

- 1) [Efficacy of low frequency **pulsed** subsensory threshold electrical stimulation vs placebo on pain and physical function in people with knee **osteoarthritis**: systematic review with meta-analysis.](#)

Negm A, Lorbergs A, Macintyre NJ.

Osteoarthritis Cartilage. 2013 Sep;21(9):1281-9. doi: 10.1016/j.joca.2013.06.015.

Conclusion:

Current evidence of low and very low quality suggests that low frequency (≤ 100 Hz) pulsed subsensory threshold electrical stimulation produced either through PEMF/PES vs sham PEMF/PES is effective in improving physical function but not pain intensity at treatment completion in adults with knee OA blinded to treatment. Methodologically rigorous and adequately powered RCTs are needed to confirm the findings of this review.

- 2) [Effect of pulsed electromagnetic fields on the bioactivity of human osteoarthritic chondrocytes.](#)

Sadoghi P, Leithner A, Dorotka R, Vavken P.

Orthopedics. 2013 Mar;36(3):e360-5. doi: 10.3928/01477447-20130222-27.

Conclusion:

The authors concluded that low-frequency PEMFs do not significantly influence the biosynthetic activity of explantcultures of human osteoarthritic cells in vitro. Nevertheless, they may be suitable as an adjuvant to a larger treatment regimen.

- 3) [\[Pulsed electromagnetic field therapy for the treatment of knee osteoarthritis: a systematic review\].](#)

Cao LY, Jiang MJ, Yang SP, Zhao L, Wang JM.

Zhongguo Gu Shang. 2012 May;25(5):384-8. Review. Chinese.

Conclusion:

Five RCTs totaling 331 patients were included. The results showed that compared with placebo control treatment, pulsed electromagnetic field therapy had little clinical benefit.

The effects of Pulsed electromagnetic field therapy for treating knee osteoarthritis need more powerful trials to be confirmed. The above conclusions still need more high-quality randomized controlled trials to be verified owing to the limitations of the number and the quality of systematic review included studies.

- 4) [Effects of pulsed electromagnetic field on knee osteoarthritis: a systematic review.](#)

Ryang We S, Koog YH, Jeong KI, Wi H.

Rheumatology (Oxford). 2013 May;52(5):815-24. doi: 10.1093/rheumatology/kes063. Epub 2012 Apr 13. Review.

Conclusion:

The present study provided suggestive evidence supporting PEMF efficacy in the management of knee OA. Our results further raise the need for more well-controlled trials, employing adequate methodology, to conclusively evaluate the efficacy of PEMF.

- 5) [Non-invasive electromagnetic field therapy produces rapid and substantial pain reduction in early knee osteoarthritis: a randomized double-blind pilot study.](#)

Nelson FR, Zvirbulis R, Pilla AA.

Rheumatol Int. 2013 Aug;33(8):2169-73. doi: 10.1007/s00296-012-2366-8. Epub 2012 Mar 27.

Conclusion:

The overall decrease in mean VAS score for the active cohort was nearly threefold that of the sham cohort ($P < 0.001$). The results suggest that non-thermal, non-invasive PEMF therapy can have a significant and rapid impact on pain from early knee OA and that larger clinical trials are warranted.

- 6) [Chondroprotective effects of pulsed electromagnetic fields on human cartilage explants.](#)

Ongaro A, Pellati A, Masieri FF, Caruso A, Setti S, Cadossi R, Biscione R, Massari L, Fini M, De Mattei M.

Bioelectromagnetics. 2011 Oct;32(7):543-51. doi: 10.1002/bem.20663. Epub 2011 Mar 15.

Conclusion:

PEMF and IGF-I augment cartilage explant anabolic activities, increase PG synthesis, and counteract the catabolic activity of IL-1 β in OA grades I and III. We hypothesize that both IGF-I and PEMF have chondroprotective effects on human articular cartilage, particularly in early stages of OA.

