
97024	Application of a modality to 1 or more areas; diathermy (e.g., microwave)
97035	Application of a modality to 1 or more areas; ultrasound, each 15 minutes

DESCRIPTION/BACKGROUND

Deep heating modalities such as ultrasound or diathermy are used for that purpose. Increased tissue temperature increases nerve conduction velocity and firing rates. Some studies have also found that heat will increase pain thresholds and reduce muscle strength (initial 30 minutes following heat application). Heat will also increase the metabolic rate, thus any heating agents should be avoided or used with caution in patients with acute inflammation (Cameron, 2022).

Ultrasound

Therapeutic ultrasound is a deep heat modality delivering high frequency mechanical waves using acoustic energy. Vibration of molecules transmits their energy into adjacent molecules. The therapeutic effects of ultrasound result from the conversion of sound to heat energy. In the body, ultrasonic energy is more rapidly attenuated and converted from acoustic energy to thermal energy in dense tissues, such as ligaments, tendons, and other connective tissues, than in less dense muscle or even less dense adipose tissue. And it is reflected by bone. Thus, tissues lying immediately next to bone can receive an even greater dosage of ultrasound, as much as 30% more. Ultrasound typically employs frequencies between 0.75 and 3.3 MHz. Most machines allow delivery of both 1 MHz and 3 MHz with 1 MHz penetrating more deeply than 3 MHz.

Ultrasound has a variety of effects considered thermal and nonthermal. Increasing tissue temperature is a thermal effect, while an increase in membrane permeability is its nonthermal effects. Continuous ultrasound provides the thermal effects, while pulsed ultrasound provides nonthermal effects. The goals are to enhance healing when applied to the appropriate condition and at the appropriate time. Phonophoresis is the use of ultrasound to enhance the delivery of a transdermal drug application. The most common use of ultrasound is to treat tendonitis and bursitis, musculoskeletal pain, degenerative arthritis, and contractures. Maximal heating may be limited by deep tissue factors and not by skin tolerance. Ultrasound may be applied directly by placing the applicator on the skin using a coupling medium, or indirectly by immersing the body part and applicator in a water-filled container. Because of the importance of appropriate technique and inherent dangers, ultrasound should be applied by a trained attendant and the devices are not appropriate for unsupervised home use.

Ultrasound Contraindications and Precautions

Contraindications to the use of ultrasound include:

- Malignant tumor
- Pregnancy
- Central Nervous Tissue
- Joint cement
- Plastic components
- Pacemaker or implantable cardiac rhythm device
- Thrombophlebitis
- Eyes
- Reproductive organs

Precautions for ultrasound include:

- Acute inflammation
- Epiphyseal plates

- Fractures
- Breast implants

Diathermy

Diathermy is another form of deep heat. Newer applications also allow for a pulsed mode, which reduces the thermal properties. Diathermy has the added benefit of large joint or area coverage versus ultrasound. Shortwave diathermy uses electromagnetic energy to provide heating and other physiologic effects. The type of tissue affects how deep or how warm the area will become. The most common device delivers 27.12 MHz frequency waves from the short wavelength radio wave section of the electromagnetic spectrum and is commonly referred to as shortwave diathermy (SWD). Devices that deliver electromagnetic waves from the microwave range of the spectrum are known as microwave diathermy; however, these machines are no longer an acceptable form of diathermy for delivery of deep heat due to the dangers associated with the treatment. SWD can be delivered continuously or through regular pulses. Pulsed SWD (PSWD) uses a timing circuit to pulse energy and thus, delivers less heat. Pulsed shortwave diathermy (PSWD) has also been referred to as pulsed electromagnetic field (PEMF), pulsed radiofrequency (PRF), and pulsed electromagnetic energy (PEME). The benefits of thermal level SWD include pain control, accelerated tissue healing and decreased joint stiffness with subsequent increased range of motion. PSWD can also provide thermal effects depending upon the settings.

SWD Contraindications and Precautions

The use of thermal shortwave diathermy (SWD) is contraindicated for the following:

- Any metal in the treatment area or on/in the body.
- Malignancy
- Eyes
- Testes
- Growing epiphyses

Contraindications for all forms of SWD:

- Implanted or transcutaneous neural stimulators including cardiac pacemakers
- Pregnancy

Precautions for all forms of SWD:

- Near electronic or magnetic equipment
- Obesity
- Copper-bearing intrauterine contraceptive devices

The use of deep heating modalities are contraindicated if the patient cannot provide the proper feedback necessary for safe application (e.g., pediatric patient, impaired mentation).

EVIDENCE REVIEW

Ultrasound

Therapeutic ultrasound is typically used for decreasing soft tissue inflammation and pain and or increasing tissue extensibility, scar tissue remodeling, and healing soft tissue injuries. Despite its use, the evidence for its effectiveness has not been well documented. Critical analysis of the literature demonstrates poor study design, inappropriate parameters, clinical error, and variability of patient responsiveness, which may explain why results show ultrasound as ineffective. Gaps in research do not allow for conclusive evidence that US provides the clinical effects described. Most systematic reviews of RCTs concluded that studies were insufficient to demonstrate conclusively that US is more effective than placebo. Poor study design was a consistent finding (Cameron, 2022). The Philadelphia Panel Evidence-Based Clinical Practice Guidelines on Selected Rehabilitation Interventions for Low Back Pain publication (2001) investigated ultrasound. Based on one RCT of therapeutic ultrasound versus placebo, no benefit was demonstrated for pain in subjects with chronic LBP after one month of therapy. The strength of this evidence was rated as fair (level II). The Panel concluded that there is poor evidence to include or exclude therapeutic ultrasound alone as an intervention for chronic LBP. Similarly, the American College of Physicians and the American Pain Society Joint Clinical Practice Guideline for the Diagnosis and Treatment of LBP (Chou et al., 2007) concluded that there was not enough evidence to support the use of ultrasound or short-wave diathermy for acute or chronic LBP. These results were based on systematic reviews and randomized trials of one or more of the aforementioned therapies for treatment of acute or chronic LBP that reported pain outcomes, back specific function, general health status, work disability or patient satisfaction (Chou and Huffman, 2007). The Philadelphia Panel found many studies that combined treatment methods, however they lacked sufficient data to make any recommendations due to the different combinations used and poor descriptions of actual interventions. In a review by Poitras and Brosseau (2008), they determined that due to limited studies of sufficient quality, no recommendations could be made for the use of ultrasound for the treatment of chronic LBP. There is insufficient evidence to support the isolated use of ultrasound as a treatment for chronic LBP.

