07.01.41 Pulsed Radiofrequency Ablation

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Related Policies:

- 07.01.58 Radiofrequency Ablation and Alternative Ablative Methods for Chronic Facet Joint Mediated Neck, Back and Sacroiliac Joint Pain*
- 07.01.66 Treatments for Occipital Neuralgia, Chronic Headaches and Persistent Idiopathic Facial Pain*
- 07.01.73 Ablative Procedures of the Peripheral Nerves to Treat Pain*

Summary

Description

Pulsed radiofrequency (PRF) ablation is a non-ablative alternative to non-pulsed or continuous radiofrequency ablation (RFA) in the treatment of peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy and many other chronic pain syndromes. The goal of PRF ablation is long-term pain relief, however, the nerves regenerate and repeat procedures may be required.

Summary of Evidence

For individuals with chronic pain syndromes (neuropathic or non-neuropathic) who have receive pulsed radiofrequency (PRF) ablation, the evidence is based on systematic reviews, randomized controlled trials (RCTs), nonrandomized retrospective, and case series and case studies. Relevant outcomes are symptoms, functional outcomes, quality of life (QOL), and medication use. Several systematic reviews have been conducted of evidence on various chronic pain syndromes including postherpetic neuralgia, cervical pain, lumbar pain, cervical and lumbar radicular syndrome (e.g., dorsal root ganglion), pudendal neuralgia, osteoarthritis of the knee, orchialgia, vulvodynia, carpal tunnel syndrome, tarsal tunnel syndrome, post-surgical pain, herpes zoster, scrotal/inguinal pain, cervicogenic and migraine headaches, occipital neuralgia, trigeminal neuralgia, and shoulder pain. While studies may be promising in showing an improvement in pain based on VAS scores and functional scores based on WOMAC outcomes, these studies were limited by their moderate to high heterogeneity, small sample sizes, short follow-up and insufficient safety data. Additional well designed randomized comparative trials with larger sample sizes and longer follow-up are needed to evaluate the efficacy and safety of PRF ablation in individuals with chronic neuropathic and non-neuropathic pain syndromes to include establishing the place of this therapy in the treatment algorithm of these individuals that also identifies the optimal parameters of PRF ablation in clinical practice. The evidence is insufficient to determine the effects of the technology on net health outcomes.

Additional Information

Not applicable

OBJECTIVE

The objective of this evidence review is to determine whether the use of pulsed radiofrequency (PRF) ablation improves the net health outcome in individuals with peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy and many other chronic pain syndromes.

PRIOR APPROVAL

Not applicable.

POLICY

Pulsed radiofrequency (PRF) ablation is considered **investigational** in the treatment of various *chronic* pain syndromes (neuropathic or non-neuropathic) including but not limited to the following, as the evidence is insufficient to determine the effects of the technology on net health outcomes:

- Calcaneal spur/heel spur
- Carpal tunnel syndrome
- Chronic head and facial pain (persistent idiopathic facial pain (PIFP)/atypical facial pain/ sphenopalatine ganglion)
- Coccydynia
- Complex regional pain syndrome/reflex sympathetic dystrophy

- Diabetic peripheral neuropathy
- Discogenic pain
- Facet joint pain cervical, lumbar and thoracic/Zygapophyseal joint pain
- Headaches (including but not limited to the following: chronic headaches; cervicogenic headaches; migraines; cluster headaches; tension headaches)
- Inguinal neuralgia
- Intercostal neuralgia
- Low back pain
- Cervical, thoracic, lumbo-sacral radicular syndrome (e.g., dorsal root ganglion)
- Meralgia paresthetica (burning pain in the outer thigh related to lateral femoral cutaneous nerve entrapment)
- Metacarpal or metatarsal joint pain of the hands and feet
- Morton's neuroma
- Myofascial pain syndrome
- Neck pain (cervical pain)
- Occipital neuralgia
- Ophthalmic neuralgia
- Orchialgia (testicular pain)
- Osteoarthritis of hip/chronic hip pain to include pain management of a previous total hip arthroplasty
- Osteoarthritis of knee/chronic knee pain to include pulsed radiofrequency of genicular nerve for the treatment of chronic knee pain due to osteoarthritis (severe degenerative disease) or previous total knee arthroplasty
- Peripheral neuromas
- Pelvic pain
- Piriformis syndrome (buttock pain and/or pain in the back of the lower extremity related to sciatic nerve irritation)
- Plantar fasciitis
- Post-herpetic neuralgia
- Pudendal neuralgia
- Refractory ventricular arrhythmias
- Sacro-iliac joint pain
- Shoulder pain (suprascapular nerve)
- Tarsal tunnel syndrome (compression neuropathy from entrapment of the posterior tibial nerve)
- Thoracic pain
- Trigeminal neuralgia
- Vulvodynia

POLICY GUIDELINES

Coding

See the Codes table for details.

BACKGROUND

PRF ablation is delivered in short bursts, twice per second, followed by a quiet phase in which no current is applied. This allows for cooling of the electrode keeping it below the neurodestructive threshold of 42°C. Since the average temperature does not reach the neurodestructive range, the risk of destroying nearby tissue is reduced. PRF ablation has been proposed as a possibly safer alternative to non-pulsed or continuous RFA.

Type	Procedure	Tissue Temperature	Key Differences
Standard RFA	Electrode tip provides thermal energy for 90 – 130 seconds	70 – 90° C	Longer term pain relief but with more adjacent thermal tissue injury and limitation in size and shape of lesion.
Pulsed RFA	Non-ablative - provides 20 ms pulses every 30 seconds	42° C	Limits tissue damage but results in shorter duration of pain relief.

RFA: radiofrequency ablation

PRF ablation has been used in the treatment of peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy, and many other chronic pain syndromes.

Regulatory Status

Several radiofrequency generators and probes have been cleared for marketing through the U.S. Food and Drug Administration (FDA) 510(k) process.

RATIONALE

This evidence review was created in May 2008 and has been updated regularly with searches of the PubMed database. The most recent literature update was performed through January 2026.

Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life (QOL), and ability to function-including benefits and harms. Every clinical condition has specific outcomes that are important to individuals and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, 2 domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent 1 or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Pulsed Radiofrequency Ablation

Clinical Context and Therapy Purpose

Pulsed radiofrequency (PRF) ablation has been used in the treatment of peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy and many other chronic pain syndromes to provide a treatment option that is an alternative to or an improvement on existing therapies.

The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is individuals with peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy and other chronic pain syndromes.

Interventions

The therapy being considered is PRF ablation.

Comparators

The following therapy is currently being used to treat peripheral neuropathies, atherogenic pain, painful trigger points, radiculopathy and other chronic pain syndromes: conservative therapy which may include analgesics, physical therapy, intra-articular injections, peripheral nerve blocks with anesthetics or corticosteroid injection.

Outcomes

The general outcomes of interest are symptoms reduction in pain, functional outcomes, QOL, reductions in medication use, and treatment related morbidity.

Study Selection Criteria

We selected methodologically credible studies, using these principles:

- To assess efficacy outcomes, we sought comparative controlled prospective trials, with a preference for RCTs with a minimum of 6 months of outcomes, and systematic reviews of RCTs. It is preferred to have double-blinded sham interventions to control for placebo effects.
- To assess long-term outcomes and adverse effects, we sought single-arm studies with longer periods of follow-up and/or larger populations.
- Within each category of study design, we included studies with larger sample sizes and longer duration.

Review of Evidence

Hayes Health Technology Assessments

Hayes health technology assessment updated June 2025 regarding percutaneous pulsed radiofrequency (PFR) for chronic postherpetic neuralgia that included 2 RCTs (Li 2025 and Lin 2024), continued to find

the overall quality of evidence to be of low-quality. There remains an uncertainty related to PRF treatment protocols, heterogeneity in treatment sites or targeted nerves and comparators, a clinical treatment benefit of any significance and lack of long-term follow-up. Additional comparative studies are warranted to determine which individuals may benefit most from PRF treatment.

Hayes health technology assessment updated June 2025 regarding percutaneous pulsed radiofrequency for chronic cervical spinal pain indications in adults, there were no relevant newly published studies that met inclusion criteria and continued to find the quality of evidence to be of low-quality and a very small number of comparative studies. While studies may have shown some promise regarding an improvement in chronic cervical pain for up to 6 months other effectiveness measures to include disability due to chronic neck pain were not found to be significantly improved compared to baseline follow-up. Additional long-term randomized comparatives studies are needed to determine the effectiveness of PRF to include determining the appropriate patient selection criteria for the treatment of chronic cervical spinal pain.

Hayes health technology assessment updated December 2025 regarding cooled or pulsed radiofrequency for chronic low back pain (CLBP) arising from the sacroiliac joint (SIJ) identified one RCT (Cohen 2025) that provided 12-month follow-up results from the observational phase of randomized, multicenter, comparative-effectiveness crossover study (Cohen 2024) included 210 patients with injection-confirmed SIJ pain who responded to prognostic lateral branch blocks were randomly assigned to receive CRFA of the L5 dorsal ramus and S1-S3/4 lateral branches or standard medical management (SMM) consisting of pharmacotherapy, physical therapy, injections, and integrative therapies. Patients were followed up at 1, 3, 6, 9, and 12 months, with participants reporting unsatisfactory SMM outcomes being allowed to crossover (XO) and receive CRFA at 3 months. The primary outcome measure was the mean change in average LBP score on a 0-10 Numeric Rating Scale (NRS), with secondary outcomes including measures of quality of life (QoL) and function. A responder was defined as a participant who experienced a $\geq$30% or $\geq$2-point decrease in average daily NRS pain score coupled with a score $\geq$5 out of 7 (moderately better) on the Patient Global Impression of Change scale. At 12 months, the mean NRS pain score declined from a baseline of 6.4±1.4 to 3.5±2.6, with 57.4% (35/61) of participants in the randomized CRFA cohort experiencing a $\geq$2-point or 30% decrease in average LBP from baseline. In the crossover cohort, 35/63 (55.6%) subjects had the same experience 12 months following the XO procedure; in the XO group, the mean LBP decreased from 6.1±1.5 to 3.4±2.5. Patients also experienced clinically meaningful improvements in QoL via EuroQoL-5D-5L at 12 months (mean change of +0.22±0.27 in the originally treated CRFA group and +0.21±0.33 in the XO group). Oswestry Disability Index (ODI) scores also improved by 12.4%±14.7 (CRFA) and 13.7%±17.1 (XO) from baseline at study-end. No serious adverse events related to the CRFA procedure were reported. However, per the Hayes assessment there was no change in the evidence and remains very low quality about the effectiveness of PRF in the treatment of CLBP arising from the SIJ. While CRFA may suggest that CRFA is safe and potentially effective for the treatment of CLBP arising from SIJ there remains an uncertainty in the longer term and what effect CRFA has on QOL. There also remains an uncertainty regarding the effectiveness of PRF ablation compared with other treatments for CLBP arising from SIJ. Additional well designed randomized comparative trials with adequate sample sizes are needed to evaluate the efficacy and safety of PRF to establish the place of this therapy in the treatment algorithm for individuals with CLBP.

Hayes health technology assessment updated September 2025 regarding pulsed radiofrequency (PRF) for treatment of chronic shoulder pain there were 2 RCTs published that were identified (Abo Efladl 2024 and Bergamaschi 2024), however, the evidence regarding the use of PRF alone or in combination with other interventions for treatment of chronic shoulder pain may provide pain relief and improvement and function for 3 to 6 months but is based on low quality evidence (only 1 study found that compared interventions). Uncertainty continues to remain regarding PRF treatment protocols, heterogeneity in comparators and patient populations, to include treatment benefit. There is also a lack of long-term follow-

up. Additional randomized comparative trials are needed to determine whether PRF is safe and effective for the treatment of chronic shoulder pain.