- 7) [Effects of pulsed electromagnetic fields on cartilage apoptosis signalling pathways in ovariectomised rats.](#)

Li S, Luo Q, Huang L, Hu Y, Xia Q, He C.

Int Orthop. 2011 Dec;35(12):1875-82. doi: 10.1007/s00264-011-1245-3. Epub 2011 Mar 15.

Animal study - excluded

- 8) [Comparing different physical factors on serum TNF- \$\alpha\$ levels, chondrocyte apoptosis, caspase-3 and caspase-8 expression in osteoarthritis of the knee in rabbits.](#)

Guo H, Luo Q, Zhang J, Lin H, Xia L, He C.

Joint Bone Spine. 2011 Dec;78(6):604-10. doi: 10.1016/j.jbspin.2011.01.009. Epub 2011 Mar 11.

Animal study - excluded

- 9) [Additional effect of pulsed electromagnetic field therapy on knee osteoarthritis treatment: a randomized, placebo-controlled study.](#)

Ozgüçlü E, Cetin A, Cetin M, Calp E.

Clin Rheumatol. 2010 Aug;29(8):927-31. doi: 10.1007/s10067-010-1453-z. Epub 2010 May 16.

Conclusion:

The results of this study show that PEMF does not have additional effect on the classical physical treatment in reducing symptoms of knee OA.

- 10) [Low frequency pulsed electromagnetic field--a viable alternative therapy for arthritis.](#)

Ganesan K, Gengadharan AC, Balachandran C, Manohar BM, Puvanakrishnan R.

Indian J Exp Biol. 2009 Dec;47(12):939-48. Review.

Conclusion:

The analysis of various studies (animal models of arthritis, cell culture systems and clinical trials) reporting the use of PEMF for arthritis cure has conclusively shown that PEMF not only alleviates the pain in the arthritis condition but it also affords chondroprotection, exerts antiinflammatory action and helps in bone remodeling and this could be developed as a viable alternative for arthritis therapy.

- 11) [Effectiveness of pulsed electromagnetic field therapy in the management of osteoarthritis of the knee: a meta-analysis of randomized controlled trials.](#)

Vavken P, Arrich F, Schuhfried O, Dorotka R.

J Rehabil Med. 2009 May;41(6):406-11. doi: 10.2340/16501977-0374. Review.

Conclusion:

Pulsed electromagnetic fields improve clinical scores and function in patients with osteoarthritis of the knee and should be considered as adjuvant therapies in their management. There is still equipoise of evidence for an effect on pain in the current literature.

- 12) [The effects of pulsed electromagnetic fields in the treatment of knee osteoarthritis: a randomized, placebo-controlled trial.](#)

Ay S, Evcik D.

Rheumatol Int. 2009 Apr;29(6):663-6. doi: 10.1007/s00296-008-0754-x. Epub 2008 Nov 18.

Conclusion:

Applying between-group analysis, we were unable to demonstrate a beneficial symptomatic effect of PEMF in the treatment of knee OA in all patients. Further studies using different types of magnetic devices, treatment protocols and patient populations are warranted to confirm the general efficacy of PEMF therapy in OA and other conditions.

- 13) [Effects of pulsed and sinusoid electromagnetic fields on human chondrocytes cultivated in a collagen matrix.](#)

Schmidt-Rohlfing B, Silny J, Woodruff S, Gavenis K.

Rheumatol Int. 2008 Aug;28(10):971-7. doi: 10.1007/s00296-008-0565-0. Epub 2008 Apr 4.

Conclusion:

In conclusion, using our in vitro setting, we were unable to detect any effects of pulsed and sinusoidal magnetic fields on human adult osteoarthritic chondrocytes.

- 14) [A programmable ramp waveform generator for PEMF exposure studies on chondrocytes.](#)

Jahns M, Durdle N, Lou E, Raso VJ.

Conf Proc IEEE Eng Med Biol Soc. 2006;1:3230-3.

