

ENHANCEMENT OF BONE CONSOLIDATION USING PULSED ELECTROMAGNETIC SHORT-WAVES: EXPERIMENTAL STUDY ON MURINE MODELS



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Abstract

Introduction: Delay in bone consolidation and nonunion occur in 5-10% of the total number of fractures and are often hard to treat in order to obtain an optimum morphologic and functional result. Regarding the bone consolidation and spinal fusion, pulsed electromagnetic field (PEMF) stimulators are the most commonly noninvasive method used. The limitations of the studies that evaluated the potential of these treatments are represented by the proper moment when to start the PEMF therapy or which spectral characteristics and energy output would be the most effective.

Materials and methods: The experiment was performed on 20 murine models. After an open fracture of the left femoral diaphysis was made, there were introduced titanium nails in order to reduce and stabilize the fracture. After the second day of the intervention, ten murine models were treated with pulsed electromagnetic short – waves (PEMSW group) provide by DIAPULSE machine, ten minutes per day at 4/400 pulses/sec, for two weeks. The bone consolidation was evaluated by optical microscopy of the histological sections, micro-CT and the mechanical resistance of the bone by tree-point bonding test. Furthermore, alkaline phosphatase and osteocalcin were analyzed before the intervention, after two weeks and after eight weeks post-surgery.

Results: Histological images, at two weeks, showed in the PEMS group a more extensive and mineralized callus and micro-CT scan revealed a higher bone volume per total tissue volume (BV/TV) in the callus area: 34.23% in the PEMS group vs. 29.87% in the control group (CG) (p=0.028). Moreover, alkaline phosphatases (AP) (p=0.023) and osteocalcin (OC) (p=0.016) serum levels were higher in the PEMS group. Tree-point bonding test showed a higher mechanical resistance in the PEMS group compared to CG (p=0.03). At eight weeks histology and micro-CT revealed a more advanced stage of bone remodeling, CG had a TV of 110.72% (p<0.001) compared to PEMS group. Furthermore, the AP (p=0.19) and OC (p=0.15) serum levels showed higher values in the CG but without statistical differences.

Conclusions: Pulsed electromagnetic short-waves, applied from the second day post-operative, showed an improvement in the bone consolidation process, reducing the total period of fracture healing.

Keywords: pulsed electromagnetic short-waves, bone consolidation, titanium nails.