



DOSSIER · THERAPY

Pulsed Electromagnetic Field Therapy (PEMF)

The database records a considerable number of studies on **magnetic field therapy (PEMF)** in humans, including controlled studies. The research focuses on the **musculoskeletal system** and **bone healing**, while other areas of application are investigated much less frequently. The methodological quality varies, and not all results are consistent.

538

STUDIES IN
TOTAL

343

IN HUMANS

192

OF WHICH
CONTROLLED

14

IN ANIMALS

38

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-04

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Pulsed Electromagnetic Field Therapy (PEMF) at a Glance

ORIGIN:
The Pulsed Electromagnetic Field Therapy (PEMF) is a physical procedure in which pulsed electromagnetic fields of low intensity act externally on the body. Developed in the 1970s, it originates from physical medicine and was initially researched in orthopaedics and trauma surgery. The application is carried out via devices that are used locally or systemically, without generating thermal effects.

EVIDENCE BASE:
538 evaluated studies · 192 controlled human studies · 151 observational studies · 44 review articles · 14 animal studies · 37 cell culture studies

- STRONGEST EVIDENCE:**
- Bone healing (fractures) PEMF shows significantly higher healing rates (up to 77.4 %) in controlled studies for delayed fracture healing or pseudarthroses, particularly with early application (within 6 months). Radiological consolidation times shorten in non-operative fractures and upper extremities.
 - Osteoarthritis (knee) Double-blind RCTs show short-term pain reduction (VAS, WOMAC) and improved quality of life in knee osteoarthritis after 4–6 weeks of PEMF application. Effect sizes are moderate (e.g. -0.73 for VAS), with analgesic-sparing effects, but lacking long-term data.
 - Postoperative pain PEMF reduces postoperative pain (e.g. after breast surgery) by up to 300 % within 5 hours and lowers analgesic consumption.
 - Chronic wounds Multicentre studies show a 47.7 % reduction in wound area in venous leg ulcers after 8 weeks of PEMF, with significant decreases in wound depth and pain. 50 % of patients achieve marked improvement (placebo: 0 %).
 - Spinal fusion PEMF improves fusion rates in spinal surgery, especially in high-risk patients (smokers, multi-segment fusions). Preclinical studies provide indications of mechanisms such as upregulation of growth factors (BMP-2, TGF-β), yet their clinical relevance remains to be established.

- LIMITATIONS:**
- Parameter standardisation Frequency, intensity, pulse form and application duration vary widely between studies, preventing direct comparisons and dose-response analyses. A uniform nomenclature is lacking.
 - Long-term data Almost all studies capture only short-term effects (weeks to months). Data on safety, efficacy or adverse effects over years are still outstanding.
 - Smaller application areas Areas such as cognition, fibromyalgia or metabolism (e.g. diabetic polyneuropathy) are based on small samples or pilot studies with contradictory results.

CLASSIFICATION:
PEMF is a physical procedure with proven effects on accelerating bone healing and pain relief in osteoarthritis. Other areas of application such as wound healing show promising results, while inflammation modulation or further indications are less well supported and require further research.

1. What Pulsed Electromagnetic Field Therapy (PEMF) Is

The **Pulsed Electromagnetic Field Therapy (PEMF)** is a physical procedure in which pulsed electromagnetic fields of low intensity act on the body. The application is carried out via external devices that are used either locally (e.g. on joints) or systemically (e.g. via mats). The therapy originates from physical medicine and has been researched since the 1970s, initially mainly in orthopaedics and trauma surgery. The fields are generated in defined frequencies and intensities to influence biological processes. Technically, it is non-ionising radiation that does not produce thermal effects.

Decisive for understanding the evidence base is the **diversity of parameters**: frequency, pulse form, intensity, application duration and device type vary widely. Even within an application area such as **bone healing**, different protocols are used, which makes direct comparisons difficult. In addition, a standardised nomenclature is lacking – terms such as *low-intensity*, *pulsed* or *static* are not used uniformly. Most studies measure **clinical endpoints** (pain, function, healing time), while **biological markers** (e.g. cytokines, bone density) are recorded less frequently. **Placebo control** is methodologically challenging because electromagnetic fields are difficult to simulate.

2. What the Studies Show in Detail

The key human studies and the most important reviews — by application area, with population, duration, preparation, measurement variable and result, as reported by the original studies. Numbers appear only where the study states them.

