PHONOCARDIOGRAM (PCG)

The phonocardiogram is an instrument used for recording the sounds connected with the pumping action of the heart. Heart sounds are generated by the beating heart and the resultant blood flow through it.

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Stethoscope is a simple device that carries sound energy from the chest of the patient to the ear of physician. Stethoscope is a Greek word "STETHOS" means chest and "SKOPEIN" means to examine.

Normal heart produce two distinct sounds that are audible in stethoscope that is "Lub-Dub". Lub is caused by the closure of atrioventricular valves, which permits flow of blood from atria into the ventricles. This is called First heart sound.

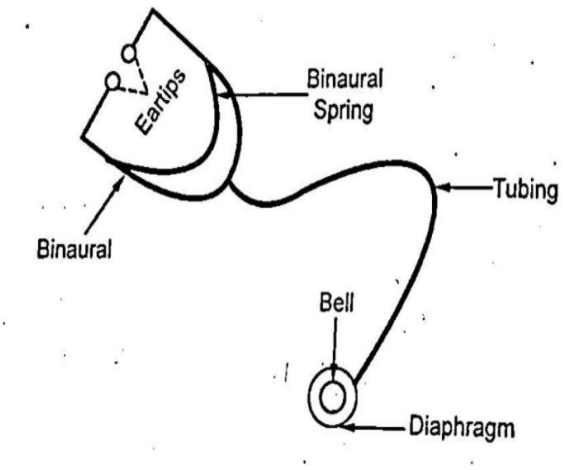

Fig: Stethoscope

Dub is caused by closing the semilunar valves which release blood into the pulmonary and systematic circulation systems. This is called second heart sound.

There are many forms of stethoscope, such as electronic stethoscope has more advantage. But for recording graphically heart sounds is called phonocardiogram. Instrument used for recording the producing heart beat is called phonocardiograph.

Heart Sound:

Heart sounds are generated by the beating heart and the resultant blood flow through it, based on this heart sounds are classified into four categories.

- Valve closure sounds (Lub)
- Ventricular filling sounds
- Valve opening sounds (Dub)
- Extra cardiac sounds

Valve closure sounds:

These sounds occur at the beginning of systole and the beginning of a diastole. Systole is due to closure of mitral and tricuspid valves i.e., (atrioventricular valves). Diastole is due to closure of aortic and pulmonary valves i.e., (semilunar valves).

Ventricular Filling sounds:

A third heart sound is sometimes heard, especially in young adults. These sounds occur either at the period of rapid filling of the ventricle. This sound, which occurs from 0.1 to 0.2 sec. After the second heart sound, is attributed to the rush of blood from the atria into the ventricles which cause some vibration of the ventricular walls.

Valve opening sounds:

These sounds occur at the time of opening of the atrio ventricular valves and semilunar valves.

Extra cardiac sounds:

These sounds occur in mind or late systole or early diastole and are caused by thickened pericardium which limits ventricular distensibility.

Different Heart sounds and its characteristics:

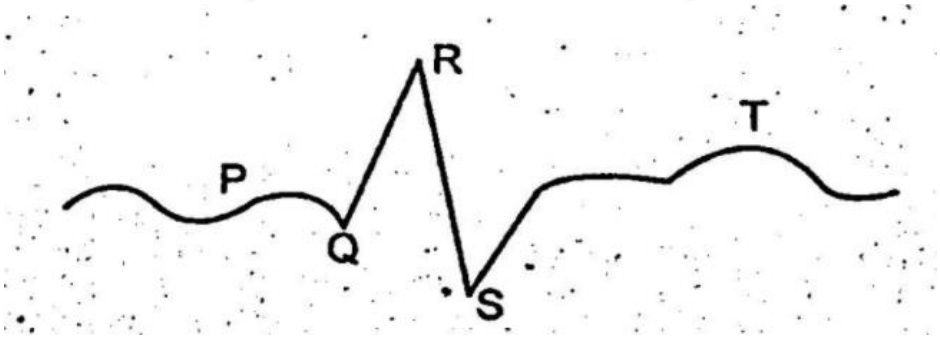

Fig: ECG waveform

Four heart sounds that occurs during the sequence of one complete cardiac cycle.

