Electromagnetic Fields and Osteoarthritis 2025

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Abstract

This mini review examines the potential efficacy of applying electromagnetic field therapy for purposes of reducing osteoarthritis pain and other related disease features such as frailty, muscle sarcopenia, obesity, bone loss and fragility, and cartilage derangements and degradation in the older adult. Based on selected English language literature published largely on PUBMED between January 2000 and October 2025, papers describing the impact and potential synthetic and disease modifying impact of electromagnetic stimuli are explored. These data reveal a high degree of promise in fostering joint tissue reparative efficacy trends post electromagnetic stimulation. Its usage may allay the extent of the disease and its degree of disablement, while facilitating function.

Introduction

Osteoarthritis, a prevalent disabling and highly complex multi factorial joint disease and one implicating varying degrees of focal joint structural and functional pathologies that predominantly affects the hyaline cartilage tissue lining of the knee, hip, hand, spine, and shoulder joints in the older population is an increasingly challenging prevalent global health concern with few means of its successful abatement. Not only is the disease often found to affect the whole joint but its extensive spectrum of biomechanical as well as biological and neuromotor underpinnings are often overlooked or are poorly integrated. As a result, it is no surprise that the condition is currently shown to be largely progressive, and one accompanied by increasing degrees of disability that arise from the presence of perpetual adverse synovial membrane reactions, soft tissue alterations and impingements, muscle weakness and imbalances, active and passive movement limitations, capsular-tendon tears or dysfunction, joint instability, proprioception deficits, and possible limb geometry alignment abnormalities. Additional functional challenges or deficits include emergent degrees of cartilage associated biology as well as mechanically derived early bone mass pathology and changes, stiffness, and increases in bone micro fractures, muscle fat mass increases, atrophy and pathology, pain, spasm, swelling and contractures. Commonly diminished as well is muscle endurance, ligament support, as well as deficits in timely and well modulated reflexes that protect the joint from impacts. This differs from intrinsic and mechanical supportive responses that normally respond optimally and adaptively with a modest energy cost to varying degrees of internal joint loading, joint contacts, compressive forces, and strains. As time progresses, however, the combined effect of these subnormal forces can foster an additional host of adverse local neural and central reactive responses, immense degrees of psychological distress, as well as an incalculable societal burden [1].

Unfortunately, despite years of study and some progress, the pathogenesis of osteoarthritis remains obscure, its treatment or prevention is often based on belief or tradition rather than on science alone and its potential for repair is commonly challenged. The desire for non pharmacologic approaches although strong is generally not one yielding limiting short term disease modifying effects to date. Moreover, a role for the possible benefits of electromagnetic stimulation as a secondary or tertiary preventive approach is not well accepted despite its sound theoretical basis that stems from physics and multiple bone interaction observations of its stimulatory and reparative potential. Additionally, even though promising, few well controlled longitudinal stand alone studies prevail in this regard, and among those that do a host of osteoarthritis insights including the salience of its multiple biological, neural, motor, metabolic, and biomechanical determinants and manifestations are rarely acknowledged, addressed or assessed in parallel with accepted definitive reproducible outcome measures. Indeed these joint attritional correlate changes that can occur in tandem as well as in isolation on occasion may if overlooked yet convey damaging pressures to the underlying bone and cartilage and accordingly impede even the most optimal research design and set of plans to advance tangible efforts to mitigate the condition. In addition, unaccounted for may be favourable responses that are not captured by uni dimensional semi-objective approaches measured sporadically or by suboptimal electromagnetic stimulus parameter applications.

As such, and being applied without a sound rationale for parameter selection as well as too late in the disease process, this promising modality has found limited usage as standard osteoarthritis mitigation and reparative treatment approaches to date. This may be because the applications are easy to apply and can be done at home and are not profitable as a whole, or because treatment efficacy is commonly masked due to poor osteoarthritis sample selection and stratification and a non holistic approach perspective, a lack of study power, reliance on observational data, an absence of biochemically sound markers, and assumptions of optimal and consistent treatment adherence and dosages. Moreover, pain phenotypes that are neuropathic and medications to quell pain if employed as a co intervention may increase rather than slow its rate of progression if joint pain is masked [1, 2].

