J Cell Physiol. 2019 Jul;234(7):10588-10601. doi: 10.1002/jcp.27734. Epub 2018 Nov 13.

Pulsed electromagnetic fields regulate osteocyte apoptosis, RANKL/OPG expression, and its control of osteoclastogenesis depending on the presence of primary cilia

Pan Wang [1], Chi Tang [1], Junjie Wu [2], Yuefan Yang [3], Zedong Yan [1], Xiyu Liu [1], Xi Shao [1], Mingming Zhai [1], Jie Gao [2], Shengru Liang [4], Erping Luo [1], Da Jing [1]

Affiliations

PMID: 30422320 DOI: 10.1002/jcp.27734

Abstract

Growing evidence has shown that pulsed electromagnetic fields (PEMF) can modulate bone metabolism in vivo and regulate the activities of osteoblasts and osteoclasts in vitro. Osteocytes, accounting for 95% of bone cells, act as the major mechanosensors in bone for transducing external mechanical signals and producing cytokines to regulate osteoblastic and osteoclastic activities. Targeting osteocytic signaling pathways is becoming an emerging therapeutic strategy for bone diseases. We herein systematically investigated the changes of osteocyte behaviors, functions, and its

regulation on osteoclastogenesis in response to PEMF. The osteocyte-like MLO-Y4 cells were exposed to 15 Hz PEMF stimulation with different intensities (0, 5, and 30 Gauss [G]) for 2 hr. We found that the cell apoptosis and cytoskeleton organization of osteocytes were regulated by PEMF with an intensity-dependent manner. Moreover, PEMF exposure with 5 G significantly inhibited apoptosis-related gene expression and also suppressed the gene and protein expression of the receptor activator of nuclear factor κB ligand/osteoprotegerin (RANKL/OPG) ratio in MLO-Y4 cells. The formation, maturation, and osteoclastic bone-resorption capability of in vitro osteoclasts were significantly suppressed after treated with the conditioned medium from PEMF-exposed (5 G) osteocytes. Our results also revealed that the inhibition of osteoclastic formation, maturation, and bone-resorption capability induced by the conditioned medium from 5 G PEMF-exposed osteocytes was significantly attenuated after abrogating primary cilia in osteocytes using the polaris siRNA transfection. Together, our findings highlight that PEMF with 5 G can inhibit cellular apoptosis, modulate cytoskeletal distribution, and decrease RANKL/OPG expression in osteocytes, and also inhibit osteocyte-mediated osteoclastogenesis, which requires the existence of primary cilia in osteocytes. This study enriches our basic knowledge for further understanding the biological behaviors of osteocytes and is also helpful for providing a more comprehensive mechanistic understanding of the effect of electromagnetic stimulation on bone and relevant skeletal diseases (e.g., bone fracture and osteoporosis).

Keywords: cell apoptosis; osteoclastogenesis; osteocytes; primary cilia; pulsed electromagnetic fields.

Related information

Gene
Gene (GeneRIF)
MedGen
Protein (RefSeq)
PubChem Compound (MeSH Keyword)

LinkOut - more resources

Full Text Sources

Wiley