Extracorporeal Magnetotransduction Therapy (EMTT) enhances Osteogenic Activity in Osteoblasts and Mesenchymal Stem Cells

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INTRODUCTION:

Osteoblasts (OB), derived from mesenchymal stem cells (MSC), play a crucial role in bone formation. After differentiation, characterized by collagen type I synthesis, OBs mineralize the extracellular matrix by deposing hydroxyapatite crystals. This osteoblastogenesis is primarily influenced by the transcription of specific genes, including RUNX-2 and SP7. Electromagnetic field therapy, commonly used for bone disorders, includes a novel approach called Extracorporeal Magnetotransduction Therapy (EMTT), distinguished by higher oscillation frequency and magnetic field strength than classic PEMF therapy (pulsed electromagnetic field therapy). Given the limited studies on EMTT, we conducted the first in vitro cell study to explore its correlation with accelerated bone formation at a biological level.

METHODS:

The study involved EMTT stimulation (2 times/week, 30 min/session) on OBs and MSCs cultured for 28 days. Various assays, including PCRs, protein assays, enzyme kinetics, and stainings, were employed to assess osteoblastogenesis phases and mineralization processes.

RESULTS:

EMTT stimulation significantly enhanced all phases of osteoblastogenesis. MSCs exhibited accelerated differentiation into osteoblastic cell lines, evident in ALP kinetics ($p<0.05$). Gene expression of key regulators of differentiation, RUNX-2 and SP7, significantly increased by day 3 ($p<0.05$ and $p< 0.001$) and day 7 ($p<0.01$ and $p>0.05$), while gene expression at day 14 showed no significant difference. ELISA and PCR revealed a significant increase in collagen 1a1 synthesis, peaking at days 11 and 14 ($p<0.001$). Sirius Red staining indicated accelerated mineralization, particularly during the first 14 days. Cell viability showed no negative impact of EMTT stimulation on OBs and MSCs.

DISCUSSION AND CONCLUSION:

After extensive investigation into the impact of electromagnetic wave therapy on bone metabolism, this study marks a significant milestone by revealing that a particular type, known as EMTT, has the capacity to amplify all stages of osteoblastogenesis. From differentiation to maturation and mineralization, EMTT exerted a substantial positive impact on OBs and MSCs, offering a promising avenue for enhancing bone health.

These findings suggest EMTT's potential as a beneficial and safe treatment for bone-related issues like fracture healing, pseudarthrosis, or osseointegration.