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Heart Sound Analysis

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Abstract: For centuries the medical profession has been aided in its diagnosis of cardiovascular diseases(CVDs) with beating and pumping of heart. But CVDs continues to be the leading cause of morbidity and mortality. Therefore, an another diagnostic parameter is introduced to mitigate this silent threat to lives, called heart sounds. The technique of listening to sounds produced by heart and any other organ and vessels of body is called Auscultation. Adoption of this technique reduced cardiovascular diseases to a greater extent by differentiating abnormal sounds produced by heart due to malfunctioning from the normal ones. Several instruments are used to record these sounds and the output is displayed in the form of graphs on the screen. The study will show relationship of heart sounds to the functioning of cardiovascular systems.
Keywords: CVDs, heart sound, vessels auscultation.

I. INTRODUCTION

Heart sounds are the noises generated by the beating heart and the resultant flow of blood through it. When the heart valves snap shut , the turbulence is reflected by the sounds. The change in the sound is associated with different types of disorders. The amount of information that can be obtained by listening to the sounds of the heart depends largely on the skill, experience and hearing ability of the physician. The principal cause of heart sounds seems to be vibrations in the blood inside the heart by the sudden closure of the valves. These vibrations together with eddy currents induced in the blood as it is forced through the closing valves, produce vibrations in the wall of the heart chambers and in the adjoining blood vessels.
The normal heart produces two distinct sounds with each heartbeat, in the stethoscope –described as "*lub dub*".

A. The *lub* is called the *first heart sound.* It is caused by closure of the atrioventricular valves. It occurs approximately at the time of QRS complex of the ECG and just before ventricular stroke.
B. The *dub* is called the *second heart sound.* It is caused by the closing of the semilunar valves. These valves close at the end of systole, just before the atrioventricular valves open.

The *third heart sound* is sometimes heard, especially in young adults. This sound occurs for a short duration of 0.1 to 0.2 seconds, after the second heart sound. This sound actually precedes atrial contraction, which means the inrush of blood to the ventricles causing this sound is passive.
The *atrial heart sound* occurs when the atria actually contract, squeezing the remainder of the blood into the ventricles. This sound is not audible because of their low amplitude and frequency but may be visible on a graphic recording.

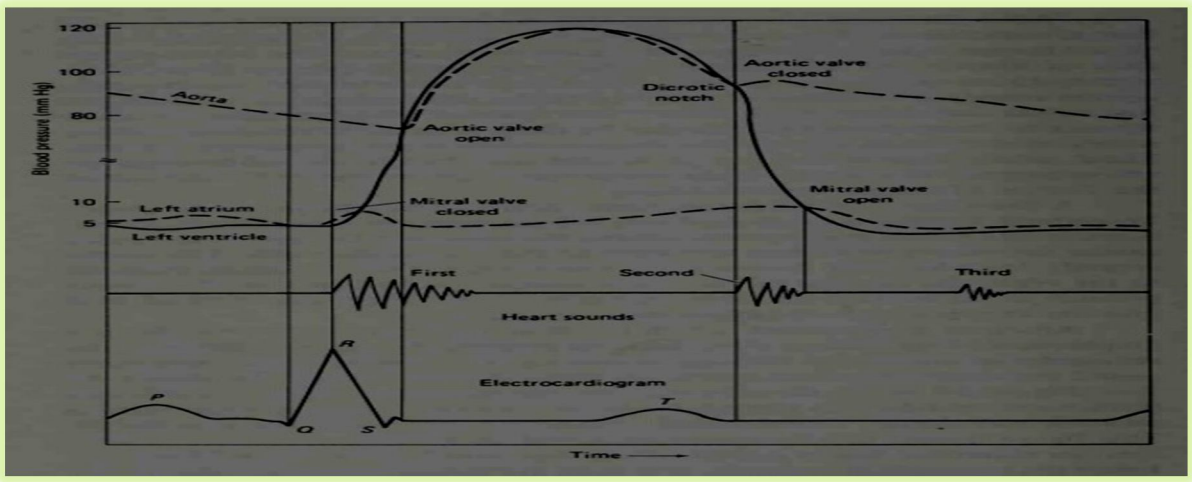


Fig 1. Relation of heart sounds to functions of the CV systems

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In abnormal hearts additional sounds, called *Murmurs* are heard between two normal heart sounds. Murmurs are generally caused either by improper opening of the valves or by regurgitation. In either case, the sound is due to high velocity blood flow through a small opening. Another cause of murmurs can be a small opening in the septum , which separates the right and left sides of the heart.

