Redefining dental care standards with advanced proven PEMF technology

Prof. Shlomo Barak DMD, Israel

Pulsed Electromagnetic Fields (PEMFs) technology, known for its therapeutic benefits, has gained recognition for its non-invasive nature and ability to fully penetrate tissues. It has been extensively studied for its impact on biological processes, including DNA synthesis, gene expression, and cell migration.

PEMFs therapy has found applications in various medical and dental treatments, offering relief from postoperative pain, managing inflammation, and aiding in bone and wound healing. This review explores the historical development of PEMFs technology, detailing its *in vitro* and *in vivo* studies, and highlighting its diverse therapeutic applications in medical and dental fields. From its origins in the 19th century to modern-day applications, PEMFs have evolved into a promising therapy with significant potential in clinical settings.

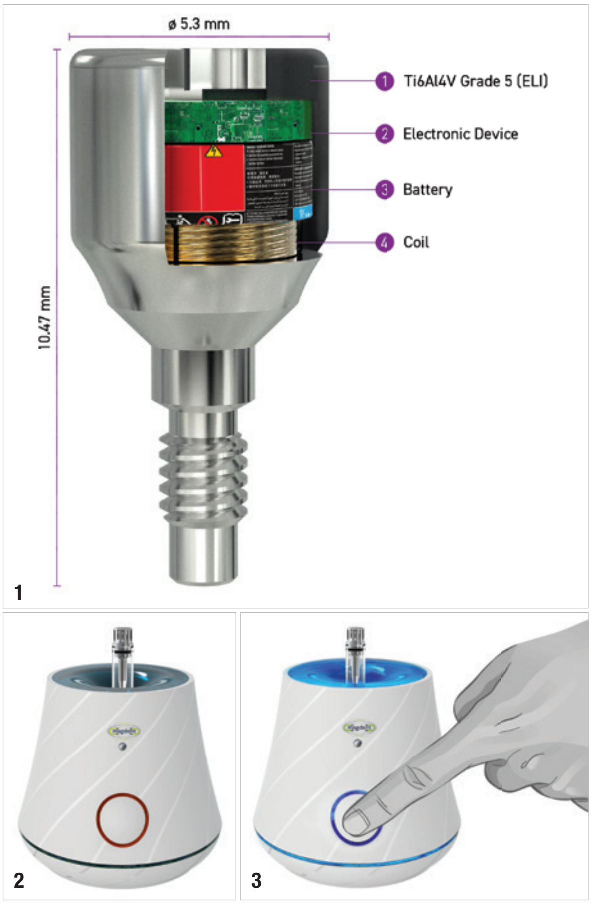
This innovation is not just a breakthrough in patient care; it represents a substantial growth opportunity in the dental tech market. Implementing Magdent's device in clinics has shown to increase income by offering efficient, premium treatments and helps implant companies to save millions on their R&D pipeline, offering its technology with their products.

In vitro studies demonstrate PEMFs' ability to influence cellular activities, such as apoptosis, proliferation, and differentiation, through modulation of ion channels and signal transduction pathways. *In vivo* studies further support these findings, showing effects on tissue hypoxia, capillary blood flow, and wound healing.

PEMFs in implantology

Pulsed Electromagnetic Fields (PEMFs) have made significant strides in dental applications, particularly in dental implantology. Dental implants, which rely on primary stability for successful osseointegration, often face challenges with poor bone quality. Studies have shown that PEMFs stimulate bone formation, induce osteoid formation, and promote neo-vascularisation, ultimately improving bone quality around dental implants.

Magdent with its exclusive proprietary patents has developed a Miniaturised Electromagnetic Device (MED) for PEMFs therapy in dental implants. This device, resembling traditional healing abutments, significantly improved implant stability, bone quality, and reduced pro-inflammatory cytokine levels compared to conventional healing abutments. It was found to enhance implant stability, particularly in the early healing phases, and contribute to improved bone development surrounding the implant.



