



# The Power of PEMF for Podiatry

This technology, well-known for healing fractures, can also be a valuable tool for reducing inflammation and pain.

BY BEN PEARL, DPM

The first medical application for PEMF (pulsed electromagnetic field) was developed in 1932 by a physician/physicist team. Abraham Ginsberg produced a unit called the Diapulse to treat wounds and burns, under the premise that by treating increasing circulation they could help wound healing. The FDA approved PEMF for delayed unions in 1979 and for postoperative pain and edema in 1991. Today the technology is widely used. The PEMF medical market was estimated to be approximately \$417 million in 2022 and is projected to double over the next decade.

## How PEMF Works

PEMF differs from continuous EMF devices such as cell phones. Its energy is delivered in discrete units, or pulses, making it inherently safer for the body,

---

**PEMF's energy is delivered in discrete units, or pulses, making it inherently safer for the body.**

---

which is like a battery and sensitive to electric charge. PEMF's pulses stimulate cell activity and enhance cell permeability through a polarizing action on the cell membrane. Our cells function as batteries that have ions like sodium and potassium, which affect neurotransmission. Because blood contains iron, it is also affected by magnetic fields that enhance circulation. PEMF also provides energy for the mitochondria, the engine of the cell, increasing the population and maturity of osteoblasts, the key cells for building bone. Because of this, it can speed up fracture healing and be used to treat osteoporosis. (Although there is no FDA clearance for such treatment of osteoporosis, several studies have shown evidence of improved bone density scores, including a randomized trial by Anwar Ebid (Ebid, 2022).<sup>1</sup>

The power, or flux density, of the PEMF unit is expressed as Gauss (GS). 10,000 Gauss is equivalent to 1 Tesla. The frequency, or rate, of pulse is expressed as hertz (Hz). Within the frequency of waves there is variation of the shape of the waves and how intermittent the waves are produced, which adds another layer of variation between machines.

Currently, there are several different PEMF devices on the market, with biologic frequencies typically in the 30 Hz range. This corresponds to the natural charge levels of the cells and allows more efficient energy transfer. The major challenge with evaluating PEMF is the lack of standardization around the power and frequency of the devices used in the studies. This makes comparison studies very difficult to evaluate with different machines at different settings.

Low-power units are generally under 1000 GS. High-power units in the clinical setting are generally between 1000 and 50,000 GS. Low-power units are widely available for consumer purchase and include mats and wraparound units. For the most part, these reside in the health and wellness category, and high-power PERF units are more appropriate for clinical settings. High-power units require much less treatment time, typically 15-20 minutes per session for one anatomic area. Patients will experience various levels of sensation before and after treatments. Depending on the sensitivity of the injury, it

*Continued on page 74*

## New Concepts and Studies

*"Clinical Innovations" is PM's ongoing series of articles dedicated to introducing new concepts, technologies and studies to the podiatric community. Readers should be aware that Podiatry Management does not specifically endorse any of the technologies, concepts, or products being discussed.*



may be necessary to start out at a low power setting. It is common for the muscles in the treatment area to contract during the pulse phase of the treatment, and patients may notice a slight vibration with home-based and wearable units. But a lack of sensation doesn't mean the PEMF isn't working. The treatment times of the lower power units typically require more time, ranging from 30 minutes to several hours, depending on the condition.

## Protocols

### Fractures

Fracture healing is the most vetted indication for PEMF. Low-power units for home use require several hours of application a day. Ultrasonic units are an alternative that require only a 20-minute treatment per day. These have a fresh fracture indication for anatomically challenging cases like Jones fractures of the fifth metatarsal. Ultrasound units require more precise alignment of the transducer with the fracture than PEMF units, because PEMF produces a field that extends beyond the surface area of the device, although the strength of the field degrades the farther the unit's distance gets from the fracture.

One advantage of treating patients immediately with a high-power unit is that the treatment can also reduce

---

---

**One advantage of treating patients immediately with a high-power unit is that the treatment can also reduce swelling and pain in the moment, without waiting for an authorization from insurance.**

---

---

swelling and pain in the moment, without waiting for an authorization from insurance. Most of these cases are only covered by patients that are in the category. Many active patients are willing to pay for treatments that are not covered by insurance because they like the option of being able to immediately treat a fracture to decrease their healing time.

### Neuropathy

PEMF has several advantages as a neuropathy treatment. It does not have any side effects like medications do. It can be administered at home—the VA recently approved a regimen with a home use PEMF device—and it can be used to treat pain. Restoring sensation is more challenging. Nerve regeneration takes much more time and, in many cases, damage may be too great to allow recovery. PEMF can also be used to stimulate motor nerve pathways that have been inactive or have decreased function (Graak V, 2009).<sup>2</sup>

### Sprains/Strains

PEMF is very effective for acute sprains and strains. It is not unusual to have dramatic reduction in swelling and pain after one or two treatment sessions. You can demonstrate the improvement and swelling to the patient by measuring the girth before treatment and taking photos of the swelling before and after treatment. It is always a good idea to document how much improvement a patient in pain has after each session.

