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Effect of Nanosecond Repetitive Pulsed Microwave Exposure on Proliferation of Bone Marrow Cells

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RELEVANCE

Recently, close attention is paid to research focused on assessment of proliferative potential and regenerative features of stem cells

To regulate cellular activity and cell proliferation one uses the import specialized nutrient media.

Despite their effectiveness, these methods are quite expensive and require long-term use to achieve the required number of stem cells.

The principal ability to stimulate cell growth and to increase the speed of stem cell proliferation is provided by application of various physical factors, in particular, EHF radiation, laser radiation, pulsed electric and magnetic fields.

It is shown that irradiated by nanosecond microwave pulses with effectively influences on the functional state of a number of cells and tissues

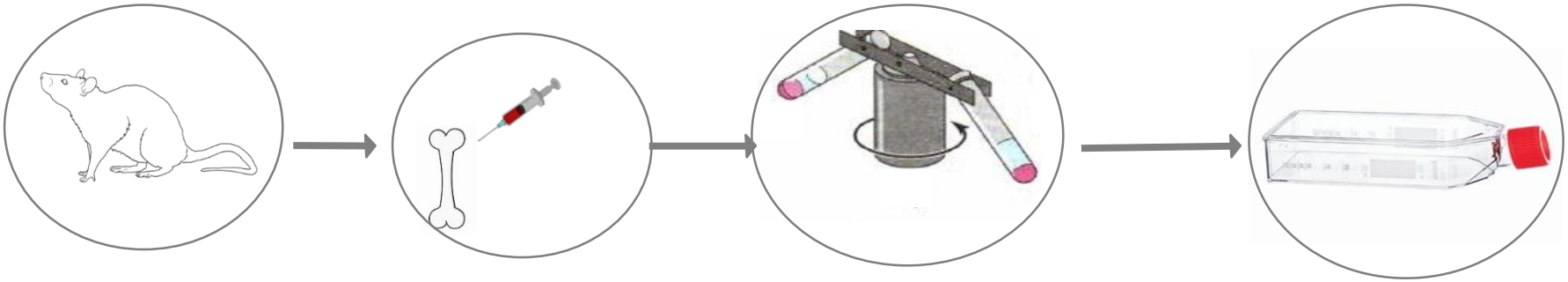
Therefore, it is not excluded that the impact of irradiated by nanosecond microwave pulses can have a stimulating effect on proliferation of stem cells, in particular, bone marrow cells?

PURPOSE

To evaluate proliferative activity of bone marrow cells after irradiated by nanosecond microwave pulses

METHODS

Obtaining mesenchymal stem cells and their cultivation



mature females (4 – 5 months) → **bone marrow washout** → **centrifugation** → **cultivation: CO2 incubator (37°C)**

Eight cultures of mononuclear cells of rat bone marrow forming monolayer on 12th -14th days (3-4 passage) were obtained to carry out experiments with the impact of nanosecond PPMR. Viability of bone marrow cells after cultivation was 91.5±2%.

METHODS

8 cultures were divided into the three groups:

1

the control one – 2 cell cultures that were not exposed to influence and were placed into a CO2 incubator.

2

the false-irradiated control one – 2 cell cultures that were placed one time near the source of microwave radiation for 5-8 minutes without switching on the generator

3

the experiment one 1 and the experiment one 2 - 4 cell cultures that werre subjected to single exposure of nanosecond microwaves with frequencies of 8 and 13 Hz.

Before starting the experiment each culture contained $4 \times 10^5 \pm 63 \times 10^3$ bone marrow cells.

IRRADIATION OF CELL CULTURE BY RPMS.

The laboratory pulse generator on the base of the MI-505 magnetron (Russia) has been used as the source of RPM.

The cells have been irradiated once with 4000 RPM pulses (carrier frequency of the generator is 10 GHz, output peak power is 180 kW, pulse duration on the half power level is 100 ns, which provides influence with peak power flow density (pPFD) of 1500 W/cm^2) with pulse repetition rates of 8 and 13 Hz.

