Calcium Waves Supported by Stress Acivated Ion Channels. Mathematical Modeling.

Following the suggestion of L.F. Jaffe [1], we propose a mathematical model of fast calcium induced calcium influx waves (CICI Waves). They can propagate at relatively high speeds (up to 1300 micrometers/s). According to [1], they propagate due to a mechanochemical interaction of actomyosin network with the cell membrane. The local stretching of the membrane caused by actin filaments opens mechanically operated ion channels resulting in the influx of calcium to the cell. Moreover, stretching the celll's membrane at one point opens nearby stretch activated calcium channels, because the mechanical force is relayed by the actin filaments interconnected by myosin bridges. The number of bridges as well as filament density increases with calcium concentration, causing the contraction of the actomyosin network. Thus, the force acting on the membrane from tangled actin filaments is transmitted ahead of the moving front of the calcium concentration. As a result, the ion channels are opened even before the signal of calcium reaches them. This leads to much larger propagation speed of CICI waves in comparison with calcium induced calcium released (CICR) waves, where the wave is sustained by the diffusion of calcium and autocatalytic release of calcium from the internal stores (e.g. endoplasmic reticula).

[1] L.F. Jaffe, Strech-activated calcium channels relay calcium waves propagated by calcium-induced calcium influx, Biol. Cell 99, 175-184 (2007)

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