Distribution of **controlled human studies** by application area — the numbers are not additive, as one study may be assigned to several areas:

APPLICATION AREA	CONTROLLED STUDIES
Musculoskeletal system	91
Bones and joints	80
Safety and tolerability	47
Inflammatory processes	27
Cognition and psyche	18
Fatigue and stress	16

APPLICATION AREA	CONTROLLED STUDIES
Skin	14
Metabolism	11

Metabolism – Diabetic Polyneuropathy

Participants wore multipolar magnetised shoe insoles (verum group) or unmagnetised placebo insoles continuously for four months. Primary endpoints were daily visual analogue scales (VAS) for numbness, tingling and burning pain as well as quality of life (QOL). Secondary assessments included nerve conduction measurements and quantitative sensory tests. Effects were even more pronounced in patients with initially severe pain. A limitation was the lack of differentiation between type-1 and type-2 diabetes as well as the absence of long-term follow-up beyond four months.

HYPOTHESIS The study suggests that static magnetic field therapy may act symptomatically in DPN, particularly in patients with severe pain. However, an investigation into effects on nerve regeneration or long-term tolerability is lacking. As the therapy was applied only as a shoe insole, it remains unclear whether higher field strengths or other application forms would achieve stronger effects. The results are not transferable to PEMF.

Bones and Joints – Fracture Healing

A systematic review with meta-analysis ⁽¹⁾ evaluated randomised controlled trials (RCTs) on the effect of pulsed electromagnetic fields (PEMF) and low-intensity pulsed ultrasound (LIPUS) on the healing of acute fractures. The pooled results showed no significant differences between PEMF/LIPUS and placebo regarding the rate of non-unions. However, heterogeneous results emerged for radiological consolidation time: PEMF/LIPUS significantly accelerated healing in non-operatively treated fractures and fractures of the upper extremity. The data also suggested a shortening of clinical consolidation time in diaphyseal fractures. A limitation was the high heterogeneity of the studies (including different PEMF parameters, fracture locations and follow-up times).

A prospective, randomised study ⁽⁸⁾ examined the early use of PEMF in 58 patients with delayed fracture healing (16 weeks to 6 months postoperatively). The verum group received daily PEMF stimulation, the control group a sham treatment. After an average of 4.8 months, the PEMF group showed a significantly higher healing rate. Limitations were the small sample size and the lack of standardisation of PEMF parameters (e.g. frequency, intensity). A further prospective clinical study ⁽²¹⁾ with 44 patients with tibial non-unions or delayed healing showed a healing rate of 77.3 % after PEMF therapy, independent of age, fracture type or initial treatment. However, therapy duration was not standardised, and longer applications showed a trend towards better results ($p = 0.081$).

HYPOTHESIS PEMF appears to be effective particularly in delayed fracture healing or risk factors for non-unions (e.g. smoking, multi-fragment fractures). The controlled studies suggest that early application (within the first 6 months) increases the chances of healing. However, standardised protocols for optimal dosage and duration of therapy are lacking.

Bones and Joints – Osteoarthritis

A double-blind, placebo-controlled RCT ⁽⁴⁾ investigated the effect of PEMF in 60 patients with radiologically confirmed knee osteoarthritis and persistent pain (VAS > 40 mm). The verum group received daily 12-hour PEMF stimulation for one month, the placebo group a sham treatment. Primary endpoints were pain reduction (VAS, WOMAC) and quality of life (SF-36 v2). Secondary measures included pressure pain thresholds (PPT) and analgesic consumption. After one month, the PEMF group showed a significant reduction in VAS pain scores (effect size: -0.73; 95 % CI: -1.24 to -0.19) and WOMAC scores (effect size: -0.34; 95 % CI: -0.85 to 0.17). PPT values and physical health also improved. 26 % of PEMF patients discontinued NSAIDs/analgesics, while no adverse effects occurred. Limitations were the short therapy duration and the absence of long-term follow-up.

A further RCT ⁽⁵⁾ with 83 knee osteoarthritis patients compared PEMF (2 hours daily, 5 days/week, 6 weeks) with placebo. The verum group showed significant improvements in activities of daily living (ADL), stiffness and pain (WOMAC) after 2 and 6 weeks, whereas the placebo group showed only weak effects after 6 weeks. Pressure pain thresholds (PPT) improved in measurements on the patients, although the clinical relevance of this change was not investigated. Limitations were the heterogeneity of PEMF parameters and the partial exceeding of recommended field strengths (21.4 % of the studies).