Figs. 1–3: A cross-sectional view of the Miniaturised Electromagnetic Device (MED) healing abutment **(1)**; an activator device which triggers the battery in the MED **(2 & 3)**.

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1 Norton MR, Astrom M. The influence of implant surface on maintenance of marginal bone levels for three premium implant brands: A systematic review and meta-analysis. Int J Oral Maxillofac Implants 2020;35(6):1099-111

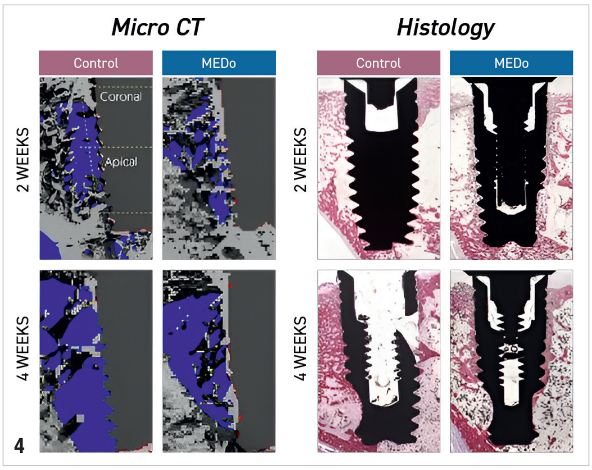

Fig. 4: Bone-to-implant contact higher in test implants after two weeks and stable after four weeks.

Furthermore, PEMFs therapy has shown promise in treating peri-implantitis, a common complication that can lead to implant loss if untreated. Studies have investigated the use of MED in implants affected by peri-implantitis, demonstrating significantly less crestal bone loss, lower levels of pro-inflammatory cytokines, and overall improvement in clinical parameters compared to conventional treatments.

The introduction of the Miniaturised Electromagnetic Device (MED) marks a significant advancement, particularly in dental implantology, by promoting implant stability, osseointegration, and antimicrobial effects, improve bone quality and address complications as peri-implantitis (Figs. 1–3).

Magdent has been working for the past few years with world-recognised researchers such as Prof. Jamil Shibli, Dr Yaniv Mayer and Dr Alberto Monje, supported by its founders, Prof. Shlomo Barak and Dr Moshe Neuman.

Based on Magdent's disrupting results, the company has been working with leading dental implant companies to distribute its products through their distribution channels, currently available in Europe, and targeting its launch in the US towards the end of 2025.

Increasing bone-to-implant contact & trabecular bone volume density: "A new device for improving dental implants anchorage: a histological and micro-computed tomography study in the rabbit". Barak et al. Clinical Oral Implants Research. 2016 Aug;27(8):935–42.

Dental implants typically require a two- to six-month healing period before loading, but shortening this time increases failure rates, particularly for unsplinted implants. Immediate loading necessitates primary stability and adequate bone tissue quantity and quality at the interface, affecting prognosis. Additional stimulants for enhanced osteogenesis are needed to overcome failures, especially in poor bone quality, and shorten loading times.

The study conducted on rabbits involved the insertion of implants in the proximal tibial metaphysis, with half receiving a healing cap containing an active PEMF and the other half receiving a traditional cap. At two and four weeks, samples underwent micro-computed tomography and histology. Results showed significant increases in trabecular bone fraction, trabecular number, and connectivity density in the coronal region of test implants compared to controls at both time points. Additionally, bone-to-implant contact was higher in test implants after two weeks and remained stable at four weeks (Fig. 4). The study concludes that the PEMF device accelerated early bone formation around dental implants resulting in higher peri-implant BIC and bone mass already after two weeks which suggests an acceleration of the osseointegration process by more than three times.

This marks a significant milestone for millions of chronic patients with poor bone quality, including those suffering from conditions like diabetes, osteoporosis, and heavy smokers, all of whom are at a high risk of failure.

Effect of PEMF on Dental Implants Stability—Accelerating Osseointegration: "Effect of the Pulsed Electromagnetic Field (PEMF) on Dental Implants Stability: A Randomized Controlled Clinical Trial". Bhukya P. Nayak et al. Materials. 2020 Apr 3;13(7):1667.

