A Model for Zebrafish Ventricular Tissue

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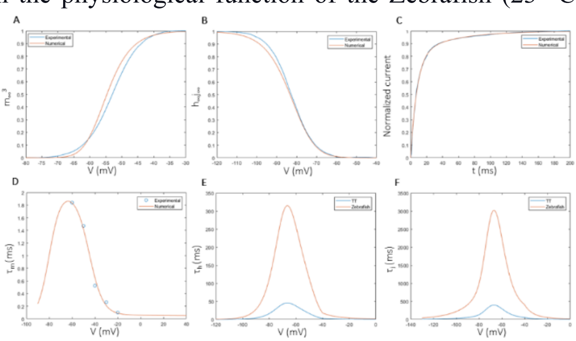
In recent years, interest in zebrafish has significantly grown thanks to its electrophysiological characteristics which make it very similar to humans. The common aspects are numerous. In particular, the zebrafish shows an action potential much closer to those of humans than other mammals generally considered. This similarity is related to the presence of ~71% of human genes orthologues that lead to a functional similarity in cardiac ion channels. Thus, zebrafish is increasingly proposed as a model for pharmacological and genetic screening. This work develops a detailed action potential model for the zebrafish by considering the main ionic channels and currents involved. The Ten Tusscher (TT) model has been reparametrized to adapt it to the zebrafish. The currents considered for the model are: fast Na^+ current I_{Na} (Figure), slow delayed rectifier current I_{Ks}, rapid delayed rectifier current I_{Kr}, inward rectifier K^+ current I_{K1}, L-type Ca^{2+} current I_{CaL}, T-type Ca^{2+} current I_{CaT} (introduced as new in the model), the Na^+/K^+ pump and the Na^+/Ca^{2+} exchanger. Instead, the transient outward current I_{to} was not considered since no evidence regarding its presence in the zebrafish was found in literature.

The model describes well the experimental data present for most of the current showing an increase in the time constants (around 7 times slower for the sodium and slow rectifying potassium current) consistent with the lower temperature associated with the physiological function of the Zebrafish (23° C against 37° C for humans). The model describes the four phases of the AP model with an upstroke of 7 mV/ms and an action potential duration of 230 ms, both in the range of experimental values.



*Steady-state and time constant curves describing the gating of the fast Na^+ current. Experimental data are from Chopra et al., 2007. **A**: steady-state activation. **B**: steady-state inactivation. **C**: activation time constants. **E**: fast inactivation time constants. **F**: slow inactivation time constants. τ_h and τ_j were obtained by scaling the TT ones due to the difference in the temperature (37 °C and 23 °C).*