Technical study - Excluded

- 15) [The effect of pulsed electromagnetic fields on chondrocyte morphology.](#)

Jahns ME, Lou E, Durdle NG, Bagnall K, Raso VJ, Cinats D, Barley RD, Cinats J, Jomha NM.

Med Biol Eng Comput. 2007 Oct;45(10):917-25. Epub 2007 Aug 14.

Technical study – Excluded

- 16) [Characterization of adenosine receptors in bovine chondrocytes and fibroblast-like synoviocytes exposed to low frequency low energy pulsed electromagnetic fields.](#)
 Varani K, De Mattei M, Vincenzi F, Gessi S, Merighi S, Pellati A, Ongaro A, Caruso A, Cadossi R, Borea PA.
Osteoarthritis Cartilage. 2008 Mar;16(3):292-304. Epub 2007 Aug 16.

Animal study - excluded

- 17) [\[Pulsed electromagnetic fields \(PEMF\)--results in evidence based medicine\].](#)
 Pieber K, Schuhfried O, Fialka-Moser V.
Wien Med Wochenschr. 2007 Jan;157(1-2):34-6. Review. German.

Conclusion:

Therapy with electromagnetic fields has a very old tradition in medicine. The indications are widespread, whereas little is known about the effects. Controlled randomized studies with positive results for pulsed electromagnetic fields (PEMF) are available for osteotomies, the healing of skin wounds, and osteoarthritis. Comparison of the studies is difficult because of the different doses applied and intervals of therapy. Therefore recommendations regarding an optimal dosis and interval are, depending on the disease, quite variable.

- 18) [Effect of pulsed electromagnetic field stimulation on knee cartilage, subchondral and epiphyseal trabecular bone of aged Dunkin Hartley guinea pigs.](#)
 Fini M, Torricelli P, Giavaresi G, Aldini NN, Cavani F, Setti S, Nicolini A, Carpi A, Giardino R.
Biomed Pharmacother. 2008 Dec;62(10):709-15. Epub 2007 Apr 3.

Animal study - excluded

- 19) [Effects of pulsed electromagnetic fields on patients' recovery after arthroscopic surgery: prospective, randomized and double-blind study.](#)
 Zorzi C, Dall'Oca C, Cadossi R, Setti S.
Knee Surg Sports Traumatol Arthrosc. 2007 Jul;15(7):830-4. Epub 2007 Feb 28.

Conclusion:

At 3 years follow-up, the number of patients who completely recovered was higher in the active group compared to the control group ($P < 0.05$). Treatment with I-ONE aided patient recovery after arthroscopic surgery, reduced the use of NSAIDs, and also had a positive long-term effect.

- 20) [Biophysical stimulation with pulsed electromagnetic fields in osteonecrosis of the femoral head.](#)
 Massari L, Fini M, Cadossi R, Setti S, Traina GC.
J Bone Joint Surg Am. 2006 Nov;88 Suppl 3:56-60.

Conclusion: - OBS Osteonecrosis

The results of this study confirm that pulsed electromagnetic field treatment may be indicated in the early stages of osteonecrosis of the femoral head (Ficat stages I and II). Pulsed electromagnetic field stimulation may be able to either preserve the hip or delay the time until surgery. The authors hypothesize that the short-term effect of pulsed electromagnetic field stimulation may be to protect the articular carti-

lage from the catabolic effect of inflammation and subchondral bone-marrow edema. The long-term effect of pulsed electromagnetic field stimulation may be to promote osteogenic activity at the necrotic area and prevent trabecular fracture and subchondral bone collapse.

- 21) [Proteoglycan synthesis in bovine articular cartilage explants exposed to different low-frequency low-energy pulsed electromagnetic fields.](#)

De Mattei M, Fini M, Setti S, Ongaro A, Gemmati D, Stabellini G, Pellati A, Caruso A.

Osteoarthritis Cartilage. 2007 Feb;15(2):163-8. Epub 2006 Aug 14.