The waiting period for functional loading after osseointegration can be lengthy in dental implants procedures. Recent advancements allow for earlier loading, addressing patient discomfort and improving quality of life. Primary

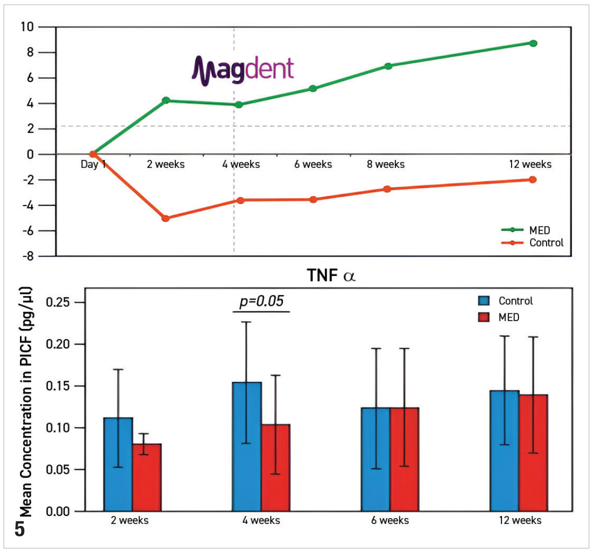

Fig. 5: Implant stability change from baseline in ISQ (Implant Stability Quotient).

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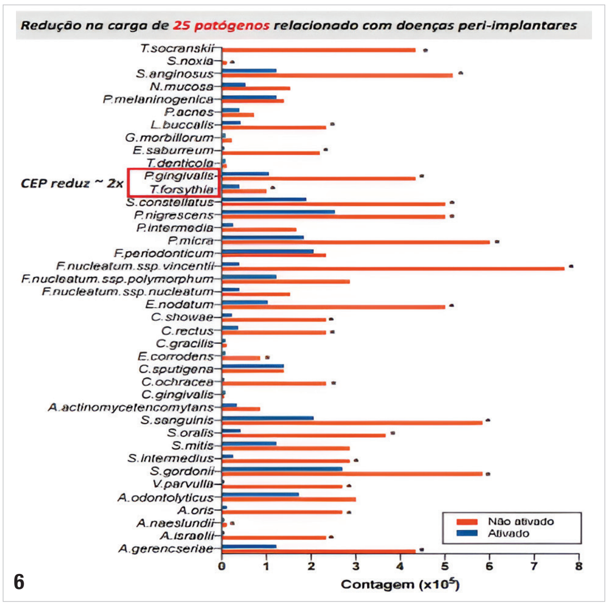


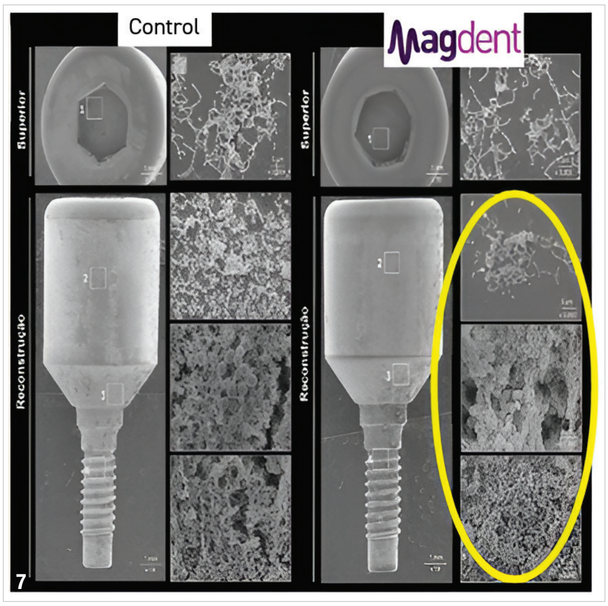


Fig. 6: Changes in bacterial biofilm around implant. **Fig. 7:** The Magdent MED generated PEMF may have an antimicrobial effect on bacterial species.

