Contribution ID: **206** Type: **Poster Presentation**

Electric Pulse Manipulation of Stem Cell Proliferation and Differentiation

Thursday 7 July 2016 14:40 (20 minutes)

A single 2.5 or 5.0 V/cm electric pulse (EP) of 90 s duration induced changes in cardiomyocyte differentiation, increasing the number of beating foci with the higher field strength increasing intracellular reactive oxygen species [1]. Similar field strengths can also induce cytoskeletal stresses that facilitate manipulation of osteoblasts and mesenchymal stem cells [2]. While effective, these treatments often require relatively long application times and the mechanisms may be challenging to apply consistently and the physical interactions may conflict with long-term physiological effects. We hypothesize that intense nanosecond electric pulses (NSEPs) can overcome these side effects while additionally leveraging additional physical mechanisms that they introduce, such as plasma membrane nanoporation, ion transport, and intracellular structure manipulation [3]. Through their ability to control growth factors and provide both mechanical and electrical stresses [4], appropriate tuning of EP parameters facilitate adequate microenvironment control to manipulate stem cell function. We experimentally assessed the impact of pulse duration, field intensity, and number of pulses on muscle stem cell population dynamics by examining increased proliferation using a photospectrometer and enhanced proliferation for various energy ranges using fluorescent microscopy. The potential implications of these results to regenerative healing and tissue repair will be discussed.

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Session Classification: Poster 2-A

Track Classification: Biological, Medical, and Environmental Applications of Power Modulators