By contrast, if apprehended in a timely insightful way, osteoarthritis treatments that address a wide array of interacting possible painful joint functional determinants and varied degrees of progressive reactionary joint derangements and catabolic inflammatory alterations along with educational efforts to limit joint impacts may yet prove beneficial, even if not curative [2].

In this regard, one modality constituted by low-frequency/energy pulsed electromagnetic fields or PEMF applied as a single or pulse burst quasi-rectangular or triangular waveform has been increasingly found to have some promise in this respect [3-6], especially in the case of early or inflammatory osteoarthritis [5, 9]. In addition to inhibiting key inflammatory pathways [3], PEMF-treated osteoarthritis has been found to yield a preserved joint structure [7] and the ability to accelerate or reinitiate healing of wounds including those pertaining to joint tissues and muscle [10, 11], as well as having a bearing on safely mitigating pain [12]. It has been identified as fostering bone fracture healing and regeneration, as well as cartilage chondrocyte proliferation and regeneration, plus the mitigation of joint and bone marrow swelling, and possible 'healing' or regeneration of ligaments and tendons [2, 11].

Review Aims

The key aim of this updated data synthesis on PEMF as applied to osteoarthritis disability was to gain current insights regarding novel or promising pulsed electromagnetic field effects that can be harnessed to reduce suffering among many older adults:

It was believed findings regarding the use of pulsed electromagnetic fields for the treatment of painful osteoarthritis in general, and specifically from the viewpoint of its interaction with cartilage, bone, and muscle plus tendons would be found to have influence joint structural integrity, and possible osteoarthritis determinants such as frailty and obesity, plus physical and cognitive function. It was further believed that the extent of its clinical potential and possible underlying mechanisms of action and their cellular and probable tissue impacts would be diverse and of clinical relevance among older adult with diverse degrees of joint damage and co occurring health conditions, and especially where surgery is often contraindicated.

The discussion focuses solely on selected recent study results and those that have some future potential rather than all available data.

Rationale

It is increasingly evident many current osteoarthritis treatments fail to produce consistently definitive efficacious clinical results, a finding that is in stark contrast to the many laboratory based research efforts. For example, on the topic of PEMF where its application yields largely favorable results no matter what joint or mode of osteoarthritis simulation is studied like results fail to materialize in the clinical realm to the same degree. This may reflect species and early stage osteoarthritis disease model differences that do not simulate or parallel the human chronic form of the disease at all accurately or realistically. Moreover, efficacious dosages in simulation studies may be hard to extrapolate to the human situation. PEMF applications found to foster laboratory based joint tissue healing indications may also fail to occur in vivo if the underlying causes of osteoarthritis remain and no effort towards essential joint protection strategies are followed assiduously. Similar to the usage of narcotics and other medications plus invasive injections to quell pain, unwanted impact loading may exacerbate joint attrition.

However, if applied insightfully, low frequency pulsed electromagnetic fields have been shown to trigger a variety of favorable verifiable biological responses via specific membranous and intracellular signaling pathways that can impact cartilage and bone cell functions, synovial membrane physiology, muscle structure and function, nerve pathways, and a host of reparative metabolic and reconstructive mobility associated attributes [7-14]. These biological signals can also be applied as a form of supportive anti inflammatory therapy post arthroscopic knee or total knee joint replacement procedures, with the expectation of excellent and beneficial structural results compared to conventional treatments that fail to use this form of supportive therapy [11,14-16] it essentially remains only 'promising' rather than necessary intervention for speeding up and solidifying osteoarthritis pain relief, especially given that unlike other mainstream options the signals can possibly stop the disease progression or maximize joint tissue regenerative and function by ameliorating osteoarthritis determinants such as sarcopenia, frailty, depression, and obesity [15, 17-22]. Its application may also help avert the onset or progression of disabling osteoporosis or loss of bone mass and attenuate bone thickening and deformation that can occur in osteoarthritis, along with the emergence of neuropathic-like pain and its central sensitization, a risk factor for poor postoperative clinical outcomes [23, 24]. In addition its mechanism of action may foster exercise induced metabolic and functional adaptations [25], inflammation may be reduced; and bone and ligament health may improve. In addition, joint shock absorption and the processes of cartilage metabolism may improve, muscle, and tendon regeneration may be forthcoming [21, 26-30] as may related health promoting muscle mitochondrial bioenergetics [26]. Measureable improvements and their otherwise possible unrelenting impacts on an array of debilitating cognitive symptoms such as depression may also emerge [28-30].