Hayes health technology assessment July 2021 regarding pulsed radiofrequency application to the dorsal root ganglion (DRG) for treatment of lumbosacral radicular pain, found the quality of evidence to be of very low quality (3 RCTs; n=28-44 patients) and was insufficient to draw conclusions regarding the application of PRF to DRG for lumbosacral radicular pain that failed to respond to conservative management. Uncertainty remains regarding PRF treatment protocols, and heterogeneity in comparators to include treatment benefit. There is also a lack of long-term follow-up. Additional randomized comparative trials are needed to determine if PRF is safe and effective for the treatment of lumbosacral radicular pain.

Systemic Reviews and Meta-Analyses

Liu et al (2022) performed a systematic review of RFA, pulsed RF, C-RFA, and RF thermocoagulation to either the genicular nerve or intra-articular nerves in patients with knee OA. The authors identified 15 RCTs which met their inclusion criteria. This assessment concluded that all studies had a low risk of bias for random sequence generation, 12 (80%) had a low risk of bias for allocation concealment, 6 (40%) had a low risk of bias for blinding of participants, and personnel as well as blinding of outcome assessment. A low risk of selective reporting was identified in 12 (80%) studies, and all studies were reported as having a low risk of other biases. No overall assessment of study quality was provided. The authors reported a mean pain score difference in favor of the radiofrequency group over the control group at 1 to 2 weeks (-1.72; 95% confidence interval [CI], -2.14 to -1.30), 4 weeks (-1.49; 95% CI, -1.76 to -1.21), 12 weeks (-1.83; 95% CI, -2.39 to -1.26), and 24 weeks (-1.96; 95% CI, -2.89 to -1.04); however, all these estimates had significant heterogeneity ranging from 66% to 97% (p<.00001). A subgroup analysis limiting the site of radiotherapy to the genicular nerve included 5 trials and found a weighted mean difference between RF and control of -1.64 (95% CI, -2.19 to -1.09; p<.001) with a high level of heterogeneity (I^2, 84%; p<.001) at 1 to 2 weeks post-treatment. The mean difference in Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores also favored the radiofrequency group over control groups at 4 weeks (-10.64; 95% CI, -13.11 to -8.17), 12 weeks (-6.12; 95% CI, -7.67 to -4.57), and 24 weeks (-10.89; 95% CI, -12.28 to -9.51). No significant heterogeneity was observed in the 4- and 12-week WOMAC score pooled estimates, but the evidence was limited to being pooled from 4 trials. The rate of adverse events appeared equivalent between groups when observed when pooling data from 13 RCTs (risk difference, 0.03; 95% CI, -0.01 to 0.06; p=.14) with no significant heterogeneity.

Wu et al (2022) conducted a systematic review and network meta-analysis of multiple RFA modalities versus other treatments for osteoarthritis (OA) with a focus on short-term clinical outcomes through 6 months post-treatment. Twenty-one RCTs were identified that were eligible for inclusion. The evidence base consisted of 1818 individuals with a range of 24 to 260 participants across the included RCTs. Outcomes of interest included VAS Pain and WOMAC function scores as well as adverse events. The authors found that C-RFA has better efficacy for pain and function than conventional or pulsed modalities and that conventional RFA outperforms pulsed RFA. Visual analog scale (VAS) pain scores were reported in 16 studies at 3 months follow-up (n=1401). All interventions, with the exception of exercise, had significant improvement compared with placebo. In a ranked surface under the cumulative ranking curve (SUCRA) analysis, monopolar C-RFA of the genicular nerve ranked first in analgesia performance, followed by conventional monopolar RFA of the genicular nerve, intraarticular platelet-rich plasma injection (IAPRP), pulsed monopolar RFA of the genicular nerve, intraarticular anesthesia injection (IAA), intraarticular dextrose injection (IAD), intraarticular sodium hyaluronate injection (IAHA), pulsed monopolar RFA of the saphenous nerve, intraarticular corticosteroid injection, nonsteroidal anti-inflammatory drugs (NSAIDs). At 6 months, 10 trials reported on 1,021 individuals for VAS pain outcomes.

All treatments, save NSAIDs, had a significantly decreased VAS score compared with exercise at 6 months follow-up. A SUCRA analysis showed that the best-performing intervention was conventional bipolar RFA of the genicular nerves (MD, -5.5; 95% CI, -4.3 to -6.7) followed by conventional monopolar RFA of the genicular nerves, pulsed monopolar intraarticular RFA, pulsed monopolar RFA of the genicular nerve, IACS, IAHA, IAPRP, and NSAIDs. WOMAC scores were reported in 14 studies (n=1091) at 3 months and by 9 studies (n=821) at 6 months follow-up. At 3 months, except for exercise, NSAIDs, and pulsed monopolar IPRFA, all treatments had a significant reduction in WOMAC scores compared to placebo. SUCRA analysis suggested the first rank intervention for improved knee performance at 3 months follow-up was cooled monopolar RFA of the genicular nerve followed by conventional bipolar RFA of the genicular nerve, pulsed monopolar intraarticular RFA, conventional monopolar RFA of the genicular nerve, pulsed monopolar intraarticular RFA plus IAPRP, IAA, pulsed monopolar RFA of the genicular nerves, pulsed monopolar IPRFA, IAS, and IAHHA. All interventions had a significant improvement in WOMAC scores at 6 months compared to exercise. SUCRA analysis showed the best performance for cooled monopolar RFA of the genicular nerve followed by conventional bipolar RFA of the genicular nerve, conventional monopolar RFA of the genicular nerve, pulsed monopolar RFA of the genicular nerve, IACS, IAHA, NSAIDs and exercise. The authors also reported that adverse events were recorded in 6 RCTs (n=836) and found 43 (8.3%) in the RFA groups, which were likely attributable to RFA; major adverse events included: pain (n=5), post-procedural pain (n=7), fall (n=5), stiffness (n=1) and swelling (n=2).

A systematic review by Alzahrani et. al (2022) reviewed the literature available through EMBASE, MEDLINE/Pub-Med, Google Scholar, and Cochrane Library from inception to November 2022. Only reports on pulsed radiofrequency (PRF) ablation on male patients for the treatment of chronic scrotal pain (chronic orchialgia) were included. There were 3 case reports, one case series, one prospective uncontrolled pilot study, and one prospective randomized RCT included in the final analysis. PRF was completed after 3-months of failed conservative management. Primary outcome measures were pain intensity using Visual Analog Scale (VAS) scores and serious adverse events (SAEs). Due to heterogeneity of the included studies the authors were unable to conduct a quantitative meta-analysis which they had planned to do as their study protocol. While the studies may have shown promise in short term pain relief there remains an uncertainty related to PRF treatment protocols, heterogeneity in treatment sites or targeted nerves and comparators, a clinical treatment benefit of any significance and lack of long-term follow-up. Additional well-designed randomized comparative studies are warranted to determine the safety and efficacy of PRF ablation for the treatment of chronic scrotal pain (chronic orchialgia).

Vij et al (2022) conducted a systematic review comparing conservative management with minimally invasive and surgical treatment in the management of tarsal tunnel syndrome (TTS). Conservative management included rest, non-steroidal anti-inflammatory drugs (NSAIDs), foot orthoses, physical therapy, stretching exercises and local anesthetics such as corticosteroid injections. Minimally invasive treatments included cryosurgery and pulsed radiofrequency (PRF) ablation. Surgical treatment of TTS is to alleviate the nerve entrapment by decompressing the densely packed neurovascular space of the posterior tarsal tunnel. Regarding the literature search for the minimally invasive treatments there were no randomized controlled trials (RCTs) or cohort studies found regarding the clinical efficacy for PRF in the treatment of TTS. The current evidence is limited to case series which found a reduction in visual analog scale (VAS) scores from 8-9 to 2-3 at 12-month follow-up in one patient and 8 to 2 after two rounds of PRF in a second patient at the 8-month follow-up. The authors stated “Though promising data, this case series is isolated and limited by level of evidence. Large scale cohort studies and clinical trials would be needed before definitive statements regarding the clinical efficacy of minimally invasive treatments in tarsal tunnel syndrome could be made.”

In 2021, Jordan et. al. performed a systematic literature review through December 2019 to identify publications describing the mechanisms of action of pulsed radiofrequency (PRF) in interventional pain

management. A total of 20 publications were included in this updated review. “It was found that PRF ablation impacts many different biological pathways involved in the modulation of chronic neuropathic pain (neuralgia) disorders. This review is primarily limited by the diverse data sets that needed to be collated and correlated, as no study was comprehensive in addressing all markers, cytokines, pathways, neurotransmitters, ion channels, proteins, genes, and gene expression changes, along with their clinical outcomes concurrently. As such the interplay of these individual pathways and mechanisms and their isolated effects on efficacy of PRF cannot be concluded. Not all PRF is the same with different parameters (frequency, pulse width, temperature, time, cannula and active tip size) variably utilized from study to study, it is possible some of the tissue effects and mechanisms of action varied with changes in parameter, not only based on parameters as a whole, but for different sets of parameters in different tissue types (i.e., sympathetic ganglia, peripheral nerves, DRG). The authors concluded “further investigation is warranted to fully understand the direct mechanisms of action of PRF for the treatment of neuropathic pain.”

In 2020, Vuka et.al. completed a systematic review regarding the safety and efficacy of pulsed radiofrequency (PRF) as a method of dorsal root ganglia (DRG) stimulation in patients with neuropathic pain. Twenty-eight studies were included with individuals suffering from lumbosacral, cervical, or thoracic radicular pain, post-herpetic neuralgia, neuropathic bone pain in cancer patients, or carpal tunnel syndrome. Only five studies were randomized controlled trials (RCTs), while others were of nonrandomized designs, predominantly before and after comparisons. A total 991 participants were included in which 204 of these participants were included RCTs. Primary outcomes were pain intensity and adverse events. The authors concluded “the evidence regarding the safety and efficacy of PRF related to the DRG for the treatment of neuropathic pain is based mainly on results from a very small studies with low evidence quality. The currently research results about the benefits of PRF related to the DRG for the treatment of neuropathic pain should be considered preliminary and confirmed through high-quality RCTs with sufficient number of participants.”

In 2020, Vuka et.al completed a systematic review regarding the safety and efficacy of pulsed radiofrequency (PRF) as a method of dorsal root ganglion (DRG) stimulation for treatment of non-neuropathic pain which included individuals with low back pain (LBP), postsurgical pain, pain associated with herpes zoster, cervicogenic headache type 1, intractable vertebral metastatic pain, chronic scrotal and inguinal pain, occipital radiating pain in rheumatoid arthritis and chronic migraine. Seventeen studies with 599 participants were analyzed with these various pain syndromes, in which 2 of the studies were RCTs. The primary outcomes were pain intensity and serious adverse events. Eleven studies had positive conclusive statements (11/17) about efficacy; the remaining had positive inconclusive statements. Only three studies provided conclusiveness of evidence statements regarding safety; two indicated that the evidence was positive conclusive, and one positive inconclusive. The authors concluded “even though PRF of DRG is primarily studied for neuropathic pain, we found as many as 17 published studies that have reported the use of DRG targeted PRF in non-neuropathic pain conditions. The quality of evidence is low, as only two RCTs were among the included studies and risk of bias was unclear in all studies. PRF treatment needs to be tested in new high-quality and large-scale trials to confirm the efficacy of this intervention.”

In 2018, Grandhi et.al. conducted a systematic review evaluating the evidence on radiofrequency ablation (RFA) and pulsed radiofrequency (PRF) ablation in the management of cervicogenic headaches (CHA). Ten publications met inclusion criteria which included CHA previously treated and treatment resistant and occurred without any other pathology of the craniofacial region or event related to trauma, The authors concluded “This systematic review demonstrated that RFA and PRFA provide very limited benefit in the management of CHA. At present, there is no high-quality RCT and/or strong non-RCTs to support the use of these techniques, despite numerous case reports which have demonstrated benefit. This review is one of the first to provide a comprehensive overview of the use of RFA and PRF in the management of CHA.”