In 2001, Robertson and Baker published a comprehensive systematic review that called into question the effectiveness of therapeutic ultrasound. Major limitations in the existing literature on ultrasound at the time were the lack of consistency among soft tissue conditions studied and the wide variety of parameters used for ultrasound frequency, intensity, and dose. Subsequent Cochrane reviews focused on the effectiveness of ultrasound for various musculoskeletal conditions. Cochrane reviews did not support the use of therapeutic US for patellofemoral pain (1 RCT) or acute ankle sprain (5 RCTs, 1 favorable) With the exception of calcific tendinitis, ultrasound was not found to be effective for the treatment of shoulder pain in two separate reviews (Philadelphia Panel Practice Guidelines, 2001; Michener et al., 2004). The Ottawa Panel Evidence-Based Clinical Practice Guidelines supported the use of US for managing rheumatoid arthritis affecting the hand (Ottawa Panel Evidence-Based Clinical Practice Guidelines, 2004). A Cochrane review in 2001 did not support the use of ultrasound for osteoarthritis of the knee based on 3 RCTs that met inclusion criteria, with only 1 study of high quality (Welch et al., 2001).

Shanks et al. (2010) completed a literature review on the effectiveness of therapeutic ultrasound for musculoskeletal conditions of the lower limb. Ten studies out of a possible 15 were included in the review. Only one trial was considered high quality, and 6 trials were considered low or poor quality. None of the 6 placebo-controlled trials found any statistically significant differences between true and sham ultrasound therapy. Authors concluded that there is currently no high-quality evidence available to suggest that therapeutic ultrasound is effective for musculoskeletal conditions of the lower limb. Graham et al. (2013) completed a systematic review on physical modalities for acute to chronic neck pain. Of 103 reviews eligible, 20 were included and 83 were excluded. No benefit was noted for pulsed US over placebo for whiplash associated disorder. Moderate evidence reported that pulsed ultrasound was no better than placebo for acute whiplash associated disorder, chronic myofascial neck pain or subacute to chronic neck pain. The evidence does not support the isolated use of ultrasound for non-specific neck pain (Grades I and II).

A 2004 systematic review of therapy for lateral epicondylitis supported the use of ultrasound to relieve pain based on positive findings in 4 out of 6 RCTs (Trudel et al., 2004). Dingemanse et al. (2014) aimed to present an evidence-based overview of the effectiveness of electrophysical modality treatments for both medial and lateral epicondylitis (LE). A total of 2 reviews and 20 RCTs were included, all of which concerned LE. Different electrophysical regimes were evaluated: ultrasound, laser, electrotherapy, ESWT, TENS and pulsed electromagnetic field therapy. Moderate evidence was found for the effectiveness of ultrasound versus placebo on mid-term follow-up. Ultrasound plus friction massage showed moderate evidence of effectiveness versus laser therapy on short-term follow-up. For all other modalities only limited/conflicting evidence for effectiveness or evidence of no difference in effect was found. Potential effectiveness of ultrasound for the management of LE was found.

Carpal tunnel syndrome was a condition that did show promise as being affected positively by US treatments. A Cochrane review in 2003 concluded there was moderate evidence for the effectiveness of ultrasound for carpal tunnel syndrome after 7 weeks of treatment, with the benefit maintained at 6 months (O'Connor et al., 2003). More RCTs have offered some additional support for the use of ultrasound for carpal tunnel syndrome. Bakhtiary and Rashidy-Pour (2004) compared pulsed 1 MHz US to low level laser treatments for 50 patients (90 hands) with EMG confirmed carpal tunnel syndrome. Patients were treated daily for 3 weeks. The ultrasound group had significantly greater improvement in pain, motor and sensory latency, and motor and sensory amplitude compared to the laser group at the end of treatment and at 4-week follow-up. Piravej and Boonhong (2004) showed that continuous ultrasound and a placebo drug was more effective than sham ultrasound plus Diclofenac at increasing median nerve action potentials, with both groups improving with respect to clinical parameters. A study by Baysal et al. (2006) suggested that ultrasound in combination with splinting and exercise produced greater patient satisfaction at 8-week follow-up than splinting and exercise or ultrasound and exercise alone, with similar improvements in symptoms noted among the groups.

However, according to a Cochrane review (2013), there is only poor-quality evidence from very limited data to suggest that therapeutic ultrasound may be more effective than placebo for either short- or long-term symptom improvement in people with carpal tunnel syndrome. There is also insufficient evidence to support ultrasound over other non-surgical interventions. Authors concluded that improved study design is needed to determine the effectiveness of ultrasound. In a Cochrane review by Ebadi et al. (2014), no high-quality evidence was found to support the use of ultrasound for improving pain or quality of life in patients with non-specific chronic LBP. There was some evidence that therapeutic ultrasound has a small effect on improving low-back function in the short term, but this benefit is unlikely to be clinically important.

According to the AHRQ publication on Non-Invasive Techniques for Low Back Pain (2016):

- For chronic low back pain, a systematic review found no difference between ultrasound versus sham ultrasound in pain at the end of treatment and two trials found no effects on pain. Evidence from 5 trials was too inconsistent to determine effects on function, though a larger, good-quality trial found no effect on the Roland Disability Questionnaire (RDQ).
- For chronic low back pain, a systematic review found no differences between ultrasound versus no ultrasound in pain or back-specific function, but estimates were imprecise.
- For chronic low back pain, evidence from 3 trials was insufficient to determine effects of ultrasound plus exercise versus exercise alone on pain or function, due to imprecision and methodological shortcomings.
- For radicular low back pain due to spinal stenosis, a small trial found no differences between ultrasound plus exercise versus sham ultrasound plus exercise in back pain, leg pain, or the Oswestry Disability Index (ODI) after 3 weeks of therapy.
- There was insufficient evidence from three small trials with methodological shortcomings to determine effects of ultrasound versus other interventions.
- For radiculopathy, there was insufficient evidence from two small trials with methodological shortcomings to determine effects of ultrasound versus other interventions.
- No study evaluated the effectiveness of ultrasound for acute non-radicular low back pain.

- One trial found no differences between ultrasound versus sham ultrasound in risk of any adverse event.

In a Lancet article by Foster et al. (2018), they conclude that passive electrical or physical modalities, such as ultrasound, are generally ineffective and not recommended for the treatment of low back pain. Although therapeutic ultrasound is not recommended in recent clinical guidelines, it is frequently used by physiotherapists in the treatment of chronic LBP. In an update of a Cochrane Review published in 2014, Ebadi et al. (2020) again reviewed the evidence to determine the effectiveness of therapeutic ultrasound in the management of chronic non-specific LBP as their primary objective. A secondary objective was to determine the most effective dosage and intensity of therapeutic ultrasound for chronic LBP. Authors included RCTs on therapeutic ultrasound for chronic non-specific LBP. We compared ultrasound (either alone or in combination with another treatment) with placebo or other interventions for chronic LBP.