Exposure duration was 8 and 5 minutes, respectively. The choice of exposure modes was based on the results of previous experiments for stimulation of tissue regeneration

RESULTS

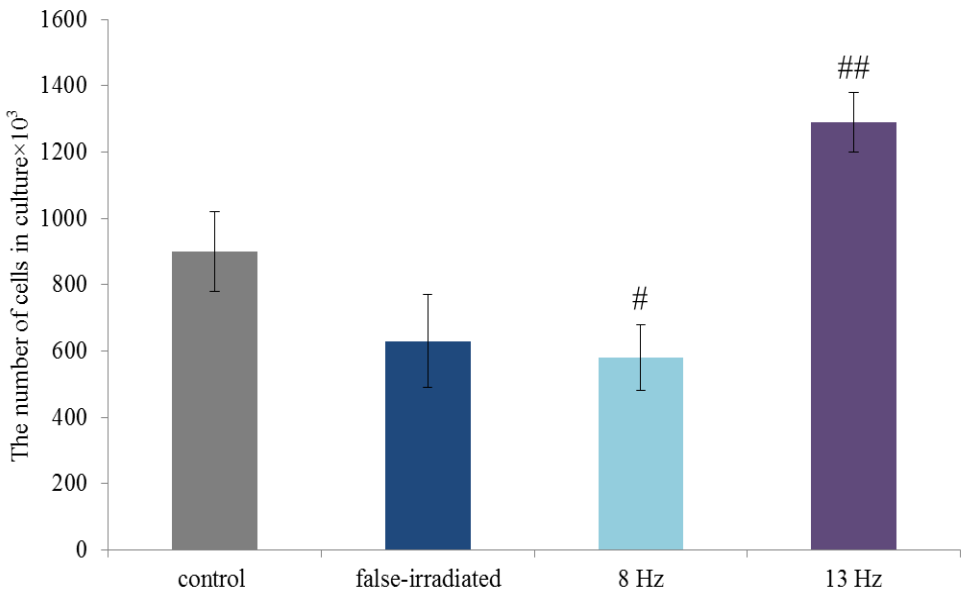


Figure – Proliferative activity of rat bone marrow cells *in vitro* after irradiation by RPMs with pPFD of 1500 W / cm^2.

Note: * - differences are statistically significant in relation to indices of control cultures of bone marrow cells; * * - differences are statistically significant in relation to the indices of control and false-radiated cultures of bone marrow cells ($p \leq 0.05$).

1. The performed study showed that to end of the experiment the number of cells in the culture of the control group has increased by **117%** in comparison with the first day and was $9 \times 10^5 \pm 112 \times 10^3$. This confirmed the high proliferative potential of the obtained cultures of bone marrow cells.

2. Analysis of the state of false-radiated cells showed that their proliferative activity decreased by **30%** in relation to the control cells . In this case, within the false-radiated group this index increased by **35%** in relation to the first day of the experiment.

3. Proliferative activity of irradiated cells was changed in dependence on the frequency of pulse repetition. In particular, irradiation of cells with pulse repetition frequency of 8 Hz in 2 days after exposure was accompanied by **40%** inhibition of cell proliferation in relation to the control group. This effect was statistically insignificant in relation to the false radiated cells. Exposure with frequency of 13 Hz, on the contrary, increased the number of cells in the irradiated culture by **30%** in relation to the control group, and by **51%** in relation to the false-irradiated culture.

SUMMARY

- It has been found that used mononuclear cells of rat bone marrow are sensitive to action of nanosecond RPM.
- The proliferative activity of irradiated cells varied in dependence on the frequency of pulse repetition.
- The obtained results have showed that it is possible to effectively stimulate proliferation of bone marrow cells *in vitro* by exposure to nanosecond RPM, which requires further research to identify exposure modes that provide the most effective stimulation of stem cell proliferation. This will serve to solve a practical problem, the rapid development of the necessary number of stem cells required for specific need for regenerative medicine.

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Thank you!