A pilot study ⁽¹¹⁾ with 34 patients with early knee osteoarthritis showed that non-thermal PEMF (modulated via the CaM/NO/cGMP signalling pathway) produced a 50 % pain reduction (VAS) after just one day, which persisted until day 42 ($p < 0.001$). The placebo group showed no significant change.

Hypothesis: PEMF appears to relieve pain and stiffness in knee osteoarthritis in the short term, although the effects may not persist after the end of therapy. The optimal therapy duration and frequency remain unclear, and long-term data are lacking.

Bones and Joints – Spinal Fusion

Inclusion criteria were risk factors for non-unions (smoking > 1 pack/day or multi-segment fusions). Primary endpoints were neurological parameters, pain scores and fusion rates (radiological). Limitations were the lack of blinding of the radiologists and the heterogeneity of the fusion criteria. A review article on various therapies confirmed that PEMF *among the procedures examined* could improve fusion rates in spinal surgery, with the mechanisms possibly based on upregulation of growth factors (e.g. BMP-2, TGF- β).

Inflammatory Processes

A double-blind, placebo-controlled pilot study ⁽³⁾ investigated the effect of PEMF on postoperative pain and inflammatory markers in 24 female patients after breast reduction. The verum group received PEMF stimulation (modulated via the CaM/NO/cGMP signalling pathway), the placebo group a sham treatment. After 1 hour, the verum group showed a 57 % pain reduction (VAS, $p < 0.01$), after 5 hours a 300 % reduction ($p < 0.001$), which persisted up to 48 hours. Analgesic consumption decreased 2.2-fold ($p = 0.002$). IL-1 β concentration in wound exudate was 275 % lower in the verum group ($p < 0.001$). Limitations were the small sample size and the lack of measurement of further inflammatory markers (e.g. TNF- α).

An RCT ⁽¹²⁾ with 32 patients with chronic musculoskeletal pain (17 of whom had fibromyalgia) compared PEMF (400 μ T, 40 minutes twice daily, 7 days) with placebo. In fibromyalgia patients, a trend towards pain reduction was observed ($p = 0.06$), whereas no effects occurred in non-fibromyalgia patients. A review article ⁽²³⁾ summarised that PEMF activates adenosine signalling pathways and modulates the inflammatory response in preclinical models.

Hypothesis: PEMF could exert analgesic and anti-oedematous effects via the modulation of inflammatory mediators (e.g. IL-1 β , NO), particularly in the early postoperative phase. However, an investigation of the effect on systemic inflammatory processes or autoimmune diseases in humans is still pending.

Skin – Chronic Wounds

A randomised, double-blind, placebo-controlled multicentre study ⁽⁶⁾ investigated the effect of PEMF in 31 patients with therapy-resistant venous leg ulcers. After 8 weeks, the verum group showed a 47.7 % reduction in wound area (placebo: +42.3 %, $p < 0.0002$), a significant decrease in wound depth ($p < 0.04$) and pain intensity ($p < 0.04$). 50 % of verum patients showed complete or marked improvement (placebo: 0 %). A review article ⁽²²⁾ confirmed that PEMF promotes wound healing through vasodilation, angiogenesis and modulation of the inflammatory response. **Hypothesis:** PEMF could be effective particularly in chronic wounds with impaired microcirculation, although the optimal therapy duration and frequency remain unclear.

Cognition and Psyche – Fibromyalgia

The verum group received 30 minutes of PEMF stimulation twice daily for 3 weeks, the placebo group a sham treatment. Primary endpoints were the Fibromyalgia Impact Questionnaire (FIQ), VAS pain, Beck Depression Inventory (BDI) and SF-36. These effects persisted until the 12-week follow-up, with the exception of the overall FIQ score. The placebo group showed improvements only in BDI and SF-36. **Hypothesis:** PEMF could have a symptomatic effect in fibromyalgia, particularly on pain and depressive symptoms. However, an investigation of long-term efficacy and the underlying neurobiological mechanisms is still pending.

Further Applications – Postoperative Pain and Orthodontics

A double-blind, placebo-controlled pilot study ⁽¹⁰⁾ investigated PEMF in 42 female patients after breast augmentation. After 3 days, the verum group showed significant pain reduction (VAS, $p < 0.001$) and lower analgesic consumption ($p = 0.002$). The effects persisted until day 7.

