

THE CONTRACTILE PROPERTIES OF THE SINGLE CELL LAYERED HEART OF *Boltenia Ovifera*

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The heart of the tunicate *Boltenia ovifera* consists of a straight, one-cell layer thick tube which propels blood through the circulatory system by means of peristaltic contractions. We investigated this heart to see if such a simple anatomy could be exploited to yield more information about excitation and contraction of myocardial tissue.

The excised heart was cannulated at both ends. The cannulae were in turn fixed to two micro-manipulators adjusted to hold the heart at constant length in tissue bath. Through the cannulae the luminal side of the heart could be perfused with different solutions (at constant pressure) in quick succession. The standard perfusate, upon which variations were made, consisted of 364mM NaCl, 10 mM KCl, 2 mM MgCl₂, and 10 mM CaCl₂. A stimulating Ag/AgCl electrode was passed along the length of the heart within the lumen so that upon electrical stimulation the whole heart contracted uniformly. An isometric tension transducer was attached to one end of the heart to measure the strength of these contractions.

Application of varying concentrations of KCl within the luminal side produced graded contractures which subsequently relaxed despite the continued presence of the elevated KCl concentration. Variation of KCl on the extraluminal side produced no contractures and the preparation remained excitable at all times. That the depolarization of only the internal membrane would lead to development of tension was consistent with another observation, i.e., the heart was responsive only when current was passed in such a direction as to depolarize the internal membrane. These two differences in response of the extra- and intraluminal sides can be explained by the assumption that only the intraluminal membrane is electrically excitable.

The tunicate myocardium showed a small but definite "rate-staircase" response. It also showed a graded tension response to changes in the duration and amplitude of the stimulus. We found a positive inotropic response to increases of luminal calcium concentrations and a negative inotropic response to that of magnesium. These effects were quantified and seem not to obey the kinetics of competitive inhibition. The inotropic response to intraluminal Ca⁺² and Mg⁺² were observed fully in the first beat after the changes in solution, implying that cations exchange readily throughout the extracellular space. Reduction of the intraluminal sodium concentration potentiated the twitch tension. However the potentiation could not be deduced from the [Ca]/[Na]² ratio.

It is concluded that (1) this perfused single-layered muscular preparation shows all the major contractile properties of cardiac tissue, (2) only excitation of the inner membrane elicits tension, (3) there is no significant extracellular space which is not readily exchangeable, (4) the rate staircase response in this tissue is independent of local variation of ionic concentrations in the extracellular space (if we assume there is no large "unstirred-layer effect"), and (5) the antagonistic effects of Ca⁺² and Mg⁺² on the developed tension are mediated on the surface membrane.