Functional expression of delayed rectifier potassium channels in cardiomyocytes derived from embryonic stem cells

S. Abtahi1,*, H. Sadraei2, M. Nasr Esfahani3, H. Baharvand3

1AJA University of Medical Sciences, Tehran, Iran
2Department of Pharmacology and Toxicology and Isfahan Pharmaceutical Sciences, Research Center, Isfahan, Iran. School of Pharmacy and Pharmaceutical Sciences, University of Medical Sciences, Isfahan, I.R.Iran.
3Department of Cell and Molecular Biology, Royan Institute for Animal Biotechnology, ACECR, Isfahan, I.R.Iran

Background and Aims: Reverse transcriptase polymerase chain reaction (RT-PCR) studies shows expression of potassium channels in mouse embryonic stem cell derived cardiomyocytes (ES-cardiomyocytes) but functional activity has not been reported in Royan B cells. Therefore, the objective of this research was to detect the functional activity of these potassium channels from stem cell stage and after differentiation into cardiomyocyte.

Methods: Mouse embryonic stem (ES) cells were differentiated into beating cardiomyocytes by hanging drop method. The ES cells and ES-cardiomyocytes were isolated to single cell suspension for current recording using whole cell patch-clamp technique. The bath solution included 130 mM NaCl and 1.5 mM CaCl2. The intracellular pipette solution included 130 mM KCl, 3 mM ATP and 0.2 mM EGTA.

Results: The predominant depolarizing current in ES-cardiomyocytes was a tetraethylammonium (TEA,10 mM) sensitive current which was partially blocked by nifedipine (1 µM) and attenuated by increasing concentration of EGTA (10 mM) in pharmacology and the pipette solution electrophysiological properties of this oscillatory sustained current very well matched with characteristics of Ca2+ activated potassium current. In addition there was another kind of sustained outward K+ current which was resistant to TEA but was inhibited by 3,4-diaminopyridine. The characteristic features of this current indicate that this current was due to activation of delayed rectifier potassium channels.

Conclusions: RT-PCR studies confirms expression of K+ channels in ES-cardiomyocytes. However these channels to less extent were also expressed in early stem cell stage. The present study shows that at early stage, these channels are not functional but develop into specific potassium ionic currents when the cells convert into adult cardiomyocytes.

Keywords: Patch-clamp; tem cel ES-cardiomyocytes; K+ current