Consequently, even though largely ignored in the current osteoarthritis mitigation realm in favor of medication or invasive therapies we believe persistent efforts to examine this topic applied alone or as a complementary or adjunctive intervention modality could yet provide insights into how to curtail considerable osteoarthritis mediated suffering and low health status in later life.

Research Question

Are efforts towards applying pulsed electromagnetic fields worthy of the time and costs entailed in the context of offsetting osteoarthritis in later life? [30].

Methods and Procedures

After studying this topic for many years, we presently elected to garner some current information on this issue as posted on **PUBMED**, **PubMed Central,** and **GOOGLE SCHOLAR** websites housing reliable medical literature sources. Key words used were: *Articular Cartilage, Bone, Frailty, Muscle, Obesity, Older Adults, Sarcopenia, Osteoarthritis*; *Pulsed Electromagnetic Fields, Repair* All forms of study were accepted, but no systematic analysis or synthesis of either the preclinical or the clinical literature was attempted-given its diversity and a clearly limited number of uniformly oriented studies. A focus was placed largely on selecting and reviewing current 2025 articles where pulsed electromagnetic fields are studied in isolation rather than as an adjunct form of therapy. Discussed in narrative form, an attempt was made to identify outcomes of as well as mechanistic explanations for PEMF stimuli in various contexts. Protocols for future study, studies of other forms of arthritis, conference proceedings, trans-cranial applications, direct current, and invasive studies, combination therapy studies, nutritional and taping/bracing and stem cell studies were excluded as were many early citation s covered in the reference sections of references 31-33. It was assumed most studies reviewed here were acceptable to experts in the field who had reviewed them, but may not have included all negative findings or suboptimal research reports. However, with over 50 years of related inquiry, it was assumed a general picture of the state of the art would be attained with relative confidence when assessed very carefully and across multiple perspectives and substrates. Readers interested in clinical and past analyses and observations and future possibilities may want to examine references [11, 31-33].

In the interim, while yet unproven, we accepted that it is possible a pulsed electromagnetic field current can induce one or more biological tissue impacts relevant to osteoarthritis mitigation such as cartilage chondrogenic differentiation effects [32, 33], muscle energy expenditure during constant-load exercises along with muscular activation [34] as well as anti inflammatory effects [35].

Results

Several past studies show the osteoarthritis joint topic presently studied is one that persists with some degree of intensity, but on the basis of little reliable epidemiological data, data forecasting ability, and lack of clarity as to what treatments are needed to alleviate the costs of late life osteoarthritis. In the pharmacologic and non-surgical realm no disease modifying remedy is consistently documented. In those realms that are promising, such as PEMF, less than desirable numbers of high quality clinically oriented PEMF studies prevail. Increasingly, common among adults older than 65 years of age, this is surprising as PEMF bone repair effects are well known and osteoarthritis primarily implicates bone as well as the thin covering tissue at the surface of bones located of one or more freely moving joints, termed cartilage, and where pain is the predominant resultant outcome and disabler.

However, based on what has been observed among frail older adults who partook in a program of PEMF exposure, this modality appears to foster significant improvements in mobility, body composition including increased skeletal muscle mass, while reducing total and visceral fat mass, particularly in the older participants. Perception of pain may also be significantly reduced.

These above improvement including basic clinical findings in which healthy individuals aged 20 years, subjected to 4 weeks of chronic PEMF exposure raised their ability to produce maximum voluntary contractile forces of the irradiated muscle. As well, a contralateral effect was observed and muscle thickness, cross-sectional area, pennation, and stiffness of the intervention muscle increased significantly [26]. This study while not definitive, clearly provides a supportive basis for the potential improvement of muscle histopathology using this technique. It may also serve as an exercise replacement strategy of high value in the author's view. By contrast, even if offering relief, neither drugs nor surgery are generally found to yield muscle or joint tissue regenerative or reparative solutions and outcomes to our knowledge and their long term impacts remain in question.