Elkhashab et al 2018 completed an evidence review through PubMed and Google Scholar from August 2012 through August 2017 regarding treatment options for coccygodynia. Interventional therapies included pulsed radiofrequency (PRF). Thirteen studies were selected for analysis. This evidence review included a retrospective case series by Gopal et al (2014) that evaluated 20 patients who underwent PRF treatment of ganglion impar after failing conservative therapies. The final outcome was defined as greater than 50% improvement in pain on the Visual Analog Scale (VAS) at 6 and 12-months follow-up. The results found that 15/20 patients (75%) had successful pain relief at 6 and 12-months with mean VAS score reduced from pre-treatment score of 6.53 to 0.93. Five patients remained refractory to PRF with a mean pre-treatment VAS score of 7.4 at 1 month which did not improve at 6 and 12-month follow-up. Review authors concluded that, “The treatment of coccygodynia remains challenging since there are no standard treatment guidelines. Based on our literature review there is limited clinical evidence to support the efficacy of interventions including ganglion impart block, local injections with steroid and local anesthetic, PRF of ganglion impar and caudal epidural block. Further randomized clinical studies are needed.”

In 2017, Vanneste et. al. summarized the literature for pulsed radiofrequency (PRF) ablation for five indications: radicular pain, trigeminal neuralgia (TN), occipital neuralgia (ON), shoulder and knee pain. They found the following: “efficacy and safety of PRF adjacent to dorsal root ganglion was documented on cervical and lumbar levels; PRF has been used in the treatment of TN, the observed duration of effect is shorter than that of conventional radiofrequency and no neurologic complications were reported; PRF of the nevi occipitals is superior to steroid injections in ON; several studies showed PRF of the nervus suprascapularis may relieve shoulder pain and improve mobility of the shoulder joint; and for treatment of knee pain different nerves have been targeted with PRF treatment.” The authors concluded “additional research is needed with high quality randomized controlled trials and identification of optimal parameters of PRF in clinical practice.”

Andres et al (2014) conducted a systematic review through Medline/PubMed (1998-2013), Cochran Library (2001-2013) and conference records and book chapters regarding the minimally invasive treatments for chronic vulvodynia. Two hundred fifteen (215) articles were included in this review. Medical management options included topical anesthetic gels to estrogen creams for perimenopausal women, oral treatment with tricyclic antidepressants (TCAs), anticonvulsants, opioids as an acute treatment for short periods for pain management, pelvic floor muscle floor training/physiotherapy along with biofeedback to achieve rehabilitation of the pelvic floor musculature and psychotherapy. Surgical treatment frequently studied is vestibulectomy. Global treatment improvement is usually measured with changes of more than 50% of clinical picture (24-hour numeric rating scale, frequency of sexual intercourse, numerical pain scale for sexual intercourse, weekly tampon test, Brief Pain Inventory, Short Form McGill Pain Questionnaire [SF-MPQ], Profile of Mood States, and Beck Depression Inventory [BDI]). Based on previously published studies pulsed radiofrequency (PRF) might interfere with normal cell function of the dorsal root ganglion (DRG) and alleviate neuropathic pain. The protocol for vulvodynia patients involves the application of PRF to the S2, S3 and S4 sacral nerves roots. The authors noted “Use of radiofrequency on the ganglion impar has shown to be effective in visceral pain syndromes and/or sympathetic pain syndromes of the perineal region. Placement of a radiofrequency electrode through the sacrococcygeal ligament have been effective in relieving perineal pain when the latter is sympathetically mediated via the ganglion impar.” Most of the published guidelines regarding the treatment of vulvodynia is of low power due to methodological shortcomings (lack of control groups, infrequent use of placebo as comparator, inadequate sample size, and inadequate or non-validated outcome measures). “Further studies are required to evaluate the relationship between electrode placement and stimulation patterns and to determine optimal stimulation parameters.”

Randomized Controlled Trials

Yildiz et al (2024) in a prospective, randomized, single-blind study compared the effectiveness of ultrasound-guided tibial nerve pulsed radiofrequency (US-guided TN PRF) and fluoroscopy-guided intralesional radiofrequency thermocoagulation (FL-guided intralesional RFT) in the treatment of painful calcaneal spur and plantar fasciitis (NCT06240507). The study's primary effectiveness outcome assessment was via the numerical rating scale (NRS) score, and the secondary outcome included changes in the American Orthopedic Foot and Ankle Society (AOFAS) score. Forty-nine patients (n=49) met the inclusion criteria and were randomized into two groups. Group U (n=25) received US-guided TN PRF and Group F (n=24) received FL-guided intralesional RFT. Measurements were taken before the procedure (the most severe NRS score during the patients first steps in the morning and the AOFAS ankle-hindfoot scores) and repeated 1 and 3-months after the treatment for NRS and 3-months after treatment for AOFAS. A $\geq$ 50% reduction in pain score was considered clinically meaningful post treatment response. In Groups U and F, 72% and 75% of patients, respectively, had at least 50% improvement at 1-month, while these rates were 60% and 58% at 3 months. No significant differences were observed between the groups ($P > 0.5$). The AOFAS score over time was statistically significant in both groups (Wilcoxin test; both $P < .001$). Adverse events include in Group U paresthesia was observed in 2 patients and numbness in 1 patients which were brief in duration and did not require treatment. Patients in Group F did not experience paresthesia or numbness. Limitations of this study included short follow-up period of 3-months, insufficient evaluation of effects of interventions on drug consumption and AOFAS subgroups and the study was small and single-blinded which may have increased the risk of bias. It was concluded a larger, double-blind, randomized controlled trial is needed.

An independent study by Elawamy et al (2021) compared pulsed radiofrequency to a single injection of platelet-rich plasma in 200 individuals with OA (NCT03886142). VAS scores showed an improvement of 50% (from a score of 6 to 3) in both groups at 3 months, with values returning to a score of 5 by the sixth month. Scores on the Index of Severity for OA of the Knee were reduced from 7 at baseline to 4 at the third month, increasing to 5 at the sixth month. Twelve-month scores were not reported. Platelet-rich plasma is not considered a standard of care treatment for OA and there were a number of additional limitations in conduct and reporting of this study. Limitations of these studies, which include potential for bias due to lack of blinding of study participants and insufficient number of individuals in follow-up,

Two double-blind sham-controlled randomized trials have assessed RFA for the treatment of chronic heel pain. Wu et al (2017) randomized 36 individuals to ultrasound-guided pulsed radiofrequency of the posterior tibial nerve. First step pain, average pain, and the AOFAS ankle-hindfoot score were assessed at baseline and at 1, 4, 8, and 12 weeks. Changes in VAS score in the sham group were modest (<1 on a 10-point VAS) and of short duration (statistically significant at weeks 1 and 4 but not weeks 8 and 12). The AOFAS ankle-hindfoot score was 60.55 at baseline and 60.05 at 12 weeks in the sham group. In the RFA group, VAS scores at weeks 1, 4, 8, and 12 were all significantly lower than baseline ($p<.001$), and the AOFAS ankle-hindfoot score increased from 55.5 to 87.6 ($p<.001$). The improvements in pain and function were greater in the RFA group than in the control group ($p<.001$ for all measures).

Makharita et al (2015) in a randomized, double-blind controlled trial evaluated the efficacy of pulsed radiofrequency (PRF) in the management of chronic inguinal neuralgia. Twenty-one patients were randomly put into two groups: Group 1 (n=11) received 2 cycles of PRF for each nerve root and Group 2 (n=10): first treatment was sham PRF plus local anesthetic and steroid and second and third treatments were PRF). The Visual Analogue Scale (VAS) was assessed post procedure and repeat PRF was allowed for any patient that reported a VAS score >30 mm in both groups during the one-year follow-up period. The number and duration of blocks to include adverse events were reported. VAS scores between both groups during the one-year follow-up period were comparable at the baseline measurement and at the second week ($P = 0.3, 0.46$, respectively). The VAS scores decreased significantly in Group 1 versus

Group 2 from the fourth week until the fourteenth week (P values were 0.026, 0.008, < 0.0001, < 0.0001, 0.006, and < 0.0001, respectively). VAS scores however, increased significantly in Group 1 versus Group 2 from the sixteenth week until the twenty-fourth week (P < 0.0001), but it was comparable at 7 and 8 months (P values = 0.1, 0.26, respectively). At 9-months for Group 1 VAS scores decreased significantly (P < 0.0001) and for Group 2 VAS scores decreased significantly 10 months and onwards (P values were 0.04, 0.002, and < 0.0001, respectively). No serious adverse events were reported. Limitations of this study included imprecision due to a small sample size. The authors concluded “for intractable chronic inguinal pain, PRF for the DRG represents a promising treatment modality.”

Observational Studies

Li et al (2024) conducted a retrospective cohort study that investigated the efficacy and safety of ultrasound-guided pulsed radiofrequency ablation (US-guided pRFA) targeting the supraorbital nerve for the treatment the ophthalmic branch of postherpetic trigeminal neuralgia who presented at the Department of Pain, Affiliated Hospital of Southwest Medical University from January 2015 to January 2022. Sixty-three patients were included based on inclusion and exclusion criteria and were divided into two groups based on the treatment method used: nerve block (NB) group (n=32) and the PRF + NB group (radiofrequency group, n=31). The visual analog scale (VAS) score, Pittsburgh Sleep Quality Index (PSQI) score, and pregabalin dose were compared between the two groups 1 weeks after the procedure, and 1, 3, and 6-months post-procedure, and the complications, such as local infection, local hematoma, and decreased visual acuity, were monitored post-treatment. The postoperative VAS scores of both PRF and NB groups were lower than the preoperative VAS scores at 1-week, 1-month, 3-months, and 6-months after surgery. The difference between the two groups at postoperative 1, 3, and 6-months was statistically significant (P < 0.01). Observations regarding the PSQI score between the PRF group and the NB group at postoperative intervals of 1-week, 1-month, 3-months, and 6-months were lower than those of the NB group after the surgery indicating the sleep quality in the PRF group was better than that of the NB group (P < 0.05). In regard to the pregabalin dose when compared within the groups There were significant differences in pregabalin dose between the PRF and NB groups at postoperative intervals of 3 and 6 months (P < 0.05). After 6-months of follow-up in the PRF group the overall response rate was 90.32% and the overall response rate for the NB group was 81.25% (P > 0.040 and < 0.05). No local infections, local hematomas or decreased visual acuity were reported in either treatment group. While this study showed promise limitations included retrospective study and small sample size. The authors noted there still needs to be further research regarding effective treatment modalities and methods in the treatment of the supraorbital nerve for the treatment the ophthalmic branch of postherpetic trigeminal neuralgia using US-guided pRFA to include the length of time of the pulse treatment and the amplitude of the voltage.

Rekas-Dudziak et al (2024) conducted a noncomparative retrospective study that analyzed data from medical records from 2017 to 2019 of patients (n=96) with osteoarthritis (OA) of the knee to determine the safety and effectiveness of pulsed radiofrequency ablation (pRFA) to the genicular nerve. In all cases an ultrasound-guided prognostic therapeutic block was applied before the ablative procedure and patients qualified for the pRFA if their diagnostic/prognostic block decreased their pain by 50% according to the numeric rating scale (NRS) for a period of 2-weeks. Pain outcomes were assessed using NRS monthly up to 12-months post ablative procedure and successful pain reduction was defined as 50% reduction in pain. Based on the study outcome the NRS pain was reduced by 50% or more in 64.06% of the cases with an average pain relief period just over 7 and a half months. There were no adverse related complications reported. Study limitations included that it was retrospective and physical function was not assessed in the follow-up period. Also, the history of drugs used including opioids were not taken into consideration which could have influenced the effects of pRFA. The study authors concluded “ future studies may focus on larger groups of patients and pay special attention to prognostic factors captured in scale, enabling patients and clinicians to determine the most effective and safe RFA procedure.”

