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The effect of intracellular Na^+ on spontaneous action potential of single cardiac myocytes in rabbit pulmonary vein

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Even though atrial fibrillation is the most prevalent arrhythmia, the mechanism of development is not yet clear. Recently, there has been several reports that the most frequent source of paroxysmal atrial fibrillation is located inside pulmonary vein. Recently we successfully isolated single cardiac myocytes which were inside of pulmonary vein and reported the spontaneous action potential was generated from these cells. Therefore these cardiac myocytes may be possible source of ectopic focus of atrial fibrillation. But still we don't know how these cells can generate such rapid firing action potentials which are usually shown in atrial fibrillation states. Generally atrial fibrillation model can be made with chronic application of rapid electrial stimulation to heart, From this idea, there may be linked between intracellular ion milleau changes and the development of atrial fibrillation. We tested the effect of the change of intracellular [Na^+] on action potential development. When we increased $[Na^+]_i$ from 0 mM to 30 mM, the action potential frequency was increased from 1-2 Hz to over 5Hz which is generally seen in the atrial fibrillation. In a Na^+ loaded condition, the MDP of action potential was changed from -51 mV to -43 mV. When we applied step depolarization from 0 mV to 60 mV with the holding potential of -40 mV, transient outward current was activated. The amplitude of the current was increased as $[Na^+]_i$ was increased. Cl^- channel blocker, 9-AC and DIDS, inhibited this current. The removal of extracellular Cl^- also inhibited the transient component of the outward current. Intracellular Ca^{2+} was chelated with 20 mM EGTA, the transient current component was abolished. Therefore, we think this current may be Ca^{2+} activated Cl^- current. In the presence of 5 mM Na^+ in pipette solution, 300 uM DIDS did not inhibit spontaneous action potential but in the presence of 15 mM Na^+, 300 uM DIDS inhibit spontaneous action potential. In conclusion, the increase of $[Na^+]_i$ increased the frequency of spontaneous action potential and this effect may be due to the activation of Ca^{2+} activated Cl^- current. The increase of $[Na^+]_i$ may induce the change of intracellular [Ca^{2+}] which may linked the generation of the atrial fibrillation.