Indeed since the early 1970s when several researchers began to examine pulsed electromagnetic fields and their interactions with cartilage and bone cells, this topic has continued to be of interest and very informative in the context of its basic potential to mitigate the hallmark of osteoarthritis pathology, namely articular cartilage degeneration and thinning and fragmentation. Most, albeit not all, do in fact continue to largely lend support to using or studying this mode of physical energy as a form of osteoarthritis therapy in this regard, regardless of methods of inquiry that includes an array of cell culture assays, animal models of osteoarthritis, animals with naturally occurring or age associated osteoarthritis, stem cell substrates and cartilage and bone explants [32, 33]. Its anti inflammatory, bone and muscle morphology, cartilage histology, muscle activation, and contractile effects may especially help slow the rate of osteoarthritis progression [25, 34].

In addition to having direct chondrogenic effects, Zhou et al. [35] report pulsed electromagnetic field therapy applied to artificially deranged joints appears to inhibit the expression of pro-inflammatory factors that can otherwise induce or hasten cartilage matrix degradation [16]. Furthermore, their pre clinical study showed pulsed electromagnetic field-treated osteoarthritis induced mice demonstrated post stimulation joint structural enhancements and a preserved joint structure. As such, it appears joint motion and stability and the ability to withstand joint impacts may improve substantively post stimulation [36] as may muscle healing post PEMF and stretching exercise when combined [37] as well as muscle healing rates where applicable, and the prevention of fibrosis and inflammatory-induced muscle pain [38].

Along with its pain relieving potential, pulsed electromagnetic field applications may thus enable more desirable osteoarthritis outcomes than not thus averting excess bouts of chronic daily stress as well as distress and degrees of suffering. At the very least it appears this is not a placebo impact but one where pulsed electromagnetic field applications may play a key role in countering the potentially devastating impact of osteoarthritis generated by cascades of degrading joint enzymes, and with this fostering more favorable repair processes in the joint as a whole as well as in specific tissues [35]. These possible benefits include, but are not limited to: probable improvements in tendon morphology [38, 39], improvements in systemic metabolism in post-surgical PEMF-usage, the risk of developing adhesions or tendon ruptures, function and a reduced degree of osteoarthritis progression [40, 41]. Importantly, PEMF stimulation appears to significantly attenuate the structural and functional progression of osteoarthritis commonly found to emerge over time, along with the magnitude of verifiable cartilage chondrocyte death processes and stimulation of protective responses via reductions in post surgical immobilization time an enhanced ability to maintain mitochondrial activation when movement is restricted and without producing potentially damaging mechanical stress [40].

Wang et al. [42] agree that pulsed electromagnetic stimuli can foster a state of cartilage chondrocyte proliferation, while exerting a protective effect on cartilage cell catabolic actions and their impact on the cellular environment, including placing excess strain in joint tissues such as its tendons. Furthermore, this technique is beneficial for allaying destructive changes in the subchondral trabecular bone micro architecture realm and thereby for subsequent prevention or retardation of cartilage aligned bone loss, and disease progression. Cadossi et al. [43] propose these aforementioned results and others are not unexpected if one considers that cell membrane receptors at the stimulation site appear responsive to electromagnetic stimuli and induce signals that foster the synthesis of intra and extracellular matrix components within cartilage and bone.

Furthermore, this form of stimulation may serve an anti inflammatory role [44] that favors the expression of anti oxidant enzymes as well as helping to stabilize or improve bone structure and its architecture as well as muscle and tendon, and its modification as a nanosecond pulsed power technology tool has diverse biological effects on cellular responses as well as pain perception and heart rate variability and neuroprotection [14, 21, 27, 45-52]. Moreover, therapeutic electromagnetic field applications may mediate desirable durable improvements in osteoarthritis muscle fiber alignment, force transmission capacity, contractile function, neuromotor response functions, muscle recovery and thus protection against progressive harmful degenerative joint loading impacts and neurodegeneration [50-53] and oxidative stresses that inhibit muscle recovery and regeneration, while exacerbating cell death and inflammation [21]. Moreover, long lasting inflammatory control may not only promote a favorable tissue regeneration environment, but heightened muscle and tendon cell repair responsiveness [44] alongside muscle pain control and function [21, 51, 53, 54].