Wang et al (2024) in a noncomparative prospective study evaluated the efficacy and safety of ultrasound-guided pulsed radiofrequency (US-guided PRF) therapy of stellate ganglion (SG) in the treatment of refractory painful diabetic peripheral neuropathy using the medical records of 56 patients with type 2 diabetes mellitus (T2DM). The patients completed visual analog scale (VAS), simplified McGill pain questionnaire (SF-MPQ), Toronto clinical score system (TCSS), sleep duration at night (SDN), pain disability index (PDI), Karnofsky performance status (KPS), and depression screening scale (PHQ-9). After procedures, the degree of perceived pain relief, numbness relief and chills relief of the patients, and side effects were assessed. All patients underwent evaluation after the last procedure at 1, 4, 12 and 24-week follow-up periods. See Table1 below for outcomes in pain relief, neurological assessment and QOL.

Table 1. Changes in Pain Relief, Neurological Assessment and Quality of Life

Time	VAS	SF-MPQ	TCSS	SDN	KPS	PDI	PHQ-9	GAD-7
Pre-PRF	5.28±1.91	14.88±8.91	10.14±4.59	6.59±1.72	82.07±9.78	16.69±11.47	5.86±5.53	2.72±4.22
1 week post PRF	2.00±1.55*	5.50±5.06*	7.21±4.09*	7.04±1.47*	86.43±8.26*	11.11±9.60*	4.61±4.40*	1.86±3.35
4 weeks post PRF	3.41±2.06*	9.29±6.91*	8.21±4.19*	7.34±2.01*	86.07±7.86*	12.57±9.48*	4.54±4.57*	2.25±3.6
12 weeks post PRF	3.93±2.16*	11.54±8.03*	9.29±4.64*	7.38±1.98*	86.07±7.86*	14.04±9.95*	4.57±4.57*	2.39±3.61
24 weeks post PRF	4.39±2.18*	12.66±8.99*	9.79±4.89	7.36±1.68*	85.36±7.93*	15.68±10.13	4.71±4.29	2.68±3.63
F	30.087	19.040	14.299	3.960	6.993	8.736	3.641	2.935
P	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	0.008	0.065

Notes: All data values are means ± SD;* P < 0.05 compared to pre-operation.
Abbreviations: VAS, visual analog scale; SF-MPQ,simplified McGill score; TCSS, Toronto Clinical Score System; PDI,Pain Disability Index; KPS, Karnofsky score; SDN, sleep duration at night; PHQ-9,Patient Health Questionnaire-9; GAD-7,Generalized Anxiety Disorder Questionnaire-7;op, operation; PRF, pulsed radiofrequency ablation.

Significant and total efficacy rates showed the following: 1-week post-procedure were 67.86% and 89.29%, and as time went on, the significant and total effective rates at 24 weeks post-procedure were 17.86% and 32.14%. These findings suggested that the clinical effect of ultrasound-guided SG PRF therapy was time dependent. Out of the 56 patients, twenty patients reported hoarseness and four had transient upper limb numbness. No serious adverse events were reported. Limitations of this study include lack of a control group, small sample size and short follow-up. Randomized controlled trials are needed to include more objective measures to validate these observations.

Tinnirello et al (2018) conducted a noncomparative retrospective single-center study to evaluate the short- and medium-term (12-month) effectiveness of pulsed radiofrequency (PRF) on the femoral articular branches and obturator nerves in 14 patients with chronic hip pain (duration longer than 6-months) nonresponsive to conservative management. Primary outcomes were pain and physical function reported by numerical rating scale (NRS) and the Oxford Hip Score (OHS) scale as used to assess the extent of disability associated with the hip pain. The PRF was considered a “treatment success” if the patient reported a follow-up NRS score relative to the respective baseline score reduced by ≥ 50% and the OHS

scale 60 “satisfactory joint function.” Patients were contacted at 1, 3, 6 and 12-months after the procedure. Adverse events reported included puncturing vessels, neuritis and significant pain after the procedure. All 14 patients reached the 12-month follow-up. The difference in NRS scores from baseline was statistically significant (P < 0.01) at every follow-up. At 12-months mean NRS score was 5.8 ± 2.4, therefore one- year after the procedure patients still experienced significantly less pain compared to baseline. Treatment successes (i.e., ≥ 50% reduction in NRS score at follow-up) were achieved in the majority (9 out of 14 patients representing 64% of the study population) of patients 1- month after the procedure. Regarding functional status, OHS improved significantly after treatment at 1, 3, and 6-months follow-up. At 12- month follow-up, OHS score was still slightly improved from base line, but this difference did not reach statistical significance (OHS at 12 months 23.3 ± 12.7 P = 0.1). Limitations included retrospective study, small sample size and lack of control group. The authors concluded “further investigation is needed confirm PRF efficacy in a RCT comparing PRF to another conservative treatment such as repeated articular injections as well as to placebo.”

Deniz et al (2015) in a prospective open-label study evaluated the efficacy of pulsed radiofrequency (PRF) in the treatment of Morton’s neuroma. Twenty (n=20) patients (16 women and 4 men) were included whom did not respond to conservative management. Two patients had two-space neuroma, so the total count of neuromas was accepted at 22. Seven of the 22 neuromas (32%) were located at the second intermetatarsal space, 13 of 22 (59%) at the third intermetatarsal space, and 2 of 22 (9%) at the fourth intermetatarsal space. Minimum follow-up was 7 months, with maximum follow-up of 15 months and mean follow-up of 9 months. Initially, pain level (numerical rating scale), successful pain control (a ≥ 50% pain decrease was accepted as successful pain control), comfort when walking (yes or no), and satisfaction level (satisfied or not satisfied) were evaluated. After PRF treatment, 12 patients (60%) achieved successful pain control (_50% decrease in pain); however, the other patients also reported a decrease in pain after PRF, but this decrease was not enough to accept successful pain control. At the initial interview all patients expressed major footwear restriction and pain while walking, but only 4 (20%) continued to experience pain after the intervention. Overall, 12 patients (60%) expressed “excellent satisfaction” with the procedure. Two patients reported complications to include superficial cellulitis and moderate hematoma. Limitations of this study include small sample size which may have not been enough to support PRF in the treatment of Morton’s neuroma and prospective comparative studies are needed to compare the results of surgical procedure(s) and PRF in the treatment of Morton’s neuroma. While this study may show that PRF is a promising treatment for Morton’s neuroma further well designed randomized prospective, placebo-controlled trails with large sample sizes and longer follow-up are needed to determine the clinical value of this treatment for this indication.

Case Series

Collard et al (2019) followed ten patients who underwent computed tomography (CT)-guided pulsed radiofrequency ablation (pRFA) of the pudendal nerve for recalcitrant neuropathic pelvic pain to determine technical feasibility, safety and efficacy of this therapy. The follow-up period was 6-months post procedure. Each patient was treated with pRFA under CT-guidance with concurrent perineural injection of anesthetic and/or corticosteroid. Pain scores were measured utilizing a numeric rating scale at fixed intervals up to 6-months. There were no immediate complications. pRFA demonstrated improved duration of pain improvement compared to the most recent perineural injection (p=0.0195), but not compared to the initial injection (p=0.64). Reported pain scores were lower with pRFA than with both the first and most recent injection, but this did not reach statistical significance (p=0.1094 and p=0.7539, respectively).

Case Study

Pereira et al (2022) evaluated a 67-year-old male with meralgia paresthetica (MP) with ultrasound-guided pulsed radiofrequency (US-guided PRF) of the lateral cutaneous femoral nerve. This individual had complaints of paresthesia in his left thigh worse with sitting or prolonged standing for a five-year duration. Patient had received no prior conservative management, EMG was performed which showed no signs of denervation of the L3 to S1 myotomes, and a lumbar MRI found no significant finding. A presumptive clinical diagnosis of MP was made. A left lateral femoral cutaneous nerve (LFCN) block was performed using 1 cc methylprednisolone 40 mg/ml plus 4 cc of ropivacaine 0.2%, which provided complete relief. At two-month follow-up clinic appointment pain relief continued to be reported, however, at 8-months a relapse occurred but the pain was reported as a lower intensity and frequency than reported at presentation and US-guided PRF was recommended. The patient again relapsed at 8-months and US-guided PRF was repeated. No adverse events were reported with either treatment. Following the second PRF treatment it is noted “the patient remained satisfied with the treatment and the results.” While this case report may show promise the authors concluded “randomized controlled trials regarding short- and long-term efficacy of PRF of MP are necessary.”

Section Summary

The available evidence on the safety and effectiveness of PRF ablation in the treatment of individuals with various chronic pain syndromes (non-neuropathic and neuropathic) includes systematic reviews, RCTs, and nonrandomized retrospective and case series and case studies. Several systematic reviews have been conducted of evidence on various chronic pain syndromes including postherpetic neuralgia, cervical pain, lumbar pain, cervical and lumbar radicular syndrome (e.g. dorsal root ganglion), pudendal neuralgia, osteoarthritis of the knee, orchialgia, vulvodynia, carpal tunnel syndrome, tarsal tunnel syndrome, post-surgical pain, herpes zoster, scrotal/inguinal pain, cervicogenic HA, migraine HA, occipital neuralgia, trigeminal neuralgia, and shoulder pain. While studies may be promising in showing an improvement in pain based on VAS scores and functional scores based on WOMAC outcomes, these studies were limited by their moderate to high heterogeneity, small sample sizes, short follow-up and insufficient safety data. Additional well designed randomized comparative trials with larger sample sizes and longer follow-up are needed to evaluate the efficacy and safety of PRF ablation in individuals with chronic neuropathic and non-neuropathic pain syndromes to include establishing the place of this therapy in the treatment algorithm of these individuals that also identifies the optimal parameters of PRF ablation in clinical practice.

SUPPLEMENTAL INFORMATION

The purpose of the following information is to provide reference material. Inclusion does not imply endorsement or alignment with the evidence review conclusions.

Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in ‘Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American Society of Pain and Neuroscience

In 2021, the American Society of Pain and Neuroscience (ASPN) performed an evidence review regarding the application of radiofrequency neurotomy which included the following regarding pulsed radiofrequency (PRF) ablation:

- "Evidence best supports the use of conventional thermal (60–80 degree centigrade) radiofrequency for 60–90 seconds. While the use of pulsed RF on the cervical medial branches has been reported, further studies are necessary."

"Research and evidence gaps exist for cervical medial branch pulsed radiofrequency (PRF). PRF allows for the application of radiofrequency current at lower temperatures, minimizing the damage to surrounding tissue, nerves and/or vasculature. Further research on PRF is required to determine both the efficacy and the safety of this treatment modality, and how it compares to conventional RF. Although several studies have demonstrated the efficacy of both continuous and pulsed RF within the range of 6 to 12 months, more evidence is clearly needed."

- "Evidence best supports the use of conventional thermal (60–80 degree centigrade) radiofrequency for 60–90 seconds. While the use of pulsed RF on the lumbar medial branches has been reported, further studies are necessary."

"Similar to the cervical region, pulsed radiofrequency (PRF) for the lumbar spine is not covered extensively in the literature. Further research in various forms of RF is needed to determine the efficacy and safety of these treatment modalities. Furthermore, additional research is clearly needed to confirm if a parallel needle placement is indeed the most optimal option, particularly in light of other modalities, such as cooled RF."

"Research and evidence gaps exist for occipital nerve pulsed radiofrequency (PRF). PRF allows for the application of radiofrequency current at lower temperatures, thereby minimizing the damage to surrounding tissue, nerve or vasculature. They may be the preferred technique given the superficial location of the occipital nerves. Further research on PRF is needed to determine the efficacy and safety of this treatment modality, and how it compares to CRF and WCRF. Although several studies have demonstrated the efficacy of both continuous and pulsed RF within the range of 6 weeks to 6 months more evidence is clearly needed.."

