Role of intrinsic heterogeneities of cardiac tissue in an arrhythmogenic mechanism

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Introduction
Cardiac cells are excitable systems

Intercellular coupling: wave propagation.
Normal rhythm: plane wave
Contraction of muscle

Half plane wave
Spiral wave: Ventricular Tachycardia
Spiral wave instabilities
Ventricular fibrillation
(Sudden Cardiac Death)

Garfinkel et al. 97
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Question: How does Ventricular Tachycardia appear?

Hypothesis:
1: Early after depolarisations

2: Conduction Block due to Dispersion of Repolarization

Study in the case of Long QT Syndrome

Long QT syndrome

Known to favor a Torsade de Pointes (Ventricular Tachycardia)

ECG:

1) Longer QT interval: prolonged action potential duration. Favors EADs

2) Wider T wave: increased dispersion of repolarizations. Favors Conduction Blocks
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**Model**

*Ionic model: Luo Rudy Dynamic (2000):*

\[ \frac{\partial V}{\partial t} = -\sum I_{ions} + D \Delta V \]

**Long QT:** leak of Na current during Action Potentials.

**Inhomogeneities:** Mcells, population of cells in the middle of ventricle with longer action potentials. → Reduction of G_{ks}

**EADs**

1) Regular pacing followed by late stimulus.
2) Regular BCL and strong LQT (Period doubling and EADs)

1) Coupling reduces EAD amplitude.
2) Secondary beat impossible without strongly inhomogeneous coupling (Montserrat et al 2000, Biktashev 2002)
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Dispersion of Repolarization: Effects of Long QT and Pacing Period

Long QT strength → Pacing Period → Stronger DoR

Conduction Blocks (1D)

Regular pacing and premature stimulus.

Unexpected behaviors:

Long QT Favors Conduction Blocks at long Basic Cycle length.
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Two dimensions

Regular line pacing on the epicardium and premature stimulus at the epicardium.

Partial conduction block

Sustained reentry

Effects of geometry on reentry length

Long lived reentries favored by:
1) wide strip .
2) big bubble at the top of the M cells region. (Pinning)
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<th>Conclusion</th>
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<td>• EADs Can not lead to a premature stimulus without inhomogeneous coupling.</td>
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<td>• CB is a possible arrhythmogenic mechanism.</td>
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