Indications also prevail that PEMFs may help maintain or improve the subject's strength capacity and associated ability to perform activities of daily living with less discomfort than in the absence of treatment [50, 54, 55]. This in itself may prove remedial and may help quite significantly to decrease reliance on narcotic medications and others, plus excess use of health services and surgery. Also reported are observations of beneficial chondrocyte viability impacts [56] as well as anti inflammatory effects that may reduce cartilage damage and noxious osteoarthritis symptoms that may well stem from the presence of osteoporosis through the findings that PEMFs can stimulate sensory nerves to produce Sema3A, a substance that promotes osteogenesis, and inhibits adipogenesis, and counters cell senescence [57], while fostering a lower rate and degree of osteoarthritis progression, and heightening muscle strength capacity, functional gains and depressive symptom relief [58].

In this regard, as has been the case for more than two decades, currently published preclinical and clinical studies examined in this overview continue to favour some form of pulsed electromagnetic field stimulation as far as having beneficial cartilage cell, muscle, bone, nerve and pain impacts. However, as in many past and current realms of inquiry, these consistently affirmative and promising data found largely in the non clinical realm have not been widely accepted nor validated clinically and must be extrapolated with some caution. These are however very promising as a whole if we consider at the very least, they can foster an array if desirable osteoarthritis tissue repair processes, and positive impacts on muscle structure and function and diverse disease attributes not readily treatable in their own right such as sarcopenia.

1. The careful application of pulsed electromagnetic field stimuli to a diseased joint or focally ro a specific joint site has the potential to improve its functional and mechanical properties including its cartilage and bone structural tissues via increasingly verifiable endogenous mechanisms and pathways of influence [7, 57. 73].
2. As per Masante et al. [2] results will depend on the applied biophysical stimulation parameters, joint site irradiated and damaged, and exposure duration.
3. Its optimal efficacy however, surely demands the modality be applied with due care, parameter selection, and precision by physicians and patients [44, 71].
4. The use of a comprehensive descriptor to enable the identification of common features across different studies could serve as a valuable tool for refining PEMF protocols and establishing standardized guidelines to support bone and cartilage repair explorations [2].
5. The failure of most clinical studies to employ advanced technologies that may well detect cartilage, bone, and tendon cell transformations at the nano molecular level as well as serum assays and functional mechanics weakens the chances for valid insights of high veracity to emerge despite this being quite a promising line of pursuit.
6. PEMF exposure may represent a non-invasive and non-strenuous method of ameliorating or preserving proprioception, sensory nerve function, chondro-and osteogenesis, and joint inflammation [57, 71, 73].
7. Diverse functional improvements in early-stage osteoarthritis, osteoporosis and arthroscopy patients, anterior cruciate ligament reconstruction as well as life quality are anticipated in a short time frame post electromagnetic stimulation therapy [3, 60-64, 67, 76].

Unfortunately, the available clinical evidence is not only limited in study numbers, but what is published is generally considered far from resounding and may not only reflect design issues but may reflect species and disease model differences that do not simulate the human disease realistically. Moreover, in terms of PEMF applications found to foster lab based joint tissue healing, this may not occur clinically if the parameters used clinically are suboptimal at best, and differ from those in the acute laboratory generated osteoarthritis model or various forms of isolated cell cultures. As well, joint protection in the real world may not be a given and is a factor often ignored. As well, the usage of narcotics and other medications plus invasive injections to quell pain is often ignored even though these interventions may inadvertently exacerbate or foster joint usage, impact loading and joint attrition.

However, considering the promise of electromagnetic pulsed field therapy and in light of the projected and present osteoarthritis social burden, immense health and economic costs it appears essential to explore if such treatments could maximize osteoarthritis management, and reduce costs in any way [65, 66]. Moreover, pursuing the idea that carefully considered integrated therapy efforts as well as well designed and controlled studies that proceed in the face of optimal PEMF exposure and stimulus dosage and amplitudes can specifically activate target cell magnetic sensors will likely prove efficacious and advantageous [44, 67, 71]. Mechanisms potentially affording cartilage repair are multiple [68, 69].