Ongoing and Unpublished Clinical Trials

Some currently ongoing and unpublished trials that might influence this review can be located at clinicaltrials.gov.

REFERENCES

1. Cahana A, Van Zundert J, Macrea L et al. Pulsed radiofrequency: current clinical and biological literature available. Pain Med. 2006 Sep-Oct;7(5):411-23.
2. Lindner R, Sluijter ME, Schleinzer W. Pulsed radiofrequency treatment of the lumbar medial branch for facet pain: a retrospective analysis. Pain Med. 2006 Sep-Oct;7(5):435-9.
3. Tekin I, Mirzai H, Ok G et al. A comparison of conventional and pulsed radiofrequency denervation in the treatment of chronic facet joint pain. Clin J Pain. 2007 Jul-Aug;23(6):524-9.
4. Van Zundert J, Patijn J, Kessels A et al. Pulsed radiofrequency adjacent to the cervical dorsal root ganglion in chronic cervical radicular pain: a double-blind sham controlled

randomized trial. Pain. 2007 Jan;127(1-2):173-82. Comment in: Expert Rev Neurother. 2007 May;7(5):471-2. Pain. 2007 Jan;127(1-2):3-4.

5. Boswell MV, Trescot AM, Datta S et al. Interventional techniques: evidence-based practice guidelines in the management of chronic spinal pain. Pain Physician. 2007 Jan;10(1):7-111.

6. Simopolous TT, Kraemer J, Nagda JV et al. Response to pulsed and continuous radiofrequency lesioning of the dorsal root ganglion and segmental nerves in patients with chronic lumbar radicular pain. Pain Physician. 2008 Mar;11(2):137-44.

7. Luleci N, Ozdemir U, Dere K et al. Evaluation of patients' response to pulsed radiofrequency treatment applied to the suprascapular nerve in patients with chronic shoulder pain. J Back Musculoskelet Rehabil. 2011 Jan 1; 24(3):189-94.

8. Van Boxem K, van Bilsen J, de Meij N et al. Pulsed radiofrequency treatment adjacent to the lumbar dorsal root ganglion for the management of lumbosacral radicular syndrome: a clinical audit. Pain Med. 2011 Aug 3. doi:10.1111/j.1526-4637.2011.01202. x. [Epub ahead of print].

9. Nagda JV, Davis CW, Bajwa ZH et al. Retrospective review of the efficacy and safety of repeated pulsed and continuous radiofrequency lesioning of the dorsal root ganglion/segmental nerve for lumbar radicular pain. Pain Physician. 2011 Jul-Aug; 14(4):371-6.

10. Todorov L. Pulsed radiofrequency of the sural nerve for the treatment of chronic ankle pain. Pain Physician. 2011 May-Jun; 14(3):301-4.

11. Korkmaz OK, Capaci K, Eyigor C et al. Pulsed radiofrequency versus conventional transcutaneous electrical nerve stimulation in painful shoulder: a prospective, randomized study. Clin Rehabil. 2010 Nov; 24(11):1000-8. Epub 2010 Aug 4.

12. Taverner MG, Ward TL, Loughnan TE. Transcutaneous pulsed radiofrequency treatment in patients with painful knee awaiting total knee joint replacement. Clin J Pain. 2010 Jun;26(5):429-32.

13. Eyigor C, Eyigor S, Korkmaz OK et al. Intra-articular corticosteroid injections versus pulsed radiofrequency in painful shoulder: a prospective, randomized, single-blinded study. Clin J Pain. 2010 Jun;26(5):386-92.

14. Vanelderen P, Rouwette T, De Vooght P et al. Pulsed radiofrequency for the treatment of occipital neuralgia: a prospective study with 6 months of follow-up. Reg Anesth Pain Med. 2010 Mar-Apr; 35(2):148-51.

15. Hansen H, Manchikanti L, Simopoulos TT et al. A systematic evaluation of the therapeutic effectiveness of sacroiliac joint interventions. Pain Physician. 2012 May-Jun; 15(3): E247-78.

16. Gofeld M, Restrepo-Garces CE, Theodore BR et al. Pulsed radiofrequency of suprascapular nerve for chronic shoulder pain: a randomized double-blind active placebo-controlled study. Pain Pract. 2012 May 4. doi: 10.1111/j.1533-2500.2012.00560. x. [Epub ahead of print]

17. Guo L, Kubat NJ, Nelson TR et al. Meta-analysis of clinical efficacy of pulsed radiofrequency energy treatment. Ann Surg. 2012 Mar; 255(3):457-67.

18. Conner-Kerr T, Isenberg RA. Retrospective analysis of pulsed radiofrequency energy therapy use in the treatment of chronic pressure ulcers. Adv Skin Wound Care. 2012 Jun;25(6):253-60.

19. Choi GS, Ahn SH, Cho YW et al. Short-term effects of pulsed radiofrequency on chronic refractory cervical radicular pain. Ann Rehabil Med. 2011 Dec;35(6):826-32. Epub 2011 Dec 30.

20. Fukui S, Rohof O. Results of pulsed radiofrequency technique with two laterally placed electrodes in the annulus in patients with chronic lumbar discogenic pain. J Anesth. 2012 Aug;26(4):606-9. Epub 2012 Apr 5.

21. Nagda JV, Davis CW, Bajwa ZH et al. Retrospective review of the efficacy and safety of repeated pulsed and continuous radiofrequency lesioning of the dorsal root ganglion/segmental nerve for lumbar radicular pain. Pain Physician. 2011 Jul-Aug;14(4):371-6.

22. Werner MU, Bischoff JM, Rathmell JP et al. Pulsed radiofrequency in the treatment of persistent pain after inguinal herniotomy: a systematic review. Reg Anesth Pain Med. 2012 May-Jun;37(3):340-3.

23. Zhang J, Shi DS, Wang R. Pulsed radiofrequency of the second cervical ganglion (C2) for the treatment of cervicogenic headache. J Headache Pain. 2011 Oct;12(5):569-71. Epub 2011 May 25.

24. Manchikanti L, Abdi S et al. An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain. Part II. Pain Physician 2013 Apr; 16: S49-283.

25. American Society of Anesthesiologists. Practice Guidelines for Chronic Pain Management: An Updated Report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine. Anesthesiology April 2010; 112: 1-1.

26. National Institute of Health. NIH Public Access. Pulsed Radiofrequency for Chronic Pain, David Byrd M.D., MPH and Sean Mackey, M.D., PhD. January 2008; 12(1):37-41.

27. Medscape. Radiofrequency Therapies in Chronic Pain. https;//www.medscape.com

28. Practical Pain Management. Use of Pulsed Radiofrequency in Clinical Practice. Available also at: http://www.practicalpainmanagment.com

29. Journal of Pain Research: Treatment of Trigeminal Neuralgia: Role of Radiofrequency Ablation. J Pain Res. 2010; 3:249-254. Published online December 12, 2010, doi:10.2147/JPRS14455

30. 3D-CT Guided Pulsed Radiofrequency Treatment for Trigeminal Neuralgia. Pain Practice.2014 Jan; 14(1):16-21. doi: 10.1111/papr.12041. Epub2013 Feb 21

31. Matthew David VanderHoek, Hieu T. Hoang, Brandon Goff, Ultrasound Guided Greater Occipital Nerve Blocks and Pulsed Radiofrequency Ablation for Diagnosis and Treatment of Occipital Neuralgia. Anesthesiology and Pain Medicine. 2013 September; 3(2):256-9

32. American Society of Interventional Pain Physicians (ASIPP). An Update of Comprehensive Evidence Based Guidelines for Interventional Techniques in Chronic Spinal Pain. Part II: Guidance and Recommendations. Pain Physicians 2013; 16: S49-S283 ISSN 1533-3159

33. American Pain Society. Guideline for Evaluation and Management of Low Back Pain, Evidence Review 2009

34. American Academy of Pain Medicine. Pulsed Radiofrequency Lesioning of Pudendal Nerve in Patient with Chronic Pain: A Case Report 2012

35. Pain Medicine News. Evidence Based Review of Radiofrequency Ablation Techniques for Chronic Sacroiliac Joint Pain

36. Pain Medicine News Special Edition December 2013, Pulsed Radiofrequency in Treatment of Peripheral Neuralgias

37. Nicholas Manolitsis, M.D., Foad Elahi, M.D., Pulsed Radiofrequency for Occipital Neuralgia, Pain Physician 2014; 17:E709-E717. Also available at www.painphysicianjournal.com

38. Slavin Konstantin, Nersesyan Hrachya et. al. Current Algorithm for the Surgical Treatment of Facial Pain, Head and Face Medicine July 2007

39. American Society of Anesthesiologists and American Society of Regional Anesthesia and Pain Medicine, Practice Guideline for Chronic Pain Management, Anesthesiology 2010 Vol 112. No 4

40. Medscape. Radiofrequency Treatment in Chronic Pain, Expert Rev Neurother 2010;10(3):469-474. Also available at https://www.medscape.com

41. Akbas Mert, Gunduz Emel, et.al. Sphenopalatine Ganglion Pulsed Radiofrequency Treatment in Patients Suffering from Chronic Face and Head Pain, April 2014, also available at http://dx.doi.org/10.1016/j.bjane .2014.06.001

42. Cohen S, Peterlin LB, Fulton L, et. al. Randomized, double-blind, comparative-effectiveness study comparing pulsed radiofrequency to steroid injections for occipital neuralgia or migraine with occipital nerve tenderness. Pain 2015 December; 156(12):2585-2594

43. Taverner MG, Ward TL, Loughnan TE. Transcutaneous pulsed radiofrequency treatment in patients with painful knee awaiting total knee joint replacement. Clin J Pain. 2010;26(5):429-432

44. Chua NH, Vissers KS, Sluijter ME. Pulsed radiofrequency treatment in interventional pain management: mechanisms and potential indications – a review. Acta Neurochir (Wien). 2011 Apr 153(4):763-71

45. Zakrzewska JM. Akram H. Neurosurgical interventions for the treatment of classical trigeminal neuralgia. Cochrane Database Syst Rev 2011 Sep 7(9): CD007312. PMID 21901707

46. Taverner MG, Loughnan TE, Soon CW. Transcutaneous application of pulse radiofrequency treatment for shoulder pain. Pain Pract 2013 Apr 13(4):310-5

47. Nagar VR, Birthi P, Grider JS, Asopa A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headache. Pain Physician 2015 Mar-Apr 18(2):109-30. PMID 25794199

48. van Boxem K, van Bilsen J, de Meij N, et. al. Pulsed radiofrequency treatment adjacent to the lumbar dorsal root ganglion for the management of lumbosacral radicular syndrome: A clinical audit. Pain Medicine 2011;12: 1322-1330

49. Shanthanna H, Chan P, McChesney J, et. al. Pulsed radiofrequency treatment of the lumbar dorsal root ganglion in patients with chronic lumbar radicular pain: a randomized, placebo-controlled pilot study. Journal of Pain Research 2014:7 47-55

50. Manolitsis N, Elahi F. Pulsed Radiofrequency for Occipital Neuralgia. Focused Review. Pain Physician 2014; 17: E709-E717

51. Ke M, Yinghui F, Yi J, et. al. Efficacy of pulsed radiofrequency in the treatment of thoracic postherpatic neuralgia from the angulus costae: A randomized double blinded, controlled trial. Pain Physician 2013; 16:15-25

52. Schianchi P, Sluijter M, Balogh S. The treatment of joint pain with intra-articular pulsed radiofrequency. Anesthesiology and Pain Medicine 2013 September;3(2):250-5

53. Guo J, Dong X, Zhao X. Treatment of trigeminal neuralgia by radiofrequency of the Gasserian ganglion. Rev Neurosci 2016 Oct 1:27(7):739-743. PMID 27383870

54. Hayase J, Vampola S, Ahadian F. et. la. Comparative efficacy of stellate ganglion block with bupivacaine vs pulsed radiofrequency in a patient with refractory ventricular arrhythmias. J Clin Anesth Jun 31;162-5. PMID 27185701

55. Bhatia A, Peng P, Cohen SP. Radiofrequency procedures to relieve chronic knee pain: An evidence based narrative review. Reg Anesth Pain Med 2016 Jul-Aug;41(4):501-10. PMID 27281721

56. Deniz S, Purtuloglu T, Tekindur S, et. al. Ultrasound guided pulsed radiofrequency treatment in Morton's neuroma. J Am Podiatr Med Assoc 2015 Jul;105(4):302-6. PMID 25945935

57. Makharita MY, Amr YM. Pulsed radiofrequency for chronic inguinal neuralgia. Pain Physician 2015 Mar-Apr;18(2): E147-55. PMID 25794213

58. Nagar VR, Birthi P, Grider JS, et. al. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headache. Pain Physician 2015 Mar-Apr;18(2):109-30. PMID 25794199

59. Kesikburun S, Yasar E, Uran A, et. al. Ultrasound guided genicular nerve pulsed radiofrequency treatment for painful knee osteoarthritis: A preliminary report. Pain Physician 2016;19: E751-E759.