A systematic review evaluated interventions to accelerate orthodontic tooth movement. Of five included RCTs, only one study examined PEMF and found no significant effects on tooth movement or treatment duration. Limitations were the low study quality and the heterogeneity of PEMF parameters. **Hypothesis:** PEMF could be effective in postoperative pain therapy, particularly in soft-tissue procedures. Clarification of efficacy in orthodontics is still pending.

Overall Picture

The controlled human studies provide indications that PEMF could potentially be effective in various clinical application areas, particularly in bone and joint disorders, chronic wounds and postoperative pain. The strongest indications from the controlled studies are for accelerating fracture healing (especially in delayed consolidation) and pain reduction in knee osteoarthritis, although the effects are often moderate and short-term. In diabetic polyneuropathy, fibromyalgia and chronic wounds, the data from controlled studies suggest symptomatic improvements, albeit with small sample sizes and methodological limitations (e.g. lack of long-term follow-up, heterogeneity of PEMF parameters).

Clear gaps exist in the standardisation of therapy protocols (field strength, frequency, duration, application form) and in the investigation of the underlying mechanisms. Most studies examine short-term effects (weeks to months), while long-term data on safety and efficacy are lacking. In addition, many studies were conducted with small sample sizes, which limits generalisability. Systematic investigations of dose-response relationships or combinations with other therapies (e.g. physiotherapy, medication) are rare.

Methodology of the Evidence Base

Some of the controlled PEMF studies are randomised and placebo-controlled, with blinding frequently achieved through sham devices. Typical study durations range between 4 weeks (e.g. postoperative pain) and 6 months (e.g. fracture healing), while long-term follow-ups (> 12 months) are rare. Primary endpoints usually include clinical parameters such as pain (VAS, WOMAC), function (ADL, SF-36) or radiological healing rates (e.g. fracture consolidation). Secondary endpoints often include inflammatory markers (e.g. IL-1 β), analgesic consumption or quality of life. Systematic weaknesses are the lack of standardisation of PEMF parameters (field strength: 400 μ T to 450 G; frequency: 7.5 Hz to 75 Hz; duration: 30 minutes to 12 hours/day) and the heterogeneity of the patient populations (e.g. different osteoarthritis stages, fracture locations). In addition, dose-finding studies and investigations of long-term effects or adverse effects are frequently lacking.

PEMF: A Procedure With Many Parameters – And Many Open Questions

The

PARAMETER DIVERSITY

is both curse and blessing of PEMF research. While the **flexibility** of the method theoretically allows **adaptation to different indications**, it leads to **inconsistent results** in practice. Even with seemingly similar applications (e.g. knee osteoarthritis) **frequency** (5–50 Hz), **intensity** (0.1–20 mT) and **duration of application** (10 minutes to several hours daily) vary so widely that **meta-analyses** can often only make **subgroup-specific statements**. The **most cited studies** (e.g. on osteoarthritis or diabetic neuropathy) use **different devices** and protocols, which limits **transferability**. In addition, **dose-response studies** are lacking that would clarify whether certain parameter ranges are more effective than others in the areas examined.

Another problem is the

LACK OF STANDARDISATION

of **placebo control**. Because electromagnetic fields can be **subjectively perceptible** (e.g. through tingling or warmth), **true blinding** is difficult. Some studies use **sham devices** that generate no fields but also no sensory effects – which may underestimate the **placebo effect**. In addition, **clinical endpoints** (e.g. pain scales) are often assessed **subjectively**, which impairs the **reliability** of the results. **Objective markers** (e.g. inflammatory parameters, bone density) are measured less frequently, although they would better reflect **causal relationships**. Basic research does show **biological effects** (e.g. on cytokines or stem cells), yet the **transfer into clinical practice** remains unclear.

3. How Reliable the Research Is

Research on **PEMF** focuses strongly on the **musculoskeletal system** and **bone healing**: the majority of controlled human studies fall into these areas, with **osteoarthritis** (especially knee and spine) and **fracture healing** the most common indications. Further application areas such as **inflammatory processes**, **fatigue** or **skin diseases** are investigated far less often, often with smaller samples or less robust designs. **Safety** has been examined in controlled studies, though usually as a secondary endpoint. Basic research (cell culture, animal models) accounts for part of the work and serves mainly to elucidate **signalling pathways** (e.g. adenosine receptors, osteoblast activity).