They performed a meta-analysis when sufficient clinical and statistical homogeneity existed. They included 10 RCTs involving a total of 1,025 participants with chronic LBP. The included studies were carried out in secondary care settings in Turkey, Iran, Saudi Arabia, Croatia, the UK, and the USA, and most applied therapeutic ultrasound in addition to another treatment, for six to 18 treatment sessions. The risk of bias was unclear in most studies. The results demonstrate that there was very low-certainty evidence (downgraded for imprecision, inconsistency, and limitations in design) of little to no difference between therapeutic ultrasound and placebo for short-term pain improvement. There was also moderate-certainty evidence (downgraded for imprecision) of little to no difference in the number of participants achieving a 30% reduction in pain in the short term. There was low-certainty evidence (downgraded for imprecision and limitations in design) that therapeutic ultrasound has a small effect on back-specific function compared with placebo in the short term), but this effect does not appear to be clinically important. There was moderate-certainty evidence (downgraded for imprecision) of little to no difference between therapeutic ultrasound and placebo on well. Two studies (n = 486) reported on overall improvement and satisfaction between groups, and both reported little to no difference between groups (low-certainty evidence, downgraded for serious imprecision). One study (n = 225) reported on adverse events and did not identify any adverse events related to the intervention (low-certainty evidence, downgraded for serious imprecision). No study reported on disability for this comparison. We do not know whether therapeutic ultrasound in addition to exercise results in better outcomes than exercise alone because the certainty of the evidence for all outcomes was very low (downgraded for imprecision and serious limitations in design). The estimate effect for pain was in favor of the ultrasound plus exercise group at short term. Regarding back-specific function and well-being, 2 RCTs; general health subscale of the SF-36), there was little to no difference between groups at short term. No studies reported on the number of participants achieving a 30% reduction in pain, patient satisfaction, disability, or adverse events for this comparison. Authors concluded that evidence from this systematic review is uncertain regarding the effect of therapeutic ultrasound on pain in individuals with chronic non-specific LBP. Whilst there is some evidence that therapeutic ultrasound may have a small effect on improving low back function in the short term compared to placebo, the certainty of evidence is very low. The true effect is likely to be substantially different. There are few high-quality randomized trials, and the available trials were very small. The current evidence does not support the use of therapeutic ultrasound in the management of chronic LBP.

Noori et al. (2020) evaluated the effectiveness of therapeutic ultrasound in the management of patients with chronic LBP and neck pain. The search strategy identified 10 trials that met the criteria for inclusion. Three studies in LBP reported that both therapeutic and sham (placebo) ultrasound provided significant improvement in pain intensity. In each of these studies, ultrasound was found to be more effective than placebo when using only one of several validated instruments to measure pain. Three of the four studies on neck pain demonstrated significant pain relief with ultrasound in combination with other treatment modalities. However, only one of these studies demonstrated that the use of ultrasound was the cause of the statistically significant improvement in pain intensity. Authors concluded that given the paucity of trials and conflicting results, they cannot recommend the use of monotherapeutic ultrasound for chronic LBP or neck pain. It does seem that ultrasound may be considered as part of a physical modality treatment plan that may be potentially helpful for short-term pain relief; however, it is undetermined which modality may be superior. In both pain syndromes, further trials are needed to define the true effect of low-intensity ultrasound therapy for axial back pain. No conclusive recommendations may be made for optimal settings or session duration.

Qing et al. (2021) evaluated the effects and safety of therapeutic ultrasound in patients with neck pain. Randomized controlled trials that compared the effects of therapeutic ultrasound on neck pain were included in this review. The included studies compared therapeutic ultrasound plus other treatments with the other treatments alone or compared therapeutic ultrasound with sham or no treatment. Outcome measures involved the effects on pain, disability, and quality of life. Other treatments included all nonultrasonic therapies (e.g., various exercises, massage, electrotherapy). Twelve randomized controlled trials (705 patients) fulfilled the inclusion criteria. Seven studies compared therapeutic ultrasound plus other treatments vs the other treatments alone (449 patients). Therapeutic ultrasound yielded additional benefits for pain, but there was high heterogeneity, and we could not draw a clear conclusion. Ultrasound did not have a better effect on disability or quality of life when it was combined with other treatments. Five studies compared therapeutic ultrasound with sham or no treatment (256 patients), and the pooled data showed that therapeutic ultrasound significantly reduced pain intensity. No adverse events of therapeutic ultrasound were reported in the included studies. Authors concluded that therapeutic ultrasound may reduce the intensity of pain more than sham or no treatment, and it is a safe treatment. Whether therapeutic ultrasound in combination with other conventional treatments produced additional benefits on pain intensity, disability, or quality of life is not clear. The randomized trials included in this review had different levels of quality and high heterogeneity. A large trial using a valid methodology is warranted.

Zhang et al. (2016) explored the effects of therapeutic ultrasound with sham or no intervention on pain, physical function, and safety outcomes in patients with knee osteoarthritis. Ten randomized controlled trials (645 patients) met the inclusion criteria. Therapeutic ultrasound showed a positive effect on pain. For physical function, therapeutic ultrasound was advantageous for reducing Western Ontario and McMaster Universities (WOMAC). No occurrence of adverse events caused by therapeutic ultrasound was reported in any trial. Authors suggest that therapeutic ultrasound is beneficial for reducing knee pain and improving physical functions in patients with knee osteoarthritis and could be a safe treatment. Bier et al. (2018) reports that physical therapists should not provide ultrasound for non-specific neck pain. Wu et al. (2019) assessed the effectiveness and safety of therapeutic ultrasound with sham ultrasound on pain relief and functional improvement in knee osteoarthritis patients. As phonophoresis is a unique therapeutic ultrasound, we also compared the effects of phonophoresis with conventional non-drug ultrasound. Randomized controlled trials comparing therapeutic ultrasound with sham ultrasound in knee osteoarthritis patients were included. Phonophoresis in the experimental and control groups were compared through conventional ultrasound, and corresponding trials were also included. Fifteen studies including three phonophoresis-related studies with 1,074 patients were included. Meta-analyses demonstrated that therapeutic ultrasound significantly relieved pain and reduced the WOMAC physical function score. In addition, therapeutic ultrasound increased the active range of motion. Subgroup analysis of phonophoresis ultrasound illustrated significant differences on the visual analogue scale (VAS), but no significant differences on WOMAC pain subscales, and total WOMAC scores were observed. There was no evidence to suggest that ultrasound was unsafe treatment. Authors concluded that therapeutic ultrasound is a safe treatment to relieve pain and improve physical function in patients with knee osteoarthritis. However, phonophoresis does not produce additional benefits to functional improvement, but may relieve pain compared to conventional non-drug ultrasound. According to Yang and Chen (2019) therapeutic ultrasound has shown some success in treating calcific tendinitis of the shoulder and lateral epicondylitis. Low intensity pulsed ultrasound may provide relief for Achille’s tendinopathy.