60. Naderi-Nabi B, Sedighinejad A, Haghighi M, et. al. Comparison of transcutaneous electrical nerve stimulation and pulsed radiofrequency sympathectomy for treating painful diabetic neuropathy. Anesth Pain Med 2015 October; 5(5): e29280

61. Schianchi P. A new technique to treat facet joint pain with pulsed radiofrequency. Anesth Pain Med 2015 February; 5(1): e21061

62. Akbas M, Gunduz E, Sanli S, et. al. Sphenopalatine ganglion pulsed radiofrequency treatment in patients suffering from chronic face and head pain. Bras Anesthesiol vol. 66 no. 1 Campinas Jan/Feb 2016

63. Chua NH, Vissers KC, Sluijter ME. Pulsed radiofrequency treatment in interventional pain management: Mechanisms and potential indications-a review. Acta Neurochir (Wien). 2011;153(4):763-771. PMID 21116663

64. Choi HJ, Oh IH, Choi SK, Lim YJ. Clinical outcomes of pulsed radiofrequency neuromodulation for the treatment of occipital neuralgia. J Korean Neurosurg Soc. 2012;51(5):281-285. PMID 22792425

65. Bui C, Pangarkar S, Zeitlin SI. Relief of urinary urgency, hesitancy, and male pelvic pain with pulse radiofrequency ablation of the pudendal nerve: A case presentation. Case Rep Urol. 2013; 2013:125703. PMID 23607041

66. Fang L, Ying S, Tao W, et al. 3D CT-guided pulsed radiofrequency treatment for trigeminal neuralgia. Pain Pract. 2014;14(1):16-21. PMID 23433058

67. Kestranek J, Spacek J, Ryska P, et al. Radiofrequency therapy for severe idiopathic vulvodynia. J Low Genit Tract Dis. 2013;17(4): e1-e4. PMID 23903198

68. Terkawi AS, Romdhane K. Ultrasound-guided pulsed radiofrequency ablation of the genital branch of the genitofemoral nerve for treatment of intractable orchialgia. Saudi J Anaesth. 2014;8(2):294-298. PMID 24843352

69. Thapa D, Ahuja V. Combination of diagnostic medial calcaneal nerve block followed by pulsed radiofrequency for plantar fasciitis pain: A new modality. Indian J Anaesth. 2014;58(2):183-185. PMID 24963184

70. Park HG, Park PG, Kim WJ, et al. Ultrasound-assisted mental nerve block and pulsed radiofrequency treatment for intractable postherpetic neuralgia: Three case studies. Korean J Pain. 2014;27(1):81-85. PMID 24478907

71. Eyigor C, Eyigor S, Akdeniz S, Uyar M. Effects of intra-articular application of pulsed radiofrequency on pain, functioning and quality of life in patients with advanced knee osteoarthritis. J Back Musculoskelet Rehabil. 2015;28(1):129-134. PMID 25061031

72. Chon JY, Hahn YJ, Sung CH, et al. Pulsed radiofrequency under ultrasound guidance for the tarsal tunnel syndrome: Two case reports. J Anesth. 2014;28(6):924-927. PMID 24728720

73. Ding DF, Li RC, Xiong QJ, et al. Pulsed radiofrequency to the great occipital nerve for the treatment of intractable postherpetic itch: A case report. Int J Clin Exp Med. 2014;7(10):3497-3500. PMID 25419389

74. Akbas M, Gunduz E, Sanli S, Yegin A. Sphenopalatine ganglion pulsed radiofrequency treatment in patients suffering from chronic face and head pain. Rev Bras Anestesiol. 2016;66(1):50-54. PMID 26768930

75. Gulati A, Shah R, Puttanniah V, et al. A retrospective review and treatment paradigm of interventional therapies for patients suffering from intractable thoracic chest wall pain in the oncologic population. Pain Med. 2015;16(4):802-810. PMID 25236160

76. De Andres J, Sanchis-Lopez N, Asensio-Samper JM, et al. Vulvodynia -- An evidence-based literature review and proposed treatment algorithm. Pain Pract. 2016;16(2):204-236. PMID 25581081

77. Guo J, Dong X, Zhao X. Treatment of trigeminal neuralgia by radiofrequency of the Gasserian ganglion. Rev Neurosci. 2016;27(7):739-743. PMID 27383870

78. Osman AM, El-Hammady DH, Kotb MM. Pulsed compared to thermal radiofrequency to the medial calcaneal nerve for management of chronic refractory plantar fasciitis: A prospective comparative study. Pain Physician. 2016;19(8): E1181-E1187. PMID 27906949

79. Bhatjiwale MG, Bhatjiwale MM, Bhagat A. Ultra-extended euthermic pulsed radiofrequency for the treatment of ophthalmic neuralgia: A case report with elaboration of a new technique. Surg Neurol Int. 2016;7(Suppl 35): S818-S823. PMID 27990312

80. Lee JJ, Sohn JH, Choi HJ, et al. Clinical efficacy of pulsed radiofrequency neuromodulation for intractable meralgia paresthetica. Pain Physician. 2016;19(3):173-179. PMID 27008291

81. Gupta A, Huettner DP, Dukewich M. Comparative effectiveness review of cooled Versus pulsed radiofrequency ablation for the treatment of knee osteoarthritis: A systematic review. Pain Physician. 2017;20(3):155-171. PMID 28339430

82. Weiss AL, Ehrhardt KP, Tolba R. Atypical facial pain: A comprehensive, evidence-based review. Curr Pain Headache Rep. 2017;21(2):8. PMID 28251523

83. Cho IT, Cho YW, Kwak SG, Chang MC. Comparison between ultrasound-guided interfascial pulsed radiofrequency and ultrasound-guided interfascial block with local anesthetic in myofascial pain syndrome of trapezius muscle. Medicine (Baltimore). 2017;96(5): e6019. PMID 28151904

84. Apiliogullari S, Gezer IA, Levendoglu F. Transient sensory recovery in stroke patients after pulsed radiofrequency electrical stimulation on dorsal root ganglia: A case series. Neurologist. 2017;22(1):18-20. PMID 28009767

85. Facchini G, Spinnato P, Guglielmi G, et al. A comprehensive review of pulsed radiofrequency in the treatment of pain associated with different spinal conditions. Br J Radiol. 2017;90(1073):20150406. PMID 28186832

86. Basal S, Ergin A, Yildirim I, et. al. A novel treatment of chronic orchialgia. J Androl. 2012;33(1):22-26

87. Chen Y, Huang-Lionnet JHY, Cohen SP. Radiofrequency ablation in coccydynia: A case series and comprehensive, evidence-based review. Pain Med 2017;18(6):1111-1130

88. Gofeld M, Restrepo-Garces CE, Theodore BR et. al. Pulsed radiofrequency of suprascapular nerve for chronic shoulder pain: a randomized double-blind active placebo-controlled study. Pain Pract. 2012 May 4

89. Park SM, Cho YW, Ahn SH, et. al. Comparison of the effects of ultrasound-guided interfascial pulsed radiofrequency and ultrasound-guided interfascial injection on myofacial pain syndrome of the gastrocnemius. Ann Rehabil Med 2016;40(5):885-892

90. Grandhi RK, Kaye AD, Abd-Elsayed A et. al. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. Curr Pain Headache Rep. 2018;22(3):18. PMID: 29476360

91. Hetta DF, Mahran AM, Kamal EE et. al. Pulsed radiofrequency treatment for chronic post-surgical orchialgia: A double-blind, sham controlled,randomized trial: Three-month results. Pain Physician. 2018;21(2):199-205. PMID: 29565950

92. Picelli A, Lobba D, Vendramin P, et al. A retrospective case series of ultrasound-guided suprascapular nerve pulsed radiofrequency treatment for hemiplegic shoulder pain in patients with chronic stroke. J Pain Res. 2018;11: 1115- 1120. PMID 29942146

93. Grandhi RK, Kaye AD, Abd-Elsayed A et. al. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. Curr Pain Headache Rep. 2018;22(3):18. PMID: 29476360

94. Hetta DF, Mahran AM, Kamal EE et. al. Pulsed radiofrequency treatment for chronic post-surgical orchialgia: A double-blind, sham controlled,randomized trial: Three-month results. Pain Physician. 2018;21(2):199-205. PMID: 29565950

95. Picelli A, Lobba D, Vendramin P, et al. A retrospective case series of ultrasound-guided suprascapular nerve pulsed radiofrequency treatment for hemiplegic shoulder pain in patients with chronic stroke. J Pain Res. 2018;11: 1115- 1120. PMID 29942146

96. Contreras Lopez WO, Navarro PA, Vargas MD, et al. Pulsed radiofrequency versus continuous radiofrequency for facet joint low back pain: A systematic review. World Neurosurg. 2019; 122:390-396. PMID: 30404055

97. Erdem Y, Sir E. The efficacy of ultrasound-guided pulsed radiofrequency of genicular nerves in the treatment of chronic knee pain due to severe degenerative disease or previous total knee arthroplasty. Med Sci Monit. 2019; 25:1857-1863.PMID: 30858350

98. Jia Y, Pan Y, Ren H, et al. Effectiveness and safety of high-voltage pulsed radiofrequency to treat patients with primary trigeminal neuralgia: A multicenter, randomized, double-blind, controlled study protocol. Pain Physician. 2018 ;21(5):469-481. PMID: 30282391

99. Li X, Zhang L, Gu S, et al. Comparative effectiveness of extracorporeal shock wave, ultrasound, low-level laser therapy, noninvasive interactive neurostimulation, and pulsed radiofrequency treatment for treating plantar fasciitis: A systematic review and network meta-analysis. Medicine (Baltimore). 2018;97(43): e12819. PMID: 30412072

100. Abd-Elsayed A, Anis A, Kaye AD. Radiofrequency ablation and pulsed radiofrequency for treating peripheral neuralgias. Curr Pain Headache Rep. 2018a;22(1):5.

101. Abd-Elsayed A, Jackson M, Plovanich E. Pulsed radiofrequency ablation for treating sural neuralgia. Ochsner J. 2018b;18(1):88-90.

102. Abdelrahman KA, Ibrahim AS, Osman Am, et al. Alpha lipoic acid with pulsed radiofrequency in treatment of chronic lumbosacral radicular pain: A prospective, randomized study. Medicine (Baltimore). 2021;100(24): e26344

103. Akural E, Jarvimäki V, Korhonen R, et al. Pulsed radiofrequency in peripheral posttraumatic neuropathic pain: A double blind sham controlled randomized clinical trial. Scand J Pain. 2017;3(3):127-131.