The **methodological quality** of the controlled studies is heterogeneous. Many works from the 1980s–2000s show **small samples**, short follow-up periods or unclear randomisation procedures. Newer studies (from 2010) are more frequently **double-blind** and **placebo-controlled**, yet **blinding** remains a challenge because participants can sometimes perceive electromagnetic fields. **Individual meta-analyses** (e.g. on osteoarthritis or fracture healing) reach **contradictory results**, which is attributed to **parameter diversity** and **publication bias**. The **most cited works** come from orthopaedics and show **clinically relevant effects** on pain and function, albeit with **small to moderate effect sizes**. **Long-term data** are almost completely absent.

4. What Is Often Claimed — and What the Data Provide

STATEMENT	RESEARCH STATUS
PEMF accelerates bone healing in fractures.	Controlled studies show heterogeneous results . While some studies report a shortening of healing time , others find no significant differences . Meta-analyses
PEMF relieves pain in osteoarthritis.	The evidence base is inconsistent . Some controlled studies show clinically relevant pain reduction , while others find no superiority over placebo. The effects
PEMF has an anti-inflammatory effect.	Laboratory studies show effects on inflammatory markers (e.g. Interleukin-1 β), yet clinical studies are rare. The few controlled studies (e.g. in postoperative ir
PEMF has been investigated for improving cognitive performance; the controlled results are inconsistent.	18

5. The Most Robust Studies

Ordered by strength of evidence, not by prominence. The complete evaluation comprises considerably more studies; the most robust ones are listed here.

Controlled Human Studies

- Static magnetic field therapy for symptomatic diabetic neuropathy: a randomized, double-blind, placebo-controlled trial (2003)
- ¹ The effects of low-intensity pulsed ultrasound and pulsed electromagnetic fields bone growth stimulation in acute fractures: a systematic review and m (2014)
- ² Pulsed electromagnetic field therapy of persistent rotator cuff tendinitis. A double-blind controlled assessment (1984)
- ³ Effects of pulsed electromagnetic fields on interleukin-1 beta and postoperative pain: a double-blind, placebo-controlled, pilot study in breast reduc (2010)
- ⁴ Pulsed electromagnetic fields in knee osteoarthritis: a double blind, placebo-controlled, randomized clinical trial (2016)

- ⁵ Treatment of knee osteoarthritis with pulsed electromagnetic fields: a randomized, double-blind, placebo-controlled study (2005)
- ⁶ A portable pulsed electromagnetic field (PEMF) device to enhance healing of recalcitrant venous ulcers: a double-blind, placebo-controlled clinical trial (1992)
- ⁷ Effects of Pulsed Electromagnetic Field Therapy on Pain, Stiffness, Physical Function, and Quality of Life in Patients With Osteoarthritis: A Systematic Review (2020)
- ⁸ Early application of pulsed electromagnetic field in the treatment of postoperative delayed union of long-bone fractures: a prospective randomized controlled trial (2013)
- ⁹ Effects of pulsed electromagnetic field on knee osteoarthritis: a systematic review (2013)
- Electrotherapy modalities for rotator cuff disease (2016)
- ¹⁰ Effects of pulsed electromagnetic fields on postoperative pain: a double-blind randomized pilot study in breast augmentation patients (2008)
- Randomized, prospective, and controlled clinical trial of pulsed electromagnetic field stimulation for cervical fusion (2008)
- ¹¹ Non-invasive electromagnetic field therapy produces rapid and substantial pain reduction in early knee osteoarthritis: a randomized double-blind pilot study (2013)
- ¹² A randomized, double-blind, placebo-controlled clinical trial using a low-frequency magnetic field in the treatment of musculoskeletal chronic pain (2007)
- Efficacy of static magnetic field therapy in chronic pelvic pain: a double-blind pilot study (2002)
- ¹³ Magnetic pulse treatment for knee osteoarthritis: a randomised, double-blind, placebo-controlled study (2001)
- ¹⁴ Low-frequency pulsed electromagnetic field therapy in fibromyalgia: a randomized, double-blind, sham-controlled clinical study (2009)
- ¹⁵ Additional effect of pulsed electromagnetic field therapy on knee osteoarthritis treatment: a randomized, placebo-controlled study (2010)
- ¹⁶ Effectiveness of pulsed electromagnetic field therapy in the management of osteoarthritis of the knee: a meta-analysis of randomized controlled trials (2009)
- ¹⁷ The effect of pulsed electromagnetic fields in the treatment of cervical osteoarthritis: a randomized, double-blind, sham-controlled trial (2006)
- ¹⁸ Pulsed electromagnetic field stimulation for acute tibial shaft fractures: a multicenter, double-blind, randomized trial (2011)
- ¹⁹ Electromagnetic Field Therapy: A Rehabilitative Perspective in the Management of Musculoskeletal Pain - A Systematic Review (2020)
- ²⁰ The effects of pulsed electromagnetic fields in the treatment of knee osteoarthritis: a randomized, placebo-controlled trial (2009)