Aiyer et al. (2020) completed a systematic review was to evaluate the effectiveness of therapeutic ultrasound in the management of patients with knee, shoulder, and hip pain. The search strategy identified 8 trials for knee, 7 trials for shoulder and 0 trials for hip that met the criteria for inclusion. All 8 trials showed improvement in knee pain, and of these studies 3 showed statistical significance improvement for therapeutic ultrasound versus the comparator. For shoulder pain, all 7 trials showed reduction in pain, but should be noted that 4 of studies demonstrated that therapeutic ultrasound is inferior to the comparator modality. Authors concluded that therapeutic ultrasound is frequently used in the treatment of knee, shoulder and hip pain and is often combined with other physiotherapeutic modalities. The literature on knee arthritis is most robust, with some evidence supporting therapeutic ultrasound, though the delivery method of ultrasound (pulsed vs continuous) is controversial. As a monotherapy, ultrasound treatment may not have a significant impact on functional improvement but can be a reasonable adjunct to consider with other common modalities. In all three pain syndromes, especially for hip pain, further trials are needed to define the true effect of low-intensity ultrasound therapy knee, shoulder, and hip pain. No conclusive recommendations may be made for optimal settings or session duration. Papadopoulos and Mani (2020) investigated the clinical effectiveness of therapeutic ultrasound in musculoskeletal acute and chronic pain, mainly through the control of inflammation and the promotion of soft tissue injury healing. Based on the evidence presented, authors state it is clinically effective in some musculoskeletal soft tissue pain conditions, but due to conflicting results in some studies, no specific positive recommendations can be made, nor does it permit exclusion of therapeutic ultrasound from clinical practice. There is scope for improving the evidence base with better designed studies.

Dantas et al. (2021) aimed to determine the effects of therapeutic ultrasound on knee osteoarthritis (KOA) symptoms in a systematic review. Four studies ($N = 234$ participants) were eligible for inclusion in our primary analyses assessing therapeutic ultrasound versus sham. The methodological quality of the included RCTs ranged from moderate to very low. Treatment with therapeutic ultrasound resulted in small, statistically significant benefits for pain (approximate 9.6% improvement on a 0-100 VAS) and self-reported measures of function (approximate 12.8% improvement on a 0-100 VAS). The overall quality of the evidence was very low. No adverse events were reported in any of the included studies. Authors concluded that the use of therapeutic ultrasound may provide additional benefits to physical therapy regimens in terms of symptom relief in individuals with KOA. However, it is not possible to make any meaningful recommendations for clinical practice due to the small number of applicable RCTs and the low methodological quality of the RCTs deemed eligible for this study.

Sung et al. (2022) conducted a systematic review and meta-analysis to evaluate the effects of ultrasound deep heat therapy (UST) on the improvement of pain and glenohumeral joint function in adhesive capsulitis compared to (1) no treatment or placebo, and (2) any other therapeutic modalities. Seven studies were included in the systematic review with five studies forming the basis for meta-analyses. The effects of UST in patients with adhesive capsulitis were compared with placebo, shockwave therapy, corticosteroid injection, platelet-rich plasma injection, or cryotherapy. The results indicated that UST significantly improved pain scores when performed together with exercise and/or other physical modalities compared to placebo; however, whether UST provides benefits for the improvement of disability and/or the range of motion was uncertain in the present results.

Authors concluded that these findings suggest that UST as a co-intervention combined with other physical modalities is an effective means of improving the overall pain in patients with adhesive capsulitis.

Smallcomb et al. (2022) compares the current state of the field in therapeutic ultrasound and shockwave therapy, including low-intensity therapeutic ultrasound, extracorporeal shockwave therapy, and radial shockwave therapy, and evaluates the efficacy in treating tendinopathies with ultrasound. Surgical and therapeutic methods, such as arthroscopic surgery, dry needling, and physical therapy, produce mixed success in reintroducing a healing response in tendinopathy due in part to inconsistent dosing and monitoring. Ultrasound is one therapeutic modality that has been shown to noninvasively induce bioeffects in tendon that may help promote healing. However, results from this modality have also been mixed. Based upon this literature review, authors found that the mixed successes may be attributed to the wide variety of achievable parameters within each broader treatment type and the lack of standardization in measurements and reporting. Despite mixed outcomes, all three therapies show potential as an alternative therapy with lower-risk adverse effects than more invasive methods like surgery. There is currently insufficient evidence to conclude which ultrasound modality or settings are most effective. More research is needed to understand the healing effects of these different therapeutic ultrasound and shockwave modalities.

Liu et al. (2022) compared the efficacy of therapeutic ultrasound in pain relief and functional recovery in knee osteoarthritis. Fourteen randomized trials covering 1,080 patients with treatment durations of 2 to 24 weeks were included. Both pulsed and continuous therapy had obvious pain relief effects, and high-intensity (>1.5 W/cm2) ultrasound seemed more effective. In addition, therapeutic ultrasound was also effective in increasing joint function as assessed by WOMAC. There was a certain degree of heterogeneity due to the differences between the subjects in the study and the ultrasound parameter settings. According to authors, analysis confirmed that both pulsed and continuous ultrasound are effective and safe for pain relief and functional recovery of knee osteoarthritis, especially in high intensity (> 1.5 W/cm2). However, more high-quality randomized controlled trials will be necessary.

Oliveira et al. (2022) aimed to assess the effects of passive mechanical-based therapies (isolated or combined with other therapies) on patients with knee OA compared to placebo, other isolated or combined interventions. They included 77 clinical studies. Ultrasound and ESWT statistically improved pain and disability comparing to placebo (combined or not with other therapies), and when added to other therapies versus other therapies alone. Ultrasound was statistically inferior to phonophoresis (combined or not with other therapies) in reducing pain and disability for specific therapeutic gels and/or combined therapies. All meta-analyses showed very-low certainty of evidence, with 15 of 42 (38%) pooled comparisons being statistically significant (weak to large effect). Authors conclude that despite the inconsistent evidence with very-low certainty, the potential benefits of passive mechanical-based therapies should not be disregard and cautiously recommended that clinicians might use them in some patients with knee OA.

Yang et al. (2022) investigated the effect of phonophoresis when various gel types were used. They included studies that were randomized controlled trials (RCTs), included patients with a diagnosis of knee osteoarthritis, included treatment with either phonophoresis or therapeutic ultrasound with placebo gel, and reported clinical and functional outcomes. A total of 2,176 studies were retrieved and analyzed (nine RCTs including 423 patients). The intervention group significantly outperformed the control group in pain scores with NSAID gel and in the WOMAC function score with corticosteroid gel. Phonophoresis alleviated pain and improved functional performance. Because of some limitations of this study, additional high-quality, large-scale RCTs are required to confirm the benefits.