### Wound/Post-Op Healing

There is some evidence that PEMF can increase the rate of wound healing (Cheing GL, 2014).<sup>3</sup> An RCT by Kwan et al reviewed chronic diabetic ulcers. One group had 14 PEMF

---

---

**These devices are very effective for acute sprains and strains, often showing dramatic reduction in swelling and pain after one or two treatment sessions.**

---

---

treatments over three weeks at settings of 12 HZ and 12 GS, while the control group only had standard wound care. The treatment group decreased the ulcer areas by 18%, compared to 10% with the control group (Flatscher, 2023).<sup>4</sup>

In vitro studies have suggested that PEMF can also decrease infection rates (Juncker RB, 2022).<sup>5</sup> The body produces electromagnetic fields on a cellular level that can become imbalanced in the presence of infection. PEMF can help restore the imbalance and stimulate whole blood cell production. More in vitro studies would be beneficial in guiding protocols and validating the clinical applications for infections.

### Combination Modalities

PEMF also can be combined with other modalities, such as shockwave. Some PEMF units have infrared built into the device itself, enabling you to apply both modalities simultaneously. There are different approaches to the order of the different modalities, e.g., starting with PEMF prior to shockwave is preferred if the treatment area is particularly sensitive. It should be noted that PEMF is able to penetrate tissue without the same impedance that other modalities have.

Patients will have different sensitivities to PEMF. Patients who have anxiety, chronic fatigue, low blood pressure, or autoimmune diseases are more likely to need lower-power doses. Some scientists suggest that extremely high frequency settings on PEMF can potentially cause free radical damage in the cells. It may be best to stay within the "biologic zones" of the cell until consensus can establish whether higher frequencies are safe for regular use.

Insurance plans only cover PEMF units that are delivered to patients for delayed and nonunion fractures. Of-

*Continued on page 76*



office-based units are not covered and are an out-of-pocket expense for patients.

In summary, PEMF is a valuable tool for office-based treatments and has many applications. More research with standardization of protocols and PEMF machines would

---

---

## PEMF is a valuable tool for office-based treatments and has many applications.

---

---

elevate this technology to the next level. AI can help in this endeavor, particularly as it becomes more sophisticated, but more attention to standardization will lead to better guidance for practitioners (Kwan RL, 2015).<sup>6</sup> PM

### References

- <sup>1</sup> Anwar Ebid. "Effect of Pulsed Electromagnetic Field versus Pulsed High Intensity Laser in the Treatment of Men with Osteopenia or Osteoporosis: a Randomized Controlled Trial." *F1000Research* (2022): n. pag. Print.
- <sup>2</sup> Graak V, Chaudhary S, Bal BS, Sandhu JS. Evaluation of the efficacy of pulsed electromagnetic field in the management of patients with diabetic polyneuropathy. *Int J Diabetes Dev Ctries.* 2009 Apr;29(2):56-61. doi: 10.4103/0973-3930.53121.

PMID: 20142869; PMCID: PMC2812751.

<sup>3</sup> Cheing GL, Li X, Huang L, Kwan RL, Cheung KK. Pulsed electromagnetic fields (PEMF) promote early wound healing and myofibroblast proliferation in diabetic rats. *Bioelectromagnetics.* 2014 Apr;35(3):161-9. doi: 10.1002/bem.21832. Epub 2014 Jan 3. PMID: 24395219

<sup>4</sup> Kwan RL, Wong WC, Yip SL, Chan KL, Zheng YP, Cheing GL. Pulsed electromagnetic field therapy promotes healing and microcirculation of chronic diabetic foot ulcers: a pilot study. *Adv Skin Wound Care.* 2015 May;28(5):212-9. doi: 10.1097/01.ASW.0000462012.58911.53. PMID: 25882659.

<sup>5</sup> Juncker RB, Lazazzera BA, Billi F. 2022. Pulsed Electromagnetic Fields Disrupt *Staphylococcus epidermidis* Biofilms and Enhance the Antibiofilm Efficacy of Antibiotics. *Microbiol Spectr*10:e01949-22. <https://doi.org/10.1128/spectrum.01949-22>

<sup>6</sup> Flatscher, J., Loriè, E. P., Mittermayr, R., Meznik, P., Slezak, P., Redl, H., & Slezak, C. (2023). Pulsed Electromagnetic Fields (PEMF)—Physiological Response and Its Potential in Trauma Treatment. *International Journal of Molecular Sciences*, 24(14), 11239.



**Ben Pearl, DPM** has served as a consultant at the NIH and is a fellow of the American Academy of Podiatric Sports Medicine. He has a sports medicine practice in Arlington, VA and is active in running, biking, skiing and soccer.