104. Apiliogullari S, Gezer IA, Levendoglu F. Transient sensory recovery in stroke patients after pulsed radiofrequency electrical stimulation on dorsal root ganglia: A case series. Neurologist. 2017;22(1):18-20.

105. Bharti N, Chattopadhyay S, Singla N, et al. Pulsed radiofrequency ablation for the treatment of glossopharyngeal neuralgia secondary to oropharyngeal carcinoma. Pain Physician. 2018;21(3):295-302.

106. Carvalho JC, Agualusa LM, Moreira LM, Costa JC. Multimodal therapeutic approach of vaginismus: An innovative approach through trigger point infiltration and pulsed radiofrequency of the pudendal nerve. Rev Bras Anestesiol. 2017;67(6):632-636.

107. Chang MC. Efficacy of pulsed radiofrequency stimulation in patients with peripheral neuropathic pain: A narrative review. Pain Physician. 2018;21(3): E225-E234.

108. Chen Y, Huang-Lionnet JHY, Cohen SP. Radiofrequency ablation in coccydynia: A case series and comprehensive, evidence-based review. Pain Med. 2017;18(6):1111-1130.

109. Cho IT, Cho YW, Kwak SG, Chang MC. Comparison between ultrasound-guided interfascial pulsed radiofrequency and ultrasound-guided interfascial block with local anesthetic in myofascial pain syndrome of trapezius muscle. Medicine (Baltimore). 2017;96(5): e6019

110. Chung Y-H, Lee J-H, Koo B-S, et al. Ultrasound-guided pulsed radiofrequency treatment for distal suprascapular neuropathy. A case report. Medicine (Baltimore). 2020;99(39): e22469.

111. Contreras Lopez WO, Navarro PA, Vargas MD, et al. Pulsed radiofrequency versus continuous radiofrequency for facet joint low back pain: A systematic review. World Neurosurg. 2019;122:390-396.

112. Cristiani F, Hernandez MA. Suprascapular nerve pulsed radiofrequency for chronic shoulder pain in a pediatric patient. Case Rep Anesthesiol. 2020;2020:5709421.

113. Dey S. Comparing neuromodulation modalities involving the suprascapular nerve in chronic refractory shoulder pain: Retrospective case series and literature review. Clin Shoulder Elb. 2021;24(1):36-41.

114. Ding Y, Li H, Yao P, et al. Clinical observation of CT-guided intra-articular conventional radiofrequency and pulsed radiofrequency in the treatment of chronic sacroiliac joint pain. J Pain Res. 2018;11:2359-2366.

115. Erdem Y, Sir E. The efficacy of ultrasound-guided pulsed radiofrequency of genicular nerves in the treatment of chronic knee pain due to severe degenerative disease or previous total knee arthroplasty. Med Sci Monit. 2019;25:1857-1863.

116. Ergonenc T, Beyaz SG. Effects of ultrasound-guided suprascapular nerve pulsed radiofrequency on chronic shoulder pain. Med Ultrason. 2018;20(4):461-466.

117. Esparza-Minana JM, Mazzinari G. Adaptation of an ultrasound-guided technique for pulsed radiofrequency on axillary and suprascapular nerves in the treatment of shoulder pain. Pain Med. 2019;20(8):1547-1550.

118. Facchini G, Spinnato P, Guglielmi G, et al. A comprehensive review of pulsed radiofrequency in the treatment of pain associated with different spinal conditions. Br J Radiol. 2017;90(1073):20150406.

119. Fadayomi O, Kendall MC, Nader A. Ultrasound-guided pulsed radiofrequency of C2 dorsal root ganglion as adjuvant treatment for chronic headache disorders: A case report. A A Pract. 2019;12(11):396-398.

120. Fam BN, El-Sayed GGE, Reyad RM, Mansour I. Efficacy and safety of pulsed radiofrequency and steroid injection for intercostobrachial neuralgia in postmastectomy pain syndrome - A clinical trial. Saudi J Anaesth. 2018;12(2):227-234.

121. Frank CE, Flaxman T, Goddard Y, et al. The use of pulsed radiofrequency for the treatment of pudendal neuralgia: A case series. J Obstet Gynaecol Can. 2019;41(11):1558-1563.

122. Grandhi RK, Kaye AD, Abd-Elsayed A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. Curr Pain Headache Rep. 2018;22(3):18.

123. Gupta A, Huettner DP, Dukewich M. Comparative effectiveness review of cooled Versus pulsed radiofrequency ablation for the treatment of knee osteoarthritis: A systematic review. Pain Physician. 2017;20(3):155-171.

124. Hetta DF, Mohamed SAB, Mohamed KH, et al. Pulsed radiofrequency on thoracic dorsal root ganglion versus thoracic paravertebral nerve for chronic postmastectomy pain, a randomized trial: 6-month results. Pain Physician. 2020;23(1):23-35.

125. Ho TY, Ke MJ, Chen LC, Wu YT. Efficacy of ultrasound-guided pulsed radiofrequency for recalcitrant metatarsalgia. A case report. J Am Podiatr Med Assoc. 2018;108(6):532-534.

126. Hong T, Wang H, Li G, et al. Systematic review and meta-analysis of 12 randomized controlled trials evaluating the efficacy of invasive radiofrequency treatment for knee pain and function. Biomed Res Int. 2019;2019:9037510.

127. Jia Y, Chen Z, Ren H, Luo F. The effectiveness and safety of 42°C pulsed radiofrequency combined with 60°C continuous radiofrequency for refractory infraorbital neuralgia: A prospective study. Pain Physician. 2019;22(3): E171-E179.

128. Jia Y, Pan Y, Ren H, et al. Effectiveness and safety of high-voltage pulsed radiofrequency to treat patients with primary trigeminal neuralgia: A multicenter, randomized, double-blind, controlled study protocol. Pain Physician. 2018 ;21(5):469-481.

129. Lee DG, Chang MC. The effect of caudal epidural pulsed radiofrequency stimulation in patients with refractory chronic idiopathic axonal polyneuropathy. Pain Physician. 2018;21(1):E57-E62.

130. Lee H-J, Cho HH, Nahm FS, et al. Pulsed radiofrequency ablation of the C2 dorsal root ganglion using a posterior approach for treating cervicogenic headache: A retrospective chart review. Headache. 2020a;60(10):2463-2472.

131. Lee SH, Choi HH, Roh EY, Chang MC. Effectiveness of ultrasound-guided pulsed radiofrequency treatment in patients with refractory chronic cervical radicular pain. Pain Physician. 2020b;23(3):E265-E272.

132. Li J, Ren H, Wang B, et al. Multicentre, prospective, randomised, controlled, blinded-endpoint study to evaluate the efficacy and safety of pterygopalatine ganglion pulsed radiofrequency treatment for cluster headache: Study protocol. BMJ Open. 2019;9(3): e026608.

133. Li J, Yin Y, Ye L, Zuo Y. Pulsed radiofrequency of C2 dorsal root ganglion under ultrasound-guidance and CT confirmed for chronic headache: Follow-up of 20 cases and literature review. J Pain Res. 2020;13:87-94.

134. Li S-Q, Jiang L, Cui L-G, Jia D-L. Clinical efficacy of ultrasound-guided pulsed radiofrequency combined with ganglion impar block for treatment of perineal pain. World J Clin Cases. 2021;9(9):2153-2159.

135. Li X, Zhang L, Gu S, et al. Comparative effectiveness of extracorporeal shock wave, ultrasound, low-level laser therapy, noninvasive interactive neurostimulation, and pulsed radiofrequency treatment for treating plantar fasciitis: A systematic review and network meta-analysis. Medicine (Baltimore). 2018;97(43): e12819.

136. Liao W, He X, Du Z, Long Y. The synergistic effects of applying pulsed radiofrequency lesioning of the suprascapular nerve plus physical therapy on pain and function in patients with adhesive capsulitis: A protocol of a prospective, randomized, controlled trial. Medicine (Baltimore). 2021;100(14): e25431.

137. Luo F, Lu J, Ji N. Treatment of refractory idiopathic supraorbital neuralgia using percutaneous pulsed radiofrequency. Pain Pract. 2018;18(7):871-878.

138. Park J, Lee YJ, Kim ED. Clinical effects of pulsed radiofrequency to the thoracic sympathetic ganglion versus the cervical sympathetic chain in patients with upper-extremity complex regional pain syndrome: A retrospective analysis. Medicine (Baltimore). 2019;98(5): e14282.

139. Park MS, Choi HJ, Yang JS, et al. Clinical efficacy of pulsed radiofrequency treatment targeting the mid-cervical medial branches for intractable cervicogenic headache. Clin J Pain. 2021;37(3):206-210.

140. Picelli A, Lobba D, Vendramin P, et al. A retrospective case series of ultrasound-guided suprascapular nerve pulsed radiofrequency treatment for hemiplegic shoulder pain in patients with chronic stroke. J Pain Res. 2018; 11:1115-1120.

141. Pushparaj H, Hoydonckx Y, Mittal N, et al. A systematic review and meta-analysis of radiofrequency procedures on innervation to the shoulder joint for relieving chronic pain. Eur J Pain. 2021;25(5):986-1011.

142. Ren H, Zhao C, Wang X, et al. The efficacy and safety of the application of pulsed radiofrequency, combined with low-temperature continuous radiofrequency, to the Gasserian ganglion for the treatment of primary trigeminal neuralgia: Study protocol for a prospective, open-label, parallel randomized controlled study. Pain Physician. 2021;24(1):89-97.

143. Vuka I, Dosenovic S, Marcius T, et al. Efficacy and safety of pulsed radiofrequency as a method of dorsal root ganglia stimulation for treatment of non-neuropathic pain: A systematic review. BMC Anesthesiol. 2020a;20(1):105.

144. Vuka I, Marcius T, Dosenovic S, et al. Efficacy and safety of pulsed radiofrequency as a method of dorsal root ganglia stimulation in patients with neuropathic pain: A systematic review. Pain Med. 2020b;21(12):3320-3343

145. Wei T, Hou H, Zhou L-L, Mu Q-X. Effect of ultrasound-guided pulsed radiofrequency on intercostal neuralgia after lung cancer surgery: A retrospective study. Medicine (Baltimore). 2021;100(19): e25338.

146. Weiss AL, Ehrhardt KP, Tolba R. Atypical facial pain: A comprehensive, evidence-based review. Curr Pain Headache Rep. 2017;21(2):8.

147. Wu C-Y, Lin H-C, Chen S-F, et al. Efficacy of pulsed radiofrequency in herpetic neuralgia: A meta-analysis of randomized controlled trials. Clin J Pain. 2020;36(11):887-895.

148. Yan J, Zhang XM. A randomized controlled trial of ultrasound-guided pulsed radiofrequency for patients with frozen shoulder. Medicine (Baltimore). 2019;98(1): e13917.

