Effect of temperature on stretch-induced cardiac action potential shortening in the rat heart: involvement of TREK-1

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The importance of stretch activated ion channels in the modulation of cardiac electrophysiology is becoming increasingly apparent. Of the stretch activated channels known, both temperature sensitive TREK-1 and non-selective cation channels exist in the rat heart. The present study aimed to evaluate the contribution of these stretch-activated channels to changes in the rat cardiac action potential duration during stretch by taking advantage of the temperature dependent nature of the TREK-1 channel.

6 male Sprague Dawley rats 450-490g were killed by cervical dislocation, their hearts excised and retrogradely perfused on a Langendorf system. Following stabilization, hearts were subjected to three consecutive diastolic pressures (control: 0-5mmHg, moderate: 20-25mmHg and extreme: 50-55mmHg) at two randomised perfusion temperatures (32°C or 37°C). During manipulation of left ventricular diastolic pressure, endocardial and epicardial monophasic action potentials (MAP) were recorded, and the action potential duration at 80% repolarisation (APD_{80}) calculated. Under control conditions of 0-5mmHg pre-load, the endocardial APD_{80} was 40.3 ±4.2ms, while the epicardial APD_{80} was 45.4 ±4.4ms at 37°C. Decreasing cardiac temperature to 32°C increased both endocardial and epicardial APD_{80} to 46.9 ±3.9ms and 61.1 ±2.7ms respectively. The addition of moderate cardiac pre-load (left ventricular diastolic pressure of 20-25mmHg), did not significantly alter epicardial APD_{80} at either temperature. By contrast, endocardial APD_{80} reduced by 12.2 ±3.2% and 11.6 ±3.7% from control values at 37°C and 32°C respectively.

Extreme left ventricular stretch (50-55mmHg) significantly reduced the APD_{80} in both epicardial and endocardial recordings at 37°C and 32°C. Epicardial APD_{80} reduced by 5.9 ±2.5% and 11.5 ±3.9% relative to control conditions at 37°C and 32°C respectively. Similarly, endocardial APD_{80} decreased by 18.4 ±3.5% and 19.3 ±3.2% at 37°C and 32°C respectively. The reductions in action potential duration observed following extreme stretch at 32°C were not significantly different than those observed at 37°C.

It was concluded that a change in cardiac temperature did not affect the magnitude of reduction in action potential duration (as measured by APD_{80}) following moderate (20-25mmHg) or extreme stretch (50-55mmHg) for either endocardial or epicardial recordings when compared to their control. Since TREK-1 channels are temperature sensitive (inactivating at lower temperatures), these results suggest that non-selective stretch-sensitive cation channels may be more important in modifying action potential duration during stretch than TREK-1 in rat heart.