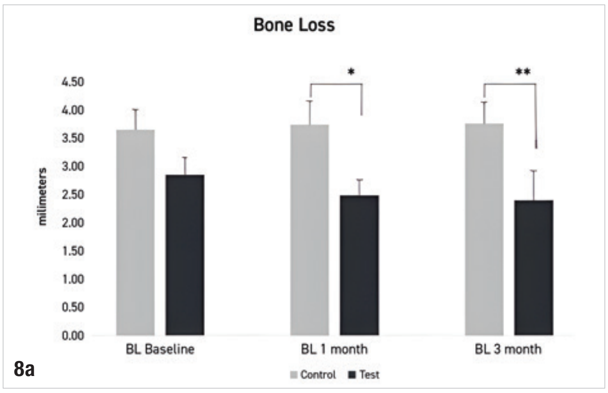
implant stability is crucial for successful osseointegration, influenced by tissue quantity and quality.

In this randomised clinical study, implants treated with the Miniaturised Electromagnetic Device (MED) showed a significant increase in stability by 13% compared to a 2% decrease in the control group. The MED-treated group also demonstrated a notable decrease in marginal bone loss at six and 12 weeks. Primary stability, crucial for long-term implant survival, remained consistently higher in the MED group throughout the study period, indicating superior total stability. This enhanced stability is attributed to PEMF's ability to promote osteoblast activity and proliferation, shifting the balance between bone resorption and formation in favour of the latter. Lower levels of proinflammatory cytokines (TNF-α and IL-1β) in the MED group further support the positive impact of PEMF treatment on implant stability by modulating the inflammatory response.

These results indicate that PEMF treatment may enhance implant stability and establish a new benchmark for care, shortening the healing period and achieving full osseointegration within four to eight weeks instead of the conventional three to six months (Fig. 5).

Impact of PEMF on bacterial biofilm colonisation around implants: "Antimicrobial effects of a pulsed electromagnetic field: an in vitro polymicrobial periodontal subgingival biofilm model". M. Faveri et al. Biofouling. 2020:1–8.

PEMF have been explored for their antimicrobial properties and potential in orthopaedics and wound healing showing that could affect bacterial membranes, altering cell metabolism and growth. The aim of this *in vitro* study was to assess the antimicrobial effects of PEMF on a polymicrobial subgingival periodontal biofilm model, potentially offering a novel approach to managing peri-implant diseases.



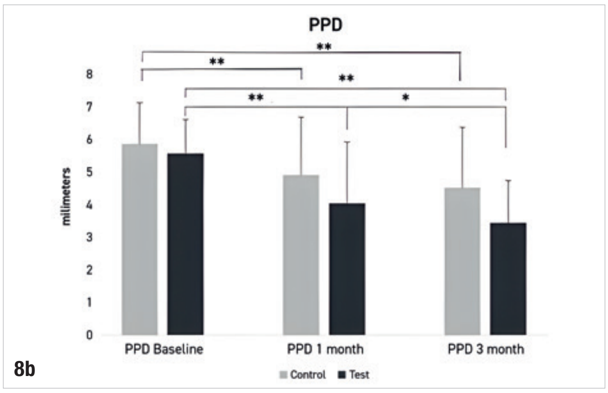
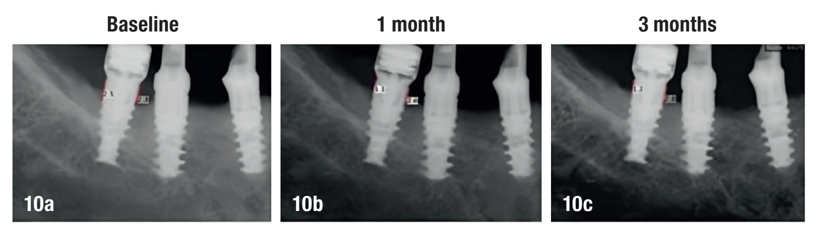