Čota et al. (2022) aimed to determine whether 4500 J T-US combined with therapeutic exercises is superior to therapeutic exercises alone regarding calcification size reduction and symptom improvement in chronic symptomatic Calcific shoulder tendinitis (CST). Patients with chronic CST were analyzed. The 46 patients with confirmed CST via sonograph were divided into two groups (56 shoulders, 26 per group). Both groups performed the same therapeutic exercises for half an hour under physiotherapist supervision. In the treatment group T-US (4500 J, 10 minutes per session at a frequency of 1 MHz and an intensity of 1.5 W/cm2), and in the placebo group, sham T-US was applied for 4 weeks. Patients were assessed for: calcification size, shoulder pain, global health (GH), shoulder mobility (ROM), handgrip strength, Health Assessment Questionnaire Disability Index (HAQ-DI), Shoulder Pain and Disability Index (SPADI), and overall rehabilitation satisfaction. All assessed variables improved in both groups. A significantly greater reduction in calcification size was recorded in the treatment group compared to placebo. There was a significantly greater decrease in HAQ-DI, reduction of VAS GH, and an increase in hand grip strength in the treatment group, while no significant differences were observed for other parameters between the groups. Results showed that adding the 4500 J T-US to therapeutic exercises in chronic symptomatic CST therapy resulted in greater calcification size reduction immediately following the treatment, as well as hand grip strength, HAQ-DI, and VAS GH improvement.

Peris Moya et al. (2022) performed a systematic review and meta-analysis of randomized controlled trials of studies with carpal tunnel syndrome treated by: ultrasound versus no treatment, therapeutic ultrasound versus sham ultrasound, ultrasound and usual care versus usual care, or ultrasound and other intervention versus the same intervention. The outcomes measures registered were pain, severity of symptoms, function, strength, and neurophysiological parameters (motor distal latency and sensory distal latency) of the median nerve. Ten clinical trials met the inclusion criteria for the systematic review. Eight trials were meta-analyzed, which included a total of 2,069 patients with carpal tunnel syndrome. The methodological quality of the included studies ranged among limited (5 trials), moderate (3 trials), and high (2 trials). In one of the electrophysiological parameters (motor distal latency), a significant difference between groups after the use of ultrasound was observed. No significant differences between groups were observed at post-treatment for pain, severity of symptoms, function, strength and for the rest of the electrophysiological parameters evaluated. Authors concluded that the use of ultrasound on patients with carpal tunnel syndrome seems to improve motor distal latency. This finding implies a partial improvement at the neurophysiological level, representing a reduction in the grade of clinical severity. Additional clinical trials with a high methodological quality are needed to investigate the doses at which ultrasound are most effective.

Dorji et al. (2022) sought to determine the effectiveness of ultrasound/phonophoresis as an adjuvant to exercise or manual therapy for the improvement of patient-centered outcomes in adults with non-specific neck pain (NSNP). Six studies involving 249 participants were included. Phonophoresis with capsaicin plus exercise improved pain at immediate post-treatment but not with diclofenac sodium plus exercise as compared to exercise. Continuous ultrasound (CUS) plus exercise improved pain and pressure pain threshold (PPT) at immediate post-treatment and at intermediate term as compared to exercise. CUS or high-power pain threshold (HPPT) ultrasound plus manual therapy and exercise showed no benefit for pain reduction did not improve function/disability at immediate or short-term as compared to manual therapy and exercise. Authors concluded that due to high risk of bias, inconsistency, and indirectness, the quality of evidence is very low in support of benefit of ultrasound/phonophoresis as an adjuvant treatment for NSNP. Clinicians using ultrasound therapy as an adjuvant intervention for management of chronic myofascial associated neck pain should carefully consider the available evidence on ultrasound, including the benefits and costs involved.

Dabbagh et al. (2023) summarized, synthesized, and integrated the evidence evaluating the effectiveness of biophysical agents compared to other conservative treatments, for the management of carpal tunnel syndrome (CTS). This was an overview of systematic reviews (SRs). Authors found 17 SRs addressing 12 different biophysical agents. The quality of the SRs was mainly critically low (n = 16) or low (n = 1). The evidence was inconclusive for the effectiveness of Low-level Laser therapy and favorable for the short-term efficacy of non-thermal ultrasound in improving symptom severity, function, pain, global rating of improvement, satisfaction with treatment, and other electrophysiological measures compared to manual therapy or placebo. Evidence was inconclusive for Extracorporeal Shockwave therapy, and favorable for the short-term effectiveness of Shortwave and Microwave Diathermy on pain and hand function. The findings were based on low-quality primary studies, with an unclear or high risk of bias, small sample sizes, and short follow-ups. Therefore, no recommendations can be made for the long-term effectiveness of any biophysical agents. High-quality evidence is needed to support evidence-based recommendations on the use of biophysical agents in the management of CTS.

Alhakami et al. (2024) evaluated the effectiveness of therapeutic ultrasound in decreasing pain intensity and improving functional disability in patients with plantar fasciitis. Five randomized control trials (RCT) were selected based on an electronic search in PubMed, All the included studies showed that ultrasound therapy is beneficial in reducing pain score and improving functional disability, except one study did not recommend using ultrasound therapy for plantar fasciitis. Moreover, regarding another outcome measure, two studies found that ultrasound therapy reduces thickness and tenderness in plantar fasciitis and improves static and dynamic balance. Authors concluded that after reviewing the five studies, this systematic review support using ultrasound therapy to decrease pain and improve functional disability in patients with plantar fasciitis.

Diathermy

Research has found increased soft tissue extensibility resulting in increased muscle length or range of motion. Nonthermal PSWD has been studied for numerous effects. Several studies demonstrated edema control and pain reduction, improved wound healing and tendon injury, Osteoarthritis (OA) symptoms have been shown to decrease upon use of PSWD in some studies, in particular knee or cervical spine OA (Cameron, 2022). Studies appear to support the use of some form of diathermy compared to ultrasound, placebo, or no treatment, but no minimal additive effect when combined with exercise or manual therapy (Cameron, 2022; Teslim et al., 2012; Draper, 2011). The American College of Physicians and the American Pain Society Joint Clinical Practice Guideline for the Diagnosis and Treatment of LBP (Chou et al., 2007) concluded that there was not enough evidence to support the use of ultrasound or short-wave diathermy for acute or chronic LBP. These results were based on systematic reviews and randomized trials of one or more of the aforementioned therapies for treatment of acute or chronic LBP that reported pain outcomes, back specific function, general health status, work disability or patient satisfaction (Chou and Huffman, 2007). According to the AHRQ publication on Non-Invasive Techniques for Low Back Pain (2016):

- For back pain of mixed duration, there was insufficient evidence from 5 RCTs to determine effects of short-wave diathermy versus sham diathermy, due to methodological limitations and imprecision.
- No study evaluated harms of short-wave diathermy.

There is insufficient evidence to support the isolated use shortwave diathermy as a treatment for chronic LBP.