In sum, what has been shown quite convincingly over time and of late is that due to their unique and differential abilities to stimulate or trigger selected cell based molecules that underlie various joint structural components, intermittent or low frequency applications of pulsed electrical field stimuli have the ability to impact joint soft tissues and support structures in the older adult with one or more damaged joints effectively and significantly. Fewer physical as well as mental health challenges may follow as well as a possible slower rate and magbitude of any disease progression.

Discussion

Despite decades of study, osteoarthritis remains poorly understood and treated despite its growing high social and economic relevance. Help that is therapeutic, revitalizing and safe using non invasive non toxic passive methods are however increasingly indicated for the older adult. As such, PEMF discussed herein appears to offer one avenue of relief, especially among aging adults where age and pain are correlated with radiographic osteoarthritis structural damage [57]. However, in this brief current overview, it appears safe to say in vitro applications derived from simulations of osteoarthritis in animals and cell cultures that are highly promising do not translate readily to the bedside.

These include cartilage, bone, tendon tissues. Nerve, and muscle repair that alone could afford pain relief in selected cases [10, 11, 58-62]. Moreover, several notable plausible evidence based mechanisms appear to support its use in reducing inflammation that greatly mars the ability to mitigate the osteoarthritis condition.

To guide challenges faced by health providers in the realm of chronic osteoarthritis in the high aged adult, and its immense related personal and societal burden, we believe the number of positive laboratory based preclinical study results clearly justifies its potential efficacy for osteoarthritis mitigation that must warrant consideration, even if other interventions are indeed helpful and take less time. This is because the ability of most traditional support therapies to directly impact the actual joint pathology of osteoarthritis is quite limited and/or can undoubtedly foster one or more disabling physical, social, or mental health disease correlates than desired. Optimal chondrogenic outcomes in this regard that are of key import can indeed be fostered in response to single, brief, low intensity exposures of 6 ms bursts of magnetic pulses applied to the chondrocyte source and must thus have immense clinical implications for osteoarthritis sufferers in their own right.

In addition, it is possible its insightful expanded application can be better demonstrated in stand alone rather than studies employing several concurrent treatment approaches, wherein using thermal doses may yet relieve pain and muscle spasm that accompanies the disease in its own right. Third, its application may alleviate bone marrow lesion pain, as well as the degree of bone micro fractures and bone damage known to hasten the progression of osteoarthritis to a high degree and limit function.

It also appears cartilage cells and their membrane receptors and others can be manipulated differentially by the location of the joint stimulated as well as what pulsed electromagnetic field parameters are employed, hence providing an uncharted area for further exploration [71]. Moreover, even if regeneration is not evidenced adequate data points to the fact joint degradation rates and intensity can be reduced or minimized post PEMF [31-33].

Indeed, these post stimulation PEMF benefits may obviate the need for a fair number of older adults with disabling osteoarthritis to resort to home care or nursing home care along with narcotic usage that may prove addictive. Its anti-inflammatory, effusion, and pain reducing properties, may be of great value if they prove equally valuable in helping the affected individual to exercise, especially important in early as well as late life osteoarthritis. The stimuli may induce effects comparable to those attributable to exercise via the use of electromagnetic field therapy applied independently or as a therapy adjunct.

In addition, because pulsed electromagnetic fields can be applied safely alone or in combination with other treatments, possible functional benefits may emerge without any possible injury to joint neural structures that may be debased by nerve blocks, intra articular injections, or surgery. Unlike exercises, since these magnetic waves can be applied even in the absence of movements that are often hard to perform in the case of pain. Benefits may also extend to opportunities to effectively reduce joint swelling, inflammation and muscle atrophy, as well as more optimal post surgery healing effects, and cartilage preservation. Indeed, the active adjunctive application of PEMF could not only be efficacious in its own right, but a useful adjuvant treatment to exercise programs in individuals with joint disease in the medium term [36] and long term [51] where it may foster mobility benefits, as well improvements in collagen production and muscle regeneration [8]. Potentially too, carefully designed treatments may help avert or postpone the need for invasive surgery or improve their outcomes. However, outcomes may depend on accurate diagnoses, selection of the targeted tissue and wave forms and whether these are tailored insightfully based on the client's health profile and what is known as regards both the cellular as well as the molecular responses of joint genes to PEMF bio stimulation.

