

# Low-frequency electromagnetic fields can influence proliferation, viability, gene expression and protein secretion of adipose-derived mesenchymal stem cells

Anna Sendera<sup>1</sup> and Agnieszka Banaś-Ząbczyk<sup>2</sup>

Department of Biology, Institute of Medical Sciences, Medical College of Rzeszow University, Rzeszow, Poland

The correspondence email: antrzyzna@ur.edu.pl

<sup>1</sup>ORCID: 0000-0001-5288-0845 <sup>2</sup>ORCID: 0000-0001-7128-861X

## Introduction

Electromagnetic fields (EMF) can positively and negatively affect the biology of stem cells including adipose-derived mesenchymal stem cell's (ASC's) fate. EMF have an impact on numerous cellular processes, such as proliferation, cell cycle as well as differentiation, by affecting specific factors and protein secretion in field type-depending and time-depending manner.

## Aim

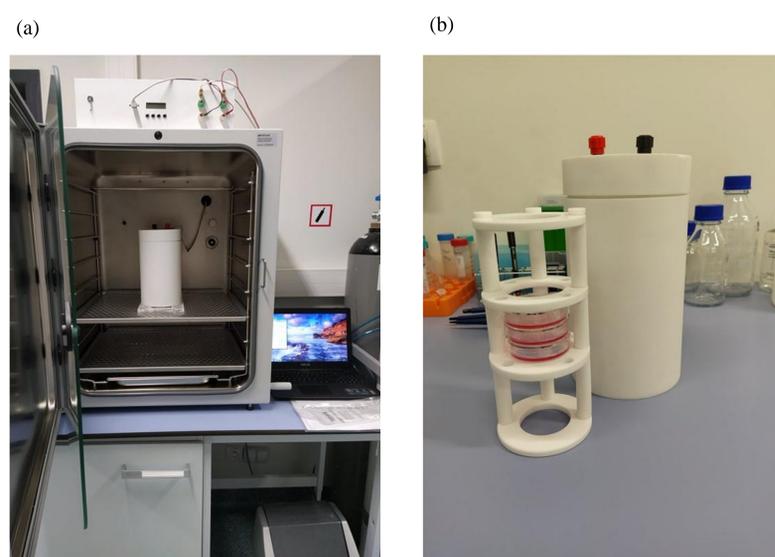
The purpose of presented study was to investigate the effect of continuous exposure of low-frequency EMF on ASCs proliferation, viability, FGF-2 protein secretion, and gene expression.

## Materials and methods

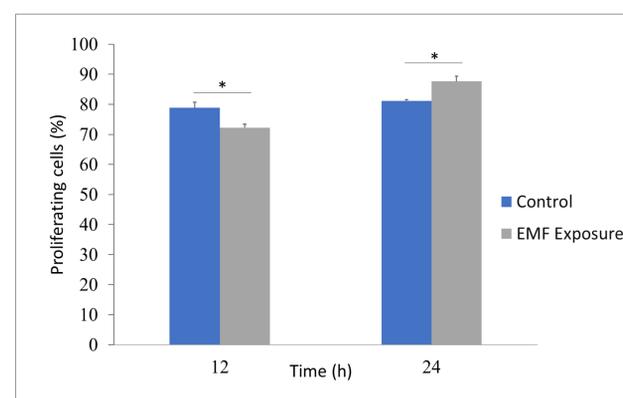
Commercially available human adipose-derived stem cells were treated with sinusoidal low-frequency EMF (76.6 Hz/20  $\mu$ T or 50 Hz/1.5 mT) continuously within the *in vitro* EMF exposure system (Fig. 1). Next, proliferation, viability, FGF-2 concentration as well as gene expression were tested with Muse<sup>®</sup> Cell Analyzer with detection of Ki67+ and Ki67- cells; FDA and PI fluorescent staining; Luminex<sup>®</sup> FLEXMAP 3D<sup>®</sup> System with Growth Factor 11-Plex Human ProcartaPlex<sup>™</sup> Panel and real-time PCR technique, respectively. Experiments were performed in triplicate, in two separate CO<sub>2</sub> incubators (one for EMF treatment, and other one for control group without EMF treatment). However, gene expression analysis is presented as preliminary results.