Cetin et al. (2008) investigated the therapeutic effects of physical agents administered before isokinetic exercise in women with knee osteoarthritis. One hundred patients with bilateral knee osteoarthritis were randomized into 5 groups of 20 patients each: group 1 received short-wave diathermy + hot packs and isokinetic exercise; group 2 received transcutaneous electrical nerve stimulation + hot packs and isokinetic exercise; group 3 received ultrasound + hot packs and isokinetic exercise; group 4 received hot packs and isokinetic exercise; and group 5 served as controls and received only isokinetic exercise. Pain and disability index scores were significantly reduced in each group. Patients in the study groups had significantly greater reductions in their visual analog scale scores and scores on the Lequesne index than did patients in the control group (group 5). They also showed greater increases than did controls in muscular strength at all angular velocities. In most parameters, improvements were greatest in groups 1 and 2 compared with groups 3 and 4. Authors concluded that using physical agents before isokinetic exercises in women with knee osteoarthritis leads to augmented exercise performance, reduced pain, and improved function. Hot pack with a transcutaneous electrical nerve stimulator or short-wave diathermy had the best outcome. Akyol et al. (2010) completed a RCT to determine if SWD increases the effectiveness of isokinetic exercise on pain, function, knee muscle strength, quality of life, and depression in the patients with knee OA. Forty women aged between 42 and 74 years, with a diagnosis of bilateral primary knee OA were randomized into two groups. Group 1 (*N*=20) received SWD and isokinetic muscular strengthening exercises. Group 2 (*N*=20) served as control group, and they received isokinetic exercises only. Both programs were performed 3 days a week, for 4 weeks, and a total of 12 sessions. Patients were assessed before treatment, after treatment, and at a 3-month follow-up. Outcome measures included visual analogue scale, Western Ontario and McMaster University Osteoarthritis Index, 6-minute walking distance, isokinetic muscle testing, Short Form 36 and Beck depression index. The patients with OA in each group had significant improvements in pain, disability, depression, walking distance, muscle strength, and quality of life when compared with their initial status ($P<0.05$). Authors concluded that use of SWD in addition to isokinetic exercise program seems to have no further significant effect in terms of pain, disability, walking distance, muscle strength, quality of life and depression in patients with knee OA.

Page et al. (2014) completed a Cochrane Review on electrotherapy modalities for adhesive capsulitis (frozen shoulder). The two main questions of the review focused on whether electrotherapy modalities are effective compared to placebo or no treatment, or if they are an effective adjunct to manual therapy or exercise (or both). The main outcomes of interest were participant-reported pain relief of 30% or greater, overall pain, function, global assessment of treatment success, active shoulder abduction, quality of life, and the number of participants experiencing any adverse event. Nineteen trials (1,249 participants) were included in the review. Only two electrotherapy modalities (low-level laser therapy (LLLT) and pulsed electromagnetic field therapy (PEMF)) have been compared to placebo. The two main questions of the review were investigated in nine trials. Authors were uncertain whether PEMF for two weeks improved pain or function more than placebo at two weeks because of the very low-quality evidence from one trial (32 participants). Seventy-five percent (15/20) of participants reported pain relief of 30% or more with PEMF compared with 0% (0/12) of participants receiving placebo. Fifty-five percent (11/20) of participants reported total recovery of joint function with PEMF compared with 0% (0/12) of participants receiving placebo. Based on very low-quality evidence from six trials, authors were uncertain whether therapeutic ultrasound, PEMF, continuous short-wave diathermy, Iodex phonophoresis, a combination of Iodex iontophoresis with continuous short wave diathermy, or a combination of therapeutic ultrasound with transcutaneous electrical nerve stimulation (TENS) were effective adjuncts to exercise. Based on low or very low-quality evidence from 12 trials, we were uncertain whether a diverse range of electrotherapy modalities (delivered alone or in combination with manual therapy, exercise, or other active interventions) were effective than other active interventions (for example glucocorticoid injection).

Draper (2014) reported on 6 cases of patients who lacked full range of motion (ROM) in the elbow because of trauma. The treatment regimen was thermal pulsed shortwave diathermy and joint mobilizations. Patients lacked a mean active ROM of 24.5° of extension approximately 4.8 years after trauma or surgery. Treatment consisted of 20 minutes of pulsed shortwave diathermy followed by 7 to 8 minutes of joint mobilizations. After posttreatment ROM was recorded, ice was applied to the area for about 30 minutes. Once the patient achieved full, active ROM or failed to improve on 2 consecutive visits, he or she was discharged from the study. By the fifth treatment, 4 participants (67%) achieved normal extension active ROM, and 2 of the 4 (50%) exceeded the norm. Five participants (83%) returned to normal activities and full use of their elbows. One month later, the 5 participants had maintained, on average, (mean ± SD) 92% ± 6% of their final measurements. Draper (2014) suggested that a combination of thermal pulsed shortwave diathermy and joint mobilizations was effective in restoring active ROM of elbow extension in 5 of the 6 patients (83%) who lacked full ROM after injury or surgery. Incebiyik et al. (2015) sought to determine the effects of short-wave diathermy (SWD) treatment on mild and moderate idiopathic carpal tunnel syndrome (CTS). The study involved 58 wrists in 31 patients diagnosed clinically and electrophysiologically with mild and moderate CTS. They were assigned randomly to one of two groups. Group 1 received a hot pack, SWD, and nerve and tendon gliding exercises and Group 2 received a hot pack, placebo SWD, and nerve and tendon gliding exercises. The treatment was applied five times weekly for a total of 15 sessions. All parameters improved significantly in the SWD group versus the controls ($p < 0.05$). Thus, authors concluded that SWD provided short-term improvements in pain, clinical symptoms, and hand function in patients with mild and moderate CTS.

