Growth Factor Expression and Healing Time After Pulsed Electromagnetic Field Stimulation of 5th Metatarsal Nonunions: A Prospective, Randomized, Double-Blind Trial

Foot & Ankle Category: Midfoot / Forefoot

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Introduction
Electric and electromagnetic bone growth stimulators have been found to biologically enhance the bone healing environment, stimulating the production of numerous growth factors such as bone morphogenetic proteins, transforming growth factors, and insulin-like growth factor-II. The purpose of this study was to quantify the effect of Pulsed Electromagnetic Fields (PEMF) on growth factor expression and healing time in 5th metatarsal nonunions.

Methods
Patients between the ages of 18 and 75 with an incompletely healed 5th metatarsal fracture after 3 months of conservative treatment were included in the study. The following exclusion criteria were used: fracture gap greater that 5mm on CT scan, history of autoimmune or connective tissue disease, history of cancer, current of previous infection of the 5th metatarsal, and pregnancy. Eight patients met the selection criteria and were computer randomized into one of two treatment groups: Group 1, inactive PEMF and surgery; Group 2, active PEMF and surgery. The postoperative protocol was standardized for both groups. Antibody arrays were used to determine the growth factor levels in the biopsy samples before and after treatment. Bridging callous across 4 cortices on postoperative radiographs was used to determine healing time. The initial surgical procedure was a standardized biopsy of the nonunion site. The sample was sent for laboratory analysis, including routine evaluation for infection and the growth factor assay. The patients were then subject to the randomization protocol and separate treatment groups. All patients were brought back to the OR at 3 weeks (+/- 1 week) for definitive intramedullary screw fixation and repeat biopsy. Patients were followed at regular time intervals postoperatively with routine radiographic evaluation.

Results
All fractures healed in both treatment groups. The average healing time was 12.5 weeks (range 6 to 20 weeks) and 8.5 weeks (range 6 to 16 weeks) for groups 1 and 2, respectively. A significant increase in Placenta Growth Factor (PIGF) level was found after active PEMF treatment (p=0.043). Other factors trended higher following active PEMF including Brain-Derived Neurotrophic Factor (BDNF), Bone Morphogenetic Protein (BMP) -7, and BMP-5. No significant differences were found in the inactive PEMF treatment group.
Conclusion
The results of this study are consistent with previous reports of increased growth factor expression after the use of PEMF in fracture healing. A trend towards faster healing time was also noted in the active PEMF group. Additional studies with larger treatment groups are needed to clarify the role of PEMF in delayed fracture healing and nonunions.