
Chapter 5

Therapeutic Devices

Cardiac Pacemaker

Natural Pacemaker

SA node → Primary pacemaker

AV node → Secondary pacemaker

Every portion of heart can act as pacemaker, though with less periodic and less magnitude pulse

Rhythmicity is provided by SA node. Rhythm influenced by

Temperature

Chemical activities

Nervous activities (ANS, portion of brain controls cardiac activities, sympathetic and parasympathetic activities)

$$HR \propto T$$

$$HR \propto \text{Sympathetic NS}$$

Natural Pacemaker

HR increase

Force of ventricular contraction

blood pressure

cardiac output

increased parasympathetic NS

fall in HR

Excitability of Heart: Nature of Electrical Stimulus

abrupt onset

intense enough

adequate duration

Artificial Pacemaker

Electrical stimulator that produces repetitive pulses of current designed to elicit contractions in atria and/or ventricles (controlled oscillator)

Consider a strip of muscle, can be taken as a parallel RC section. If the voltage across is v and the total current is i , then with a voltage of Δv in d duration

$\tau = RC \rightarrow$ membrane time constant

$$i = i_C + i_R = C \frac{dv}{dt} + \frac{v}{R}$$

when $d = \infty$, $i = \Delta v/R = b$

$$v = iR(1 - e^{-t/\tau})$$

$b \rightarrow$ Rheobasic current

$$\Delta v = iR(1 - e^{-d/\tau})$$

$$i = \frac{b}{1 - e^{-d/\tau}}$$

Pacemaker mode of operation

Two chambers: atrial, ventricular

Three modes

Fixed rate pacemaker: asynchronous/ free running / non triggered / permanent

Delivers rhythmic stimuli to ventricle at a constant rate (fixed or externally controlled by program)

Independent of the natural pacemaker activity

Applied in complete AV block

Problems

Competitive pacing

Ventricular fibrillation

Reduced battery life

Triggered Pacemaker: Responsive to cardiac activity. Two types

Atrial Triggered Pacemaker

P wave is detected

delay of about 0.15 sec (AV conduction time) is given
stimulus is delivered to ventricles

Pacemaker mode of operation (contd)

Ventricular triggered Pacemaker: sense R wave, avoid competitive pacing

Ventricular Synchronous Pacemaker: delivers stimuli in the refractory period of ventricles

Ventricular Inhibited Pacemaker: delivers stimuli after a delay of 0.8-1 sec and then waits for another R wave

Pacemaker Energy Sources

Hg-Zn Battery

Hg → anode (compressed mixture of HgO, graphite & AgO)

Zn → cathode, pores zinc

Defibrillator

Device that delivers electric shock to cardiac muscle undergoing fatal arrhythmia, used to treat **ventricular fibrillation**

Before 1960, ac defibrillators (5-6 A at 60 Hz for 0.25 -1 sec) were used

- Successive attempts required

- Can't correct atrial fibrillation (turns VF)

DC defibrillators has mostly discharging currents forms as:

- Lown waveform (20A, 3-6 kV, 10 ms (5+5))

- Monopulse waveform (20A, 3-6 kV, 10 ms)

- Tapered delay waveform (20A, 1.2 kV, 15 ms)

- Trapezoidal waveform (20A, 0.8 kV, 20 ms)

Defibrillators

Lown: Capacitor is charged to 100 - 400 J

Monopulse: L is replaced by high R

Tapered delay: cascading 2 LC sections

Trapezoidal: wave shaping

Control Circuit

Electrodes (Pads)

6-8 cm dia for adults, 4-6 cm for childs

Anterior-anterior

Anterior-posterior (larger dia)

Questions?
Comments!

Thank You !!!