## Results

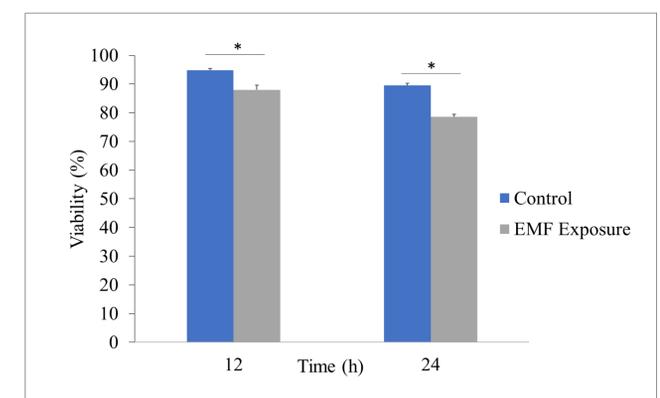
Results have shown that EMF can influence ASCs proliferation, viability, FGF-2 protein secretion as well as gene expression. We have observed that proliferation decreased after 12 hours and then increased after 24 hours (76.6 Hz) compared to control group (without EMF stimulation), however cell viability decreased (76.6 Hz; 12h, 24h). Moreover, FGF-2 protein secretion has been shown to change with time while exposed to EMF (50 Hz). We have observed 3-fold increase in FGF-2 concentration at 48 hours, and then a 2-fold decrease at 72 hours when compared to the control group. Also, relative gene expression of stem cell surface markers (CD105, CD44, CD90) and stemness markers (OCT4, SOX2) have been changed under EMF influence (76.6 Hz; 12h, 24h).



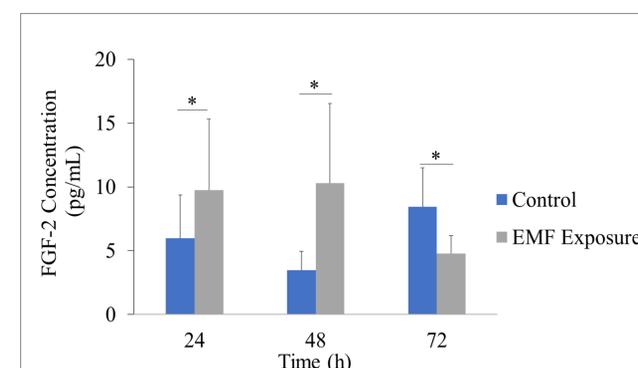
**Fig. 1** The electromagnetic field exposure system. (a) Electromagnetic fields applicator placed in CO<sub>2</sub> Incubator New Brunswick Galaxy<sup>®</sup> 170R connected with electromagnetic fields generator (b) Coil and tripod with cell culture petri dishes.



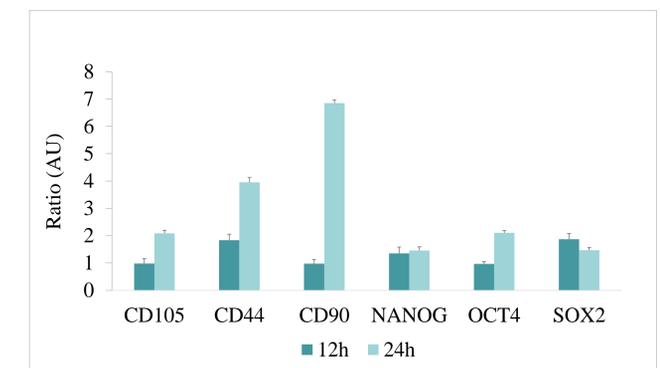
**Fig. 2** The effect of low-frequency EMF (76.6 Hz/20  $\mu$ T) on adipose-derived mesenchymal stem cells proliferation. \* indicates  $p < 0.05$ .



**Fig. 3** The effect of low-frequency EMF (76.6 Hz/20  $\mu$ T) on adipose-derived mesenchymal stem cells viability. \* indicates  $p < 0.05$ .



**Fig. 4** The effect of low-frequency EMF (50 Hz/1.5 mT) on FGF-2 secretion by adipose-derived mesenchymal stem cells. \* indicates  $p < 0.05$ .



**Fig. 5** The effect of low-frequency EMF (76.6 Hz/20  $\mu$ T) on relative gene expression by adipose-derived mesenchymal stem cells after 12 and 24 hours to untreated cells.

## Conclusions

The presented results show that EMF influence stem cell functioning and physiological processes, and in response to a new environmental conditions, such as low-frequency EMF, ASCs may engage changes in various programs and mechanisms (e.g. proliferation, viability, protein secretion, gene expression). Enhancement of proliferation as well as FGF-2 protein secretion after EMF stimulation may be important finding for use in regenerative medicine in the context of tissue regeneration and cell-free therapy establishment. Adjusting the EMF parameters that cause a specific biological effect on stem cell functioning is crucial in the background of basic studies as well as regenerative medicine.

## References

- [1] Trzyzna A, et al. (2020). *Arch Biol Sci.* 72(3):339-347. doi:10.2298/ABS200321028T
- [2] Trzyzna A, et al. (2021). *J Med Phys.* 46(3):148-153. doi:10.4103/jmp.JMP\_10\_21

## Authors note

Full materials and methods, results and discussions for proliferation, viability and different protein secretion can be found in Trzyzna et al. (2020) and Trzyzna et al. (2021).