Animal study - excluded

- 22) [Pulsed electromagnetic energy treatment offers no clinical benefit in reducing the pain of knee osteoarthritis: a systematic review.](#)

McCarthy CJ, Callaghan MJ, Oldham JA.

BMC Musculoskelet Disord. 2006 Jun 15;7:51. Review.

Conclusion:

This systematic review provides further evidence that PEMF has little value in the management of knee osteoarthritis. There appears to be clear evidence for the recommendation that PEMF does not significantly reduce the pain of knee osteoarthritis.

- 23) [Effects of pulsed electromagnetic fields on articular hyaline cartilage: review of experimental and clinical studies.](#)

Fini M, Giavaresi G, Carpi A, Nicolini A, Setti S, Giardino R.

Biomed Pharmacother. 2005 Aug;59(7):388-94. Review.

Conclusion:

Therefore, there is a strong rationale supporting the in vivo use of biophysical stimulation with PEMFs for the treatment of OA. In the present paper some recent experimental in vitro and in vivo data on the effect of PEMFs on articular cartilage were reviewed. These data strongly support the clinical use of PEMFs in OA patients.

- 24) [Pulsed electromagnetic fields reduce knee osteoarthritic lesion progression in the aged Dunkin Hartley guinea pig.](#)

Fini M, Giavaresi G, Torricelli P, Cavani F, Setti S, Canè V, Giardino R.

J Orthop Res. 2005 Jul;23(4):899-908. Epub 2005 Mar 17.

Animal study - excluded

- 25) [The effect of pulsed electromagnetic fields in the treatment of cervical osteoarthritis: a randomized, double-blind, sham-controlled trial.](#)

Sutbeyaz ST, Sezer N, Koseoglu BF.

Rheumatol Int. 2006 Feb;26(4):320-4. Epub 2005 Jun 29.

Conclusion:

The results of this study are promising, in that PEMF treatment may offer a potential therapeutic adjunct to current COA therapies in the future.

- 26) [Treatment of knee osteoarthritis with pulsed electromagnetic fields: a randomized, double-blind, placebo-controlled study.](#)

Thamsborg G, Florescu A, Oturai P, Fallentin E, Tritsarlis K, Dissing S.
Osteoarthritis Cartilage. 2005 Jul;13(7):575-81.

Conclusion:

Applying between group analysis we were unable to demonstrate a beneficial symptomatic effect of PEMF in the treatment of knee OA in all patients. However, in patients <65 years of age there is significant and beneficial effect of treatment related to stiffness.

- 27) [A multicenter clinical trial on the use of pulsed electromagnetic fields in the treatment of temporomandibular disorders.](#)

Peroz I, Chun YH, Karageorgi G, Schwerin C, Bernhardt O, Roulet JF, Freesmeyer WB, Meyer G, Lange KP.
J Prosthet Dent. 2004 Feb;91(2):180-7.

Conclusion:

Pulsed electromagnetic fields had no specific treatment effects in patients with temporomandibular disorders.

- 28) [Modification of osteoarthritis by pulsed electromagnetic field--a morphological study.](#)

Ciombor DM, Aaron RK, Wang S, Simon B.
Osteoarthritis Cartilage. 2003 Jun;11(6):455-62.

Conclusion:

Treatment with PEMF appears to be disease-modifying in this model of osteoarthritis. Since TGFbeta is believed to upregulate gene expression for aggrecan, down-regulate matrix metalloprotease and IL-1 activity, and upregulate inhibitors of matrix metalloprotease, the stimulation of TGFbeta may be a mechanism through which PEMF favorably affects cartilage homeostasis.

- 29) [Pulsed magnetic field therapy for osteoarthritis of the knee--a double-blind sham-controlled trial.](#)

Nicolakis P, Kollmitzer J, Crevenna R, Bittner C, Erdogmus CB, Nicolakis J.
Wien Klin Wochenschr. 2002 Aug 30;114(15-16):678-84.

Conclusion:

In patients with symptomatic osteoarthritis of the knee, PMF treatment can reduce impairment in activities of daily life and improve knee function.