Fukuda et al. (2011) evaluated the effect of PSW treatment in different doses and compared low-dose and high-dose PSW groups with control and placebo groups. One hundred twenty-one women with a diagnosis of knee OA participated in the study; 35 participants did not receive any treatment (control group), 23 received a placebo treatment, 32 received low-dose PSW treatment, and 31 received high-dose PSW treatment The results demonstrated the short-term effectiveness of the PSW at low and high doses in patients with knee OA. Both treatment groups showed a significant reduction in pain and improvement in function compared with the control and placebo groups. There were no differences in results between PSW doses, although a low dose of PSW appeared to be more effective in the long term. Authors suggest that PSWD may be an effective method for pain relief and improvement of function and quality of life in the short term in women with knee OA. Laufer and Dar (2012) assessed the effectiveness of short-wave diathermy (SWD) treatment in the management of knee osteoarthritis (KOA) and to assess whether the effects are related to the induction of a thermal effect. Included were trials that compared the use of SWD treatment in patients diagnosed with KOA with a control group (placebo SWD treatment or no intervention) and studies that used high-frequency electromagnetic energy (i.e., 27.12 MHz) with sufficient information regarding treatment dosage. Seven studies were included in the final analysis. Treatment protocols (dosage, duration, number of treatments) varied extensively between studies. The meta-analysis of the studies with low mean power did not favor SWD treatment for pain reduction, while the results of studies employing some thermal effects were significant. No treatment effect on functional performance measures was determined. Authors reported that this meta-analysis found small, significant effects on pain and muscle performance only when SWD evoked a local thermal sensation. However, the variability in the treatment protocols makes it difficult to draw definitive conclusions about the factors determining the effectiveness of SWD treatment. Teslim et al. (2013) compared the effects of pulsed (PSWD) and continuous short-wave diathermy (CSWD) on pain, range of motion, pulse rate and skin temperature in subjects with chronic knee osteoarthritis. The pain experienced by participants in the CSWD group was significantly lower than that of the PSWD groups ($P < 0.03$) after 4 weeks. Also, both active and passive knee range of motions significantly increased in the CSWD group compared to that of PSWD group ($p < 0.01$ and 0.002). Authors concluded that CSWD was more effective than PSWD in alleviating pain and in increasing knee flexion range of motion among subjects with chronic knee OA. Also, a mild elevation of skin temperature was able to elicit physiological effects that could exert therapeutic effects. D'Sylva et al. (2010) assessed the effect of 1) manipulation and mobilization, 2) manipulation, mobilization, and soft tissue work, and 3) manual therapy with physical medicine modalities on pain, function, patient satisfaction, quality of life (QoL), and global perceived effect (GPE) in adults with neck pain. Moderate quality evidence suggested mobilization, manipulation and soft tissue techniques decrease pain and improved satisfaction when compared to short wave diathermy, and that this treatment combination paired with advice and exercise produces greater improvements in GPE and satisfaction than advice and exercise alone for acute neck pain. Boyaci et al. (2013) compared the efficacy of three different deep heating modalities: phonophoresis (PH), short-wave diathermy (SWD), and ultrasound (US), in knee osteoarthritis. Patients who consented to participate in the study were randomly divided into the following three groups. Group 1 ($n = 33$) received PH, Group 2 ($n = 33$) received US, and Group 3 ($n = 35$) received SWD. Each of the three physical therapy modalities was applied 5 days a week for 2 weeks (a total of 10 sessions). The results of the study showed that VAS, 15-m walking time, and WOMAC parameters were improved with all three deep heating modalities and all the three modalities were effective. However, there was no significant difference between the three modalities in terms of efficacy. There was also no significant difference between the three groups in terms of post-treatment general evaluation of the physician and the patient. Authors suggest that choosing one of PH/US/SWD therapy options would provide effective results and none of them are superior to the others.

According to the American College of Physician's clinical practice guideline (2017) on noninvasive treatments for acute, subacute, and chronic low back pain, evidence was insufficient to determine the effectiveness of short-wave diathermy and ultrasound. In a Lancet article by Foster et al. (2018), they conclude that passive electrical or physical modalities, such as shortwave diathermy, are generally ineffective and not recommended for the treatment of low back pain.

Wang et al. (2017) evaluated the efficacy and safety of short-wave therapy with sham or no intervention for the management of patients with knee osteoarthritis. Studies included randomized controlled trials compared with a sham or no intervention in patients with knee osteoarthritis. Eight trials (542 patients) met the inclusion criteria. The effect of short-wave therapy on pain was found positive. The pain subgroup showed that patients received pulse modality achieved clinical improvement and the pain scale in female patients decreased. In terms of extensor strength, short-wave therapy was superior to the control group. There was no significant difference in the physical function. For adverse effects, there was no significant difference between the treatment and control group. Authors concluded that short-wave therapy is beneficial for relieving pain caused by knee osteoarthritis (the pulse modality seems superior to the continuous modality), and knee extensor muscle combining with isokinetic strength. Function is not improved. Chou et al. (2018) reports that clinicians should not use short wave diathermy for low back and neck pain, given lack of effectiveness. Babaei-Ghazani et al. (2020) explored the effectiveness of shortwave diathermy on pain, function, and grip strength of patients with chronic lateral epicondylitis. Fifty patients suffering from lateral epicondylitis for more than 3 months, without any systemic diseases or history of other pathologies, were divided into two groups. In both groups, the patients were instructed to perform specific stretching and strengthening exercises. In addition, the patients in the experimental group, received 15 min of 40-60 W, continuous short-wave diathermy while sham diathermy was applied for the control group. The primary outcome measure was pain and the secondary outcome measures were functional ability and pain free grip strength. Outcomes were assessed at the base line, after the 5th and the 10th session of treatment as well as after 3 months. Authors concluded that adding continuous short-wave diathermy to a specific regimen of exercises, reduces pain and improves function in patients suffering from chronic lateral epicondylitis more than sham diathermy and exercise.

Wu et al. (2018) investigate the efficacy and safety of the pulsed electromagnetic field (PEMF) therapy in treating osteoarthritis (OA) in a meta-analysis. Twelve trials were included, among which ten trials involved knee OA, two involved cervical OA and one involved hand OA. The PEMF group showed more significant pain alleviation than the sham group in knee OA and hand OA, but not in cervical OA. Similarly, comparing with the sham-control treatment, significant function improvement was observed in the PEMF group in both knee and hand OA patients, but not in patients with cervical OA. Sensitivity analyses suggested that the exposure duration <=30 min per session exhibited better effects compared with the exposure duration >30 min per session. Three trials reported adverse events, and the combined results showed that there was no significant difference between PEMF and the sham group. Authors concluded that PEMF could alleviate pain and improve physical function for patients with knee and hand OA, but not for patients with cervical OA. Meanwhile, a short PEMF treatment duration (within 30 min) may achieve more favorable efficacy. However, given the limited number of study available in hand and cervical OA, the implication of this conclusion should be cautious for hand and cervical OA.

de Paula Gomes et al. (2020) analyzed the clinical effects of the inclusion of interferential current therapy (ICT), shortwave diathermy therapy (SDT) and photobiomodulation (PHOTO) into an exercise program in patients with knee OA. 100 volunteers aged 40 to 80 years with knee OA were recruited. Participants were allocated into five groups: exercise, exercise + placebo, exercise + ICT, exercise + SDT, and exercise + PHOTO. The outcome measures included WOMAC, numerical rating pain scale (NRPS), pressure pain threshold (PPT), self-perceived fatigue and sit-to-stand test (STST), which were evaluated before and after 24 treatment sessions at a frequency of three sessions per week. Authors concluded that the addition of ICT, SDT or PHOTO into an exercise program for individuals with knee OA is not superior to exercise performed in isolation in terms of clinical benefit. Yang et al. (2020) aimed to examine the effects of PEMF therapy and PEMF parameters on symptoms and quality of life (QOL) in patients with OA. Sixteen studies were included in our systematic review, while 15 studies with complete data were included in the meta-analysis. Authors concluded that compared with placebo, there was a beneficial effect of PEMF therapy on pain, stiffness, and physical function in patients with OA. Duration of treatment may not be a critical factor in pain management. Further studies are required to confirm the effects of PEMF therapy on QOL.