To this end expanding upon the promise of this understudied modality as a more standard form of osteoarthritis therapy has been discussed [77, 79]. This idea clearly rests upon solid underpinnings but also on future observations that target and detail possible salient clinical intracellular mechanisms of electromagnetic field bone, cartilage, and muscle stimuli of various parameters and their outcome responses with adequate reliability and consistency. As well, the most optimal stimulation and devise design parameters and its long term efficacy should be identified [77-80].

Conclusion

As of October3 2025 we conclude that although many older adults suffer with osteoarthritis, they do so without much relief, and despite favourable preclinical related observations of possible relief and even disease regression or repair post electromagnetic stimulation. In particular we conclude a useful treatment may be overlooked because of the limited number of studies as well as shortcomings of these clinical studies that cannot easily be aggregated. Moreover, an inconsistent array of studies where most fail to apply clinically meaningful well designed research designs and validated outcome measures often lack power and are implemented for short durations.

As such, and after studying this topic for many years, we believe very little counter evidence prevails and most current authors imply it is still worthwhile to pursue the PEMF osteoarthritis connection in light of the increasing rates of worldwide suffering among the older population from potentially treatable osteoarthritis pain and success in advancing PEMF healing understandings. Here, we advocate with reasonable confidence that clinicians can still consider applying pulsed electromagnetic field treatments to quell osteoarthritis pain and to foster function and possible cartilage repair or maintenance, especially if applied sooner rather than later.

Indeed, while this broad based overview may not have included all available studies, and the quality of those identified cannot be readily established in many cases, it appears safe to offer four potentially clinically relevant reflection points that encapsulate the state of the art in 2025.

- Osteoarthritis is a common painful joint disease affecting many older adults and one warranting more study of its origins and regenerative treatment options.
- Non invasive low frequency pulsed electromagnetic field applications appear to provide a safe and well tolerated form of biophysical energy that can be harnessed and titrated to promote intrinsic tissue healing, cartilage viability, and repair.
- As well as attenuating joint pain and inflammation, older individuals with chronic osteoarthritis may benefit functionally from the application of pulsed electromagnetic fields to their affected joint [s], especially if applied at the outset of the condition.
- Validating and clarifying the potential of pulsed electromagnetic fields and its biological impacts on joint status may reduce considerable suffering as well as health care costs.
- Extending research efforts to embody the features of the whole joint and their interactions in the older adult population, if impaired, as well as with their reaction to pulsed electromagnetic field therapy plus its added impact on possible complementary interventions such as collagen intake maximization, joint protection approaches, and muscle strength training is also likely to prove highly promising.
- Despite some disputes, the observable transcriptional, cellular and sub-cellular molecular effects of PEMF that appear to foster cartilage, muscle, ligament, tendon, nerve and bony tissue repair or reverse this disease process are especially noteworthy.

Factors influencing pulsed electromagnetic field outcomes include their electrophysiological parameters, the stimulated cell configuration, the stimulation mode and duration, the pathological state of the stimulated tissue and cells. Mechanistic explanations for PEMF effects are its ability to interact with cell surface membrane receptors to enable transduction signals that upregulate anabolic processes, and DNA and collagen synthesis and downgrade damaging disease associated catabolic reactions and enzymes a possible reduction in the degree of cell death processes.

Final Thoughts

Pulsed electromagnetic field stimulation, a non-invasive treatment that utilizes electromagnetic fields to reduce inflammation and promote tissue repair may engender or deliver considerable pain benefits and others to the older adult with disabling osteoarthritis. Indeed, even though not fully accepted as mainstream, or a topic avidly studied in the clinical realm, and especially in joints other than the knee, strong evidence of its varied mechanistic impacts not only appear remarkable, but of high clinical salience if well designed study results offer a gateway that can be harnessed to alleviate widespread suffering. Allied approaches that deal specifically with biomechanical issues such as the need to secure joint protection and reduce high strain repetitive loading day to day or occupational impacts including weight management, and protective wearables are likely to help in securing long term or regenerative results. Future directions that embrace early osteoarthritis detection, personalized intervention strategies, and combination therapies are likely to afford far reaching benefits as well.

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