6. Summary

PEMF showed effects in controlled studies on delayed fracture healing (healing rates up to 77,4 %), knee osteoarthritis (pain reduction, improved function) and postoperative pain (analgesic reduction, anti-inflammatory effects). In chronic wounds (venous ulcers) PEMF significantly accelerated healing. Safety was examined in studies as a secondary endpoint, without serious adverse effects. However, the effects are often moderate and short-term, with heterogeneous parameters and missing long-term data.

HYPOTHESIS PEMF could act via the modulation of signalling pathways (e.g. adenosine receptors, CaM/NO/cGMP, growth factors such as BMP-2), which explains the observed effects on bone healing, inflammation and wound healing. In diabetic polyneuropathy, data indicate symptomatic improvements, particularly in severe pain, but without evidence of nerve regeneration. In fibromyalgia, analgesic and antidepressant effects could be due to neurobiological mechanisms (e.g. adenosine signalling pathways), yet long-term studies are lacking here. **Hypothesis:** Efficacy could depend on the application form – local stimulation (e.g. in fractures) shows stronger effects than systemic applications (e.g. shoe insoles). A combination with other therapies (physiotherapy, medication) could act synergistically, but has hardly been investigated.

Future studies must develop standardised protocols to clarify dose-response relationships (field strength, frequency, duration). Long-term studies are essential to evaluate safety, efficacy and possible late effects. Mechanistic studies should further elucidate the underlying signalling pathways (e.g. osteoblast activity, inflammatory mediators), particularly in applications outside the musculoskeletal system (e.g. cognition, metabolism). Methodologically, double-blind, placebo-controlled RCTs with larger samples and uniform endpoints (e.g. radiological consolidation, pain scores) are necessary to reduce the heterogeneity of the existing data. In addition, the combination with established therapies (e.g. physiotherapy in osteoarthritis) should be systematically investigated to examine additive effects.

7. What Remains Open

- **Dose-response relationship:** Systematic studies are lacking that clarify which **frequencies, intensities and application durations** are optimal for which indications.
- **Long-term effects:** Almost all studies have **short follow-up periods** (weeks to months). It is unclear whether effects are **sustained** or whether there are **late sequelae**.
- **Mechanisms:** Although **signalling pathways** (e.g. adenosine receptors) have been identified, the **causal link** between laboratory findings and clinical effects is not fully clarified.

Frequently Asked Questions

Can PEMF be used for chronic wounds (e.g. diabetic ulcers)?

The evidence base is **still developing**. One of the most frequently cited controlled studies (1992) shows **accelerated healing** in **venous ulcers**, albeit with a **small sample** and **short follow-up**. Newer studies are lacking. Basic research suggests **effects on angiogenesis and inflammation**, yet clinical recommendations cannot be derived from this.

Are there indications of an effect of PEMF in neurological conditions (e.g. Parkinson's, multiple sclerosis)?

The research is **very limited**. There are **no controlled studies** on Parkinson's or MS. Individual studies on **cognitive effects** show **no consistent results**. Basic research examines **neuroprotection** and **synaptic plasticity**, yet a **clinical benefit** is not established.

How safe is PEMF? Are there known side effects?

Controlled studies examined **safety**, usually as a secondary endpoint. **Serious adverse effects** were not reported. **Mild effects** such as **tingling, sensation of warmth or transient increase in pain** occur occasionally. **Contraindications** (e.g. pregnancy, pacemaker) have **not been systematically investigated**, but are **empirically taken into account** in practice.

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International Health Research

Research, put in context. Every statement leads to the original paper; the decision in the individual case rests with the treating professional.
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