	Timing	Ausculatory Area	Frequency	Duration
First heart sound	low frequency vibration occurs approximately 0.05 sec, after the onset of QRS complex of the ECG	Heard at the apex of the mid pericardium	Ranges above 30-50 Hz	Lasts for 0.1 to 0.12 sec
Second heart sound	sound starts approximately 0.03 - 0.05 sec, after the end of 'T' wave of the ECG	Heard in the aortic and pulmonary areas	Range upto 250 Hz	Lasts for 0.08 - 0.14 sec
Third heart sound	It starts at 0.12 - 0.18 sec, after the onset of the second heart sound	Heard at the apex and left lateral position after lifting the legs.	Range above 10 - 100 Hz	Lasts for 0.04 - 0.08 sec
Fourth heart sound	It starts approximately 0.12 - 0.18 sec, after the onset of the p-wave	In audible because of extremely low frequency	Range about 10 -50 Hz	Lasts for 0.03 - 0.06 sec

Physical characteristics of sound:

It is usually characteristics by three physical properties.

1. Frequency
2. Amplitude
3. Quality

Frequency:

Heart sound and murmurs are between the frequency of 10 to 1000Hz.

- Low range is 10-60Hz for third and fourth heart sounds.
- Medium range is 60-150Hz for first and second heart sounds.
- High-pitch range is 150-1000Hz for aortic and pulmonary insufficiency.

Amplitude

Heart sound and murmurs are differ by various factors

- Low frequency, heart sounds have highest amplitude.
- High frequency, heart sounds have lowest amplitude.

Quality:

Depends upon the overtones quality varied.

Block diagram of Phonocardiograph:

The block diagram of the phonocardiograph for recording of heart sounds is shown below,

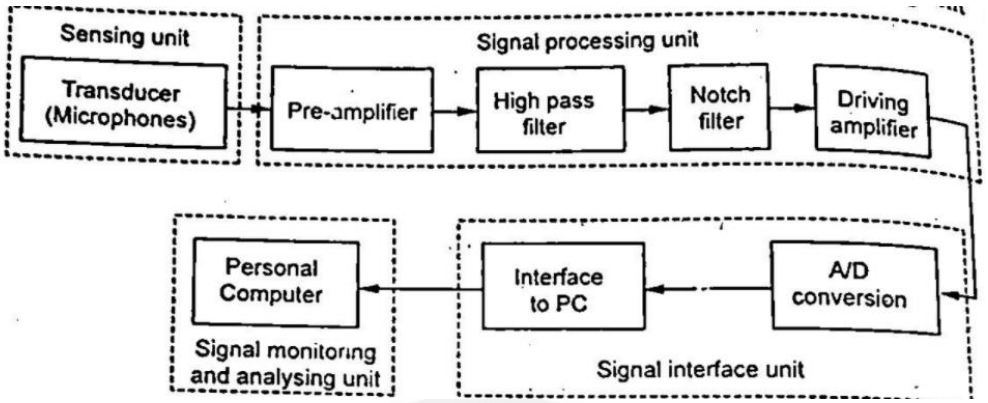

Fig: Block diagram of phonocardiograph

Sensing unit:

The sensing unit consists of the carbon microphone, which with the supporting circuitry converts the heart sounds into proportional electric signals.

Signal Processing unit:

The signal processing unit comprises an amplification and filtering circuit. The amplifier used for a PCG has wide bandwidth with a frequency range of about 20 to 2000Hz. Filter permits selection of suitable frequency bands. So that particular heart sound frequencies can be recorded.

PCG amplifiers usually have gain compensation circuits to increase the amplification of high frequency signals, which are usually of low intensity. The appropriate filter characteristics may be selected to attenuate the unwanted frequencies at filter slopes of 12 dB/ octave or 24 dB/ octave.

Signal Interfacing unit and signal monitoring and analysing unit:

The output of the signal processing unit is given to the digital interface unit which converts the analog signal into a proportional digital signal. The digital signal is then connected to PC for display on the PC monitor in real time. The signal is analysed in time and frequency domain with the help of software algorithms.

