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Calcium dynamics within the nuclei of cardiac muscle

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Cardiovascular disease is the leading cause of death in Australia; responsible for 30% of deaths. Diseases that affect the heart are commonly accompanied by a condition known as hypertrophy — heart enlargement through cell growth. This condition leads to uneven heart beats and, eventually, heart failure.

Hypertrophy is regulated by the flow of calcium ions within the cell. Calcium dynamics control the activation of the proteins required for hypertrophic gene expression and their localisation to the cell nucleus. However, there has been little research done on calcium flow within the nuclei of normal heart cells let alone those of diseased hearts.

We focus specifically on modelling the mechanics of calcium flow within the nucleus and distinguishing the signal for heart cell growth in the nucleus where gene expression takes place over the background signal for the heartbeat. Using a finite element model, we describe the spatiotemporal properties of these background calcium oscillations as they propagate into the nucleus. We verify this model with existing data to produce a clearer picture of the calcium dynamics involved in initiating hypertrophy.

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