- 30) [Pulsed magnetic field therapy for osteoarthritis of the knee--a double-blind sham-controlled trial.](#)

Müllner M.
Wien Klin Wochenschr. 2002 Nov 30;114(21-22):953; author reply 953. No abstract available.

Excluded - No access to abstract

- 31) [Biochemical and morphological study of human articular chondrocytes cultivated in the presence of pulsed signal therapy.](#)

Fioravanti A, Nerucci F, Collodel G, Markoll R, Marcolongo R.
Ann Rheum Dis. 2002 Nov;61(11):1032-3. No abstract available.

Excluded - No access to abstract

- 32) [Nonpharmacologic management of osteoarthritis.](#)

Sharma L.
Curr Opin Rheumatol. 2002 Sep;14(5):603-7. Review.

Conclusion:

Several nonpharmacologic interventions for osteoarthritis are in different stages of development, investigation, and application. Such interventions capitalize on current knowledge of the causes of symptoms, disease progression, and disability in patients with osteoarthritis. Many nonpharmacologic interventions are low in cost and incorporate self-management approaches or home-based activities and, as such, may ultimately have substantial public health impact. Recent studies and reviews of exercise, weight loss, education, inserts, footwear, bracing, therapeutic ultrasound, acupuncture, and pulsed electromagnetic field therapy will be highlighted in this review. For many of these interventions, further investigation will be necessary to define their place in the management of osteoarthritis.

- 33) [Electromagnetic fields for the treatment of osteoarthritis.](#)

Hulme J, Robinson V, DeBie R, Wells G, Judd M, Tugwell P.
Cochrane Database Syst Rev. 2002;(1):CD003523. Review.

Conclusion:

Current evidence suggests that electrical stimulation therapy may provide significant improvements for knee OA, but further studies are required to confirm whether the statistically significant results shown in these trials confer to important benefits.

- 34) [Pulsed electromagnetic field therapy in the management of knee OA.](#)

Pfeiffer K.
Ann Rheum Dis. 2001 Jul;60(7):717. No abstract available.

Excluded - editorial

- 35) [Electromagnetic fields and magnets. Investigational treatment for musculoskeletal disorders.](#)

Trock DH.
Rheum Dis Clin North Am. 2000 Feb;26(1):51-62, viii. Review.

Conclusion:

Certain pulsed electromagnetic fields (PEMF) affect the growth of bone and cartilage in vitro, with potential application as an arthritis treatment. PEMF stimulation is already a proven remedy for delayed fractures, with potential clinical application for osteoarthritis, osteonecrosis of bone, osteoporosis, and wound healing. Static magnets may provide temporary pain relief under certain circumstances. In both cases, the available data is limited. The mechanisms underlying the use of PEMF and magnets are discussed.

- 36) [Pulsed electromagnetic fields influence hyaline cartilage extracellular matrix composition without affecting molecular structure.](#)

Liu H, Abbott J, Bee JA.

Osteoarthritis Cartilage. 1996 Mar;4(1):63-76.

Excluded – technical study

- 37) [The effect of pulsed electromagnetic fields in the treatment of osteoarthritis of the knee and cervical spine. Report of randomized, double blind, placebo controlled trials.](#)

Trock DH, Bollet AJ, Markoll R.

J Rheumatol. 1994 Oct;21(10):1903-11.

Conclusion:

PEMF has therapeutic benefit in painful OA of the knee or cervical spine.

- 38) [A double-blind trial of the clinical effects of pulsed electromagnetic fields in osteoarthritis.](#)

Trock DH, Bollet AJ, Dyer RH Jr, Fielding LP, Miner WK, Markoll R.

J Rheumatol. 1993 Mar;20(3):456-60.

Conclusion:

The decreased pain and improved functional performance of treated patients suggests that this configuration of PEMF has potential as an effective method of improving symptoms in patients with OA. This method warrants further clinical investigation.

Articles spread in four