PCG waveforms:

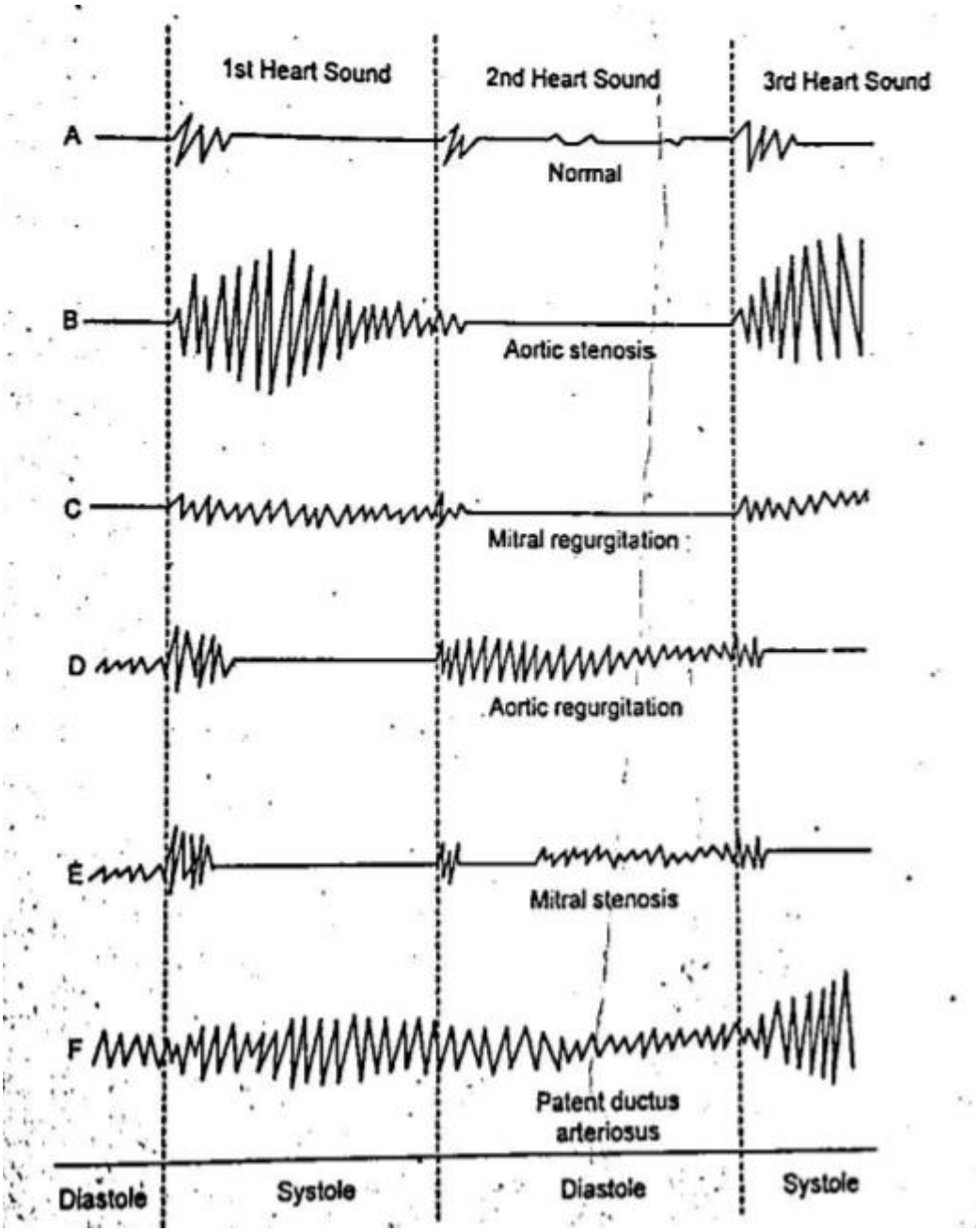

Fig: PCG waveforms