Fig. 8a: The distance from the implant shoulder to bone crest was measured on X-rays using the ImageJ software at baseline (T0), one month (T2) and three months (T3). *$p<0.05$, **$p<0.01$ **Fig. 8b:** Mean of pocket depth measurements at baseline, one and three months in control and test groups. *$p<0.05$, **$p<0.01$



Figs. 9a–c: The distance from the implant shoulder to bone crest in a patient from the test group: Measurements taken at baseline **(a)**; after one month **(b)**; and after three months **(c)**. **Figs. 10a–c:** The distance from the implant shoulder to bone crest in a patient from the test group: Measurements taken at baseline **(a)**; after one month **(b)**; and after three months **(c)**.

The results indicate significant differences in bacterial counts between the test and control groups. Total bacterial counts were lower in the test group compared to the control group, with a statistically significant difference ($p = 0.0492$). Analysis of specific bacterial species revealed that seven species were significantly elevated in the control group, including *E. nodatum*, *F. nucleatum ssp. nucleatum*, *S. intermedius*, *S. anginosus*, *S. mutans*, *F. nucleatum ssp. vicentii*, and *C. ochracea* ($p < 0.05$). The mean percentage of DNA probe counts revealed significantly higher proportions of two bacterial species in the test group (*G. morbillorum* and *A. gerencseriae*) compared to three bacterial species in the control group (*E. nodatum*, *F. nucleatum ssp. nucleatum*, and *S. mutans*; Fig. 6).

The Magdent MED generated PEMF may have an antimicrobial effect on bacterial species and can be considered as a new treatment modality to control bacterial colonisation around dental implants.
Recently, the company has undertaken a comparable clinical study, confirming identical results and presenting a significant new approach to managing peri-implant diseases (Fig. 7).

Influence of PEMFs on peri-implantitis: "A novel non-surgical therapy for peri-implantitis using focused pulsed electromagnetic field: A pilot randomized double-blind controlled clinical trial". Mayer et al. Bioelectromagnetics. 2023;44:144–55.

Peri-implantitis, characterised by inflammation and bone loss around dental implants, is a significant concern in dentistry. While various treatments exist, their effectiveness can be limited. This study aimed to evaluate the effectiveness of PEMF therapy as an adjunct to non-surgical treatment for peri-implantitis.

The study encompassed patients diagnosed with peri-implantitis, categorised into two groups: a test group undergoing PEMF therapy via an innovative healing abutment embedding active PEMF, and a control group receiving inactive PEMF. Following non-surgical mechanical debridement of the implant surface, assessments—clinical, radiographic, and immunological—were conducted at baseline, one month, and three months (Figs. 8–10). Among the 23 patients with 34 implants studied, the test group exhibited significantly lower mean crestal bone loss compared to the control group. Additionally, IL-1β levels were notably reduced in the test group at two weeks. Noteworthy improvements were observed in peri-implant pocket depth, plaque index, and bleeding on probing across both groups throughout the study duration.

The study findings underscore the potential of PEMF therapy as a complementary approach to non-surgical treatments for peri-implantitis, showcasing its ability to reduce inflammation and bone loss. Notably, PEMF therapy exhibits promise in fostering tissue repair and diminishing proinflammatory cytokines. Mayer et al. emphasise a new paradigm in dental implantology by using PEMF therapy receiving favourable outcomes with the test group displaying enhanced clinical parameters and decreased bone loss relative to the control group over a brief observation period.

about the author

Prof. Shlomo Barak DMD is an internationally recognised oral and maxillofacial surgeon who has published over 45 articles on oral surgery and dentistry. He is former director of Dental & Maxillofacial department—"Hillel Yafe" medical center. Prof. Barak founded and managed the "Maccabi-Dent" dental clinics chain for 18 years.

contact

Prof. Shlomo Barak
Magdent MED
Bnei-Brak, Israel
benny@magdentmed.com