Cardiac Muscle Physiology

Special characteristics of cardiac muscle

- Branching and interdigitating cells
- At their ends, they are connected by INTERCALATED DISCS
- The discs are always at the Z-lines of the myofibrils
- The disc bind the myocytes together and cause them to pull on each other when they contract
- The adjacent fibers also form low-resistance GAP JUNCTIONS
- This way action potentials are transmitted rapidly from one fiber to another
- This permits the myocardium to function as a SYNCTIUM
- The T-tubules are AT THE Z LINES, not at the A-I junction as they are in the skeletal muscle

- the resting membrane potential of a myocardial cell is about -80mV

CONTRACTILE RESPONSE

- starts just after the start of depolarization
- lasts about 300 msec

MAJOR DIFFERENCE is that instead of being directly attached to the Ryanodine receptor, the L-type “dihydropyridine receptor” calcium channel has to release some calcium into the cell. Seeing as the Ryanodine receptor is a calcium-gated calcium channel, this initiates the release of calcium.

GLYCOSIDE DRUGS

- Eg. Digoxin
- Inhibit Na+/K+ ATPase
- Thus, more Na+ and less K+ inside the cell
- This reduces the activity of the Na+/Ca++ exchanger (which runs mainly on Na+ concentration gradient)
- Thus, less Ca++ is exchanged out of the cell
- More intracellular Ca++ = greater contractility

GLYCOSIDE TOXICITY

Overinhibition of the Na+/K+ ATPase results in a partially depolarized cell. This slows conduction and can cause the cell to depolarize spontaneously. Hence, arrhythmias and bradycardia.

... digoxin also competes with K+ ions for the same binding site on the ATPase; thus in hypokalemia, its effect is greater because it has no competition. In hyperkalemia, it may be outcompeted and thus not therapeutic.

REFRACTORY PERIOD

Phases 0, 1, 2 and most of 3 are refractory to stimulation. In fact, until the membrane reaches -50 mV the myocyte cannot contract again. This is the ABSOLUTE REFRACTORY PERIOD.

Thankfully, it means the cardiac muscle can never suffer tetany.

FIBER TYPES

- oxidative metabolism is the main form here
- ATPase activity is relatively low