RELATIONSHIP BETWEEN ION CURRENTS AND MEMBRANE CAPACITANCE IN CANINE VENTRICULAR MYOCYTES

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Current density, the membrane current value divided by membrane capacitance (C_m) is a widely used parameter in describing transmembrane ionic currents. Calculating current density is often referred to as "normalizing" the current values. This convention assumes that C_m and ion current magnitudes are linearly related for any given ion current, however, this assumption has not been thoroughly investigated so far on cardiac muscle.
Therefore, we have investigated the dependence of amplitudes and integrals of the major cardiac ion currents on C_m, using linear regression, under conventional voltage clamp (CVC) and action potential voltage clamp (APVC) conditions.
The relationship between C_m and ion current parameters was characterized by correlation analyses. Under CVC conditions the correlation was good for I_{K1}, moderate for I_{Kr} and $I_{Ca,L}$, while negligible for I_{Ks}. In the case of $I_{to1,}$ the correlation between the peak amplitude and C_m was negligible when analyzing all cells together, however, correlations were high when the cells were analyzed separately for subepicardial, subendocardial and mid-myocardial origin. Under APVC conditions high correlations were observed in the case of $I_{K1,}$ I_{Kr} and $I_{Ca,L}$. For I_{NCX}, $I_{Na,late}$ and I_{Ks} there were low-to-moderate correlations between C_m and the current parameters. The linear regression indicated a true linear relationship between C_m and current amplitudes or integrals.
In conclusion, we found good correlation between ion current amplitudes or integrals and C_m. Limited correlations are likely consequences of spatial inhomogeneity of ion current density and/or non-ideal experimental conditions. This must be considered when interpreting ion current measurements in cardiac cells.

Keywords: cardiac ion currents, membrane capacitance, current densities, current integrals, dog myocytes

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