149. Yang S, Chang MC. Effect of bipolar pulsed radiofrequency on chronic cervical radicular pain refractory to monopolar pulsed radiofrequency. Ann Palliat Med. 2020;9(2):169-174

150. Zheng B, Song L, Liu H. Pulsed radiofrequency of brachial plexus under ultrasound guidance for refractory stump pain: A case report. J Pain Res. 2017;10:2601-2604

151. Wu YT, Chang CY, Chou YC, et al. Ultrasound-Guided Pulsed Radiofrequency Stimulation of Posterior Tibial Nerve: A Potential Novel Intervention for Recalcitrant Plantar Fasciitis. Arch Phys Med Rehabil. May 2017; 98(5): 964-970. PMID 28209507

152. Jordan S, Catapano M, Sahni S, et. al. Pulsed radiofrequency in interventional pain management: Cellular and molecular mechanisms of action – an update and review. Pain Physician 2021 Dec;24(8):525-532. PMID 3473641

153. Vuka I, Marcius, T, Dosenovic S, et.al., Efficacy and safety of pulsed radiofrequency as a methods of dorsal ganglia stimulation in patients with neuropathic pain: a systemic review. Pain Med 2020 Dec 25;21(12):3320-3343. PMID 32488240

154. Grandhi RK, Kaye AD, Abd-Elsayed A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. Curr Pain Headache Rep. 2018 Feb 23;22(3):18. PMID 29476360

155. Vuka I, Marcius, T, Dosenovic S, et.al., Efficacy and safety of pulsed radiofrequency as a method of dorsal root ganglia stimulation for treatment of non-neuropathic pain: a systematic review. BMC Anesthesiology 2020 May 4;20(1):105. PMID 32366286

156. Liu J, Wang T, Zhu ZH. Efficacy and safety of radiofrequency treatment for improving knee pain and function in knee osteoarthritis: a meta-analysis of randomized controlled trials. J Orthop Surg Res. Jan 15 2022; 17(1): 21. PMID 35033150

157. Wu L, Li Y, Si H, et al. Radiofrequency Ablation in Cooled Monopolar or Conventional Bipolar Modality Yields More Beneficial Short-Term Clinical Outcomes Versus Other

Treatments for Knee Osteoarthritis: A Systematic Review and Network Meta-Analysis of Randomized Controlled Trials. Arthroscopy. Jul 2022; 38(7): 2287-2302. PMID 35157969

158. Wu BP, Grits D, Foorsov V, et al. Cooled and traditional thermal radiofrequency ablation of genicular nerves in patients with chronic knee pain: a comparative outcomes analysis. Reg Anesth Pain Med. Aug 03 2022. PMID 35922077

159. Hayes, a symplr company. Health Technology Assessment. Pulsed Radiofrequency Application to the Dorsal Root Ganglion for Treatment of Cervical Radicular Pain. Annual Review June 15, 2021/Annual Review January 25, 2023

160. Hayes, a symplr company. Health Technology Assessment. Percutaneous Pulsed Radiofrequency for Chronic Cervical Spinal Pain Indication. May 5, 2023/Annual Review June 13, 2025

161. Hayes, a symplr company. Health Technology Assessment. Pulsed Radiofrequency Application to the Dorsal Root Ganglion for Treatment of Lumbosacral Radicular Pain. May 16, 2019/Annual Review July 2021

162. Hayes, a symplr company. Percutaneous Pulsed Radiofrequency for Chronic Postherpetic Neuralgia. Health Technology Assessment. May 5, 2023/ Annual Review July 12, 2025

163. Hayes, a symplr company. Pulsed Radiofrequency for Treatment of Chronic Shoulder Pain. September 30, 2022/Annual Review September 16, 2025

164. Hayes, a symplr company. Health Technology Assessment. Cooled or Pulsed Radiofrequency for Chronic Low Back Pain Arising from the Sacroiliac Joint. December 20, 2022/Annual Review December 15, 2025

165. Hayes, a symplr company. Evidence Analysis Research Brief. Pulsed Radiofrequency Application to the Dorsal Root Ganglion for the Treatment of Lumbosacral Radicular Pain. January 25, 2023

166. Hayes, a symplr company. Evolving Evidence Review. Pulsed Radiofrequency for the Treatment of Pudendal Neuralgia. November 18, 2024/Annual Review November 15, 2025

167. Alzahrani M, Safar O, Almurayyi M, et. al. Pulsed radiofrequency ablation for orchialgia – A literature review. Diagnostics (Basel). 2022 Nov 27;12(12):2965. PMID 36552972

168. Dudziak-Rekas A, Brzezinski K, Kotlinska-Hasiec E, et al A retrospective assessment of the effectiveness of pulsed radiofrequency ablation in the treatment of chronic pain caused by advanced knee osteoarthritis. Anaesthesiol Intensive Ter 2024;56,2:151-159. PMID 39166507

169. Lee D, Pritzlaff S, Jung M, et. al. Latest evidence-based application for radiofrequency neurotomy (LEARN): Best Practice Guidelines from the American Society of Pain and Neuroscience (ASPN). J Pain Res 2021 Sep 8:14:2807-2831. PMID 34526815

170. De Andres J, Sanchis-Lopez N, Asensio-Samper J, et. al. Vulvodynia an evidence based literature review and proposed treatment algorithm. Pain Pract 2016 Feb;16(2):204-36. PMID 25581081

171. Kestranek J, Spacek J, Ryska P, et. al. Radiofrequency therapy for severe idiopathic vulvodynia. J Low Genit Tract Dis. 2013 Oct;17(4):e1-4. PMID 23903198

172. Wang S, Wang H, Wang H et. al. Comprehensive comparison of therapeutic efficacy of radiofrequency thermocoagulation and pulsed radiofrequency in treatment of elderly patients with thoracic postherpetic neuralgia. Med Sci Monit. 2023 Dec 11:29:e942108. PMID 38073138

173. Vij N, Kaley H, Robinson C, et. al. Clinical results following conservative management of tarsal tunnel syndrome compared with surgical treatment: A system review. Orthop Rev (Pavia). 2022 Sep 5;14(3):37539. PMID 36072502

174. Yildiz G, Perdecioglu G, Yuruk G, et. al. Comparison of tibial nerve pulsed radiofrequency and intralesional radiofrequency thermocoagulation in the treatment of painful calcaneal spur and plantar fasciitis: a randomized controlled trial. Pain Med 2024 Aug 1;25(8):493-499. PMID 38652568

175. Collard MD, Xi Y, Patel A, et. al. Initial experience of CT-guided pulsed radiofrequency ablation of the pudendal nerve for chronic recalcitrant pelvic pain. Clin Radiol 2019 Nov;74(11):897.e17-897.e23. PMID 31447049

176. Tinnirello A, Todeschini M, Pezzola D, et. al. Pulsed radiofrequency application on femoral and obturator nerves for hip joint pain: retrospective analysis with 12-month follow-up results. Pain Physician. 2018 Jul;21(4):407-414. PMID 30045597

177. Li F, Gong G, Zhang Y et. al. Efficacy and safety of ultrasound-guided pulsed-radiofrequency in the treatment of the ophthalmic branch of postherpetic trigeminal neuralgia. Front Neurol 2024 May 28:15:1398696. PMID 38863510

178. Deniz S, Purtuloglu T, Tekindur S, et. al. Ultrasound-guided pulsed radiofrequency treatment in Morton's neuroma. J Am Podiatr Med Assoc. 2015 Jul;105(4):302-6. PMID 25945935

179. Pereira MC and Carvalho JL. Ultrasound-guided pulsed radiofrequency treatment for meralgia paresthetica. Cureus 2022 Feb 8;14(2):e22015. PMID 35282534

180. Uang S and Chang MC. Efficacy of pulsed radiofrequency in controlling pain caused by spinal disorders: a narrative review. Ann Palliat Med. 2020 Sep:9(5):3528-356. PMID 32921088

181. Nabi B, Sedighinejad A, Haghighi M, et. al. Comparison of transcutaneous electrical nerve stimulation and pulsed radiofrequency sympathectomy for treating painful diabetic neuropathy. Anesth Pain Med 20215 Oct 10;5(5):e29280. PMID 26587405

182. Wang J, Xu W, Wang Q, et. al. Efficacy and safety of ultrasound-guided pulsed radiofrequency therapy of stellate ganglion on refractory painful diabetic peripheral neuropathy. J Pain Res. 2024 Dec 25:17:4521-4531. PMID 39737247

183. Chen Y, Huang-Lionnet J, Cohen S. Radiofrequency ablation in coccydynia: A case series and comprehensive, evidence based review. Pain Med. 2017 Jun 1;18(6):1111-1130. PMID 28034983

184. Orhurhu V, Khan F, Quispe R, et. al. Use of radiofrequency ablation for the management of facial pain: A systematic review. Pain physician 2020 Nov;23(6):E559-E580. PMID 33185371

185. Lefel N, van Suijekom H, Cohen S, et. al. Cervicogenic headache and occipital neuralgia. Pain Practice 2025 Jan;25(1):e13405. PMID 39219023

186. Gupta S, Ghai B, Makkar J et al Effectiveness of ultrasound-guided pulsed radiofrequency ablation of suprascapular nerve versus local anaesthetics with steroids in patients with chronic shoulder pain: A randomized controlled trial. Indian J Anaesth. 2024 Aug;68(8):731-734. PMID 39176114

187. Saotjahoj B, Adriansyah D, Yudistira M, et. al. The analgesic effectiveness of genicular nerve-targeted cooled and pulsed radiofrequency ablation for osteoarthritis knee pain: a

systematic review and meta-analysis. Pain Physician 2024 Sep:27(7):357-373. PMID 39353105

188. Rekas-Dudziak A, Brzezinski K, Kotlinska-Hasiec E, et. al. A retrospective assessment of the effectiveness of pulsed radiofrequency ablation in the treatment of chronic pain caused by advanced knee osteoarthritis. Anaesthesiol Intensive Ther. 2024;56(2):151-159. PMID 39166507

189. Alzahrani M, Safar O, Almuravyi M, et. al. Pulsed radiofrequency ablation for orchialgia a literature review. Diagnostics 2022 Nov 27;12(12):2965. PMID 365529972

190. UpToDate. Postherpetic neuralgia. Topic last updated September 2025. Also available at https://www.uptodate.com

191. UpToDate. PostMastectomy pain syndrome: Risk reduction and management. Topic last updated November 27, 2024. Also available at https://www.uptodate.com

192. UpToDate. Interventional therapies for chronic pain. Topic last updated September 2025. Also available at https://www.uptodate.com

193. UpToDate. Short-lasting unilateral neuralgiform headache attacks: Treatment and prognosis. Topic last updated August 2024. Topic last updated August 2024. Also available at https://www.uptodate.com

194. UpToDate. Meralgia paresthetica (lateral femoral cutaneous nerve entrapment) Topic last updated May 2024. Also available at https://www.uptodate.com

195. UpToDate. Trigeminal neuralgia. Topic last updated May 2025. Also available at https://www.uptodate.com

196. UpToDate. Central neuropathic facial pain. Topic last updated January 2024. Also available at https://www.uptodate.com

197. UpToDate. Cervicogenic headache. Topic last updated September 2025. Also available at https://www.uptodate.com

198. UpToDate. Subacute and chronic low back pain: Nonsurgical interventional treatment. Topic last updated. April 2025. Also available at https://www.uptodate.com

CODES

To report provider services, use appropriate CPT codes, HCPCS codes, Revenue codes, and/or ICD diagnosis codes.

Codes	Number	Description
CPT		
	64999	Unlisted procedure, nervous system *(The American Medical Association's CPT Editorial Panel decided in June 2005 that the unlisted CPT code 64999 should be used for pulsed radiofrequency treatment as opposed to other specific codes)*

Codes	Number	Description
HCPCS		
	None	
Type of Service	Surgery	
Place of Service	Outpatient/Inpatient	

POLICY HISTORY

Date	Action	Action
January 2026	Annual Review	Policy Renewed
January 2025	Annual Review	Policy Revised
March 2024	Annual Review	Policy Renewed
March 2023	Annual Review	Policy Revised
March 2022	Annual Review	Policy Revised
March 2021	Annual Review	Policy Revised
March 2020	Annual Review	Policy Revised
March 2019	Annual Review	Policy Revised
March 2018	Annual Review	Policy Revised
March 2017	Annual Review	Policy Revised
March 2016	Annual Review	Policy Revised
October 2015	Interim Review	Policy Revised
April 2015	Annual Review	Policy Renewed
May 2014	Annual Review	Policy Revised
August 2013	Annual Review	Policy Revised
September 2012	Annual Review	Policy Revised
September 2011	Annual Review	Policy Revised

New information or technology that would be relevant for Wellmark to consider when this policy is next reviewed may be submitted to:

Wellmark Blue Cross and Blue Shield
Medical Policy Analyst
PO Box 9232
Des Moines, IA 50306-9232

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