Early osteoarthritis (EOA) still represents a challenge for clinicians. Exercise remains a core treatment for EOA; however, several physical modalities are commonly used in this population. Letizia Maura et al. (2021) investigated the role of physical agents in the treatment of EOA. A technical expert panel (TEP) of 8 medical specialists with expertise in physical agent modalities and musculoskeletal conditions performed the review. Authors found preclinical and clinical data on transcutaneous electrical nerve stimulation (TENS), extracorporeal shockwave therapy (ESWT), low-intensity pulsed ultrasound (LIPUS), pulsed electromagnetic fields stimulation (PEMF), and whole-body vibration (WBV) for the treatment of knee EOA. We found two clinical studies about TENS and PEMF and six preclinical studies-three about ESWT, one about WBV, one about PEMF, and one about LIPUS. The preclinical studies demonstrated several biological effects on EOA of physical modalities, suggesting potential disease-modifying effects. However, this role should be better investigated in further clinical studies, considering the limited data on the use of these interventions for EOA patients. Sun et al. (2021) assessed the effectiveness of pulsed electromagnetic field (PEMF) on pain and physical function in patients with low back pain. Authors included randomized controlled trials that investigated the effectiveness of PEMF in patients with low back pain. The primary outcome was pain intensity, and the secondary outcome was physical function, both were evaluated by assessment scales. Fourteen trials involving 618 participants were included. The PEMF treatment showed more significant pain alleviation than placebo or other therapy alone in patients with low back pain. In addition, a significant difference in pain alleviation was observed in patients with chronic low back pain, whereas no significant difference was observed in patients with acute low back pain. PEMF did not improve physical function compared with the control treatment. Authors concluded that PEMF is beneficial for alleviating pain in patients with chronic low back pain despite having no advantage in improving physical function.

Jia et al. (2022) compared the efficacy and safety of focused low-intensity pulsed ultrasound (FLIPUS) with pulsed shortwave diathermy (PSWD) in subjects with painful knee osteoarthritis (OA). In a prospective randomized trial, 114 knee OA patients were randomly allocated to receive FLIPUS or PSWD therapy. The primary outcome was the change from baseline in the WOMAC total scores. Secondary outcomes included the numerical rating scale (NRS) for pain assessment, time up and go (TUG) test, active joint range of motion (ROM) test, and Global Rating of Change (GRC) scale. Data were collected at baseline, 12 days, 12 weeks, and 24 weeks. Patients receiving FLIPUS therapy experienced significantly greater improvements in the WOMAC total scores than patients receiving PSWD therapy at 12 days. The results of the NRS, TUG test, ROM test and GRC scale showed that participants treated with FLIPUS reported less pain and better physical function and health status than those treated with PSWD at 12 days. Furthermore, patients in the FLIPUS group showed significant improvements in the WOMAC total scores and NRS scores at 12 weeks and 24 weeks of follow-up. There were no adverse events during or after the interventions in either group. This study concluded that both FLIPUS and pulsed SWD are safe modalities, and FLIPUS was more effective than PSWD in alleviating pain and in improving dysfunction and health status among subjects with knee OA in the short term.

Markovic et al. (2022) synthesized the current knowledge on the use of PEMF in OA. Overall, 69 studies were identified. 10 studies were included in the final analysis. All studies focused on knee OA, and 4 studies also reported on cervical, 2 on hand, and 1 on ankle OA. In terms of the level of evidence and bias, most studies were of low or medium quality. Most concurrence was observed for pain reduction, with other endpoints such as stiffness or physical function showing a greater variability in outcomes. Authors concluded that PEMF therapy appears to be effective in the short term to relieve pain and improve function in patients with OA. The existing studies used very heterogeneous treatment schemes, mostly with low sample sizes and suboptimal study designs, from which no sufficient proof of efficacy can be derived.

Tong et al. (2022) aimed to assess the efficacy of PEMF on the major symptoms of patients with OA compared with efficacy of other interventions. Randomized controlled trials (RCTs) investigating OA patients treated with PEMF and with pain, stiffness, and physical function impairment since 2009 were included. The VAS and WOMAC scores were used for assessment. Eleven RCTs consisting of 614 patients were enrolled in this meta-analysis, of which 10 trials comprised knee OA and 1 comprised hand OA. Compared with the control groups, the PEMF treatment yielded a more favorable output. PEMF alleviated pain and restored physical function. Authors concluded that PEMF therapy ameliorates OA symptoms such as pain, stiffness, and physical function in patients compared to other conservative treatments.

Kandemir et al. (2024) evaluated the 3-month effects of pulsed electromagnetic field therapy (PEMF) in the treatment of subacromial impingement syndrome (SIS). Of the 250 individuals screened for eligibility, participants with a diagnosis of SIS (*N*=80) were randomized to intervention or control groups. The first group received PEMF + exercise and the second group received sham PEMF + exercise 5 days a week for a total of 20 sessions. Visual Analog Scale (VAS), Constant Murley Score (CMS), Shoulder Pain and Disability Index (SPADI), Short Form-36 (SF-36) Quality of Life Questionnaire, and shoulder muscle strength measurement with an isokinetic dynamometer. Evaluations were performed before treatment (T0), after treatment (T1), and 12th week (T2). Evaluation at T1 and T2 showed improvement in most parameters in both groups compared with baseline. In the comparison between the 2 groups at T1 and T2, more improvement was found in the PEMF group in most parameters. Authors concluded that based on their study, PEMF was found to be superior to sham PEMF in terms of pain, ROM, functionality, and quality of life at the first and third months.

PRACTITIONER SCOPE AND TRAINING

Practitioners should practice only in the areas in which they are competent based on their education, training, and experience. Levels of education, experience, and proficiency may vary among individual practitioners. It is ethically and legally incumbent on a practitioner to determine where they have the knowledge and skills necessary to perform such services and whether the services are within their scope of practice.

It is best practice for the practitioner to appropriately render services to a member only if they are trained, equally skilled, and adequately competent to deliver a service compared to others trained to perform the same procedure. If the service would be most competently delivered by another health care practitioner who has more skill and training, it would be best practice to refer the member to the more expert practitioner.

Best practice can be defined as a clinical, scientific, or professional technique, method, or process that is typically evidence-based and consensus driven and is recognized by a majority of professionals in a particular field as more effective at delivering a particular outcome than any other practice (Joint Commission International Accreditation Standards for Hospitals, 2020).

Depending on the practitioner's scope of practice, training, and experience, a member's condition and/or symptoms during examination or the course of treatment may indicate the need for referral to another practitioner or even emergency care. In such cases it is prudent for the practitioner to refer the member for appropriate co-management (e.g., to their primary care physician) or if immediate emergency care is warranted, to contact 911 as appropriate. See the *Managing Medical Emergencies (CPG 159 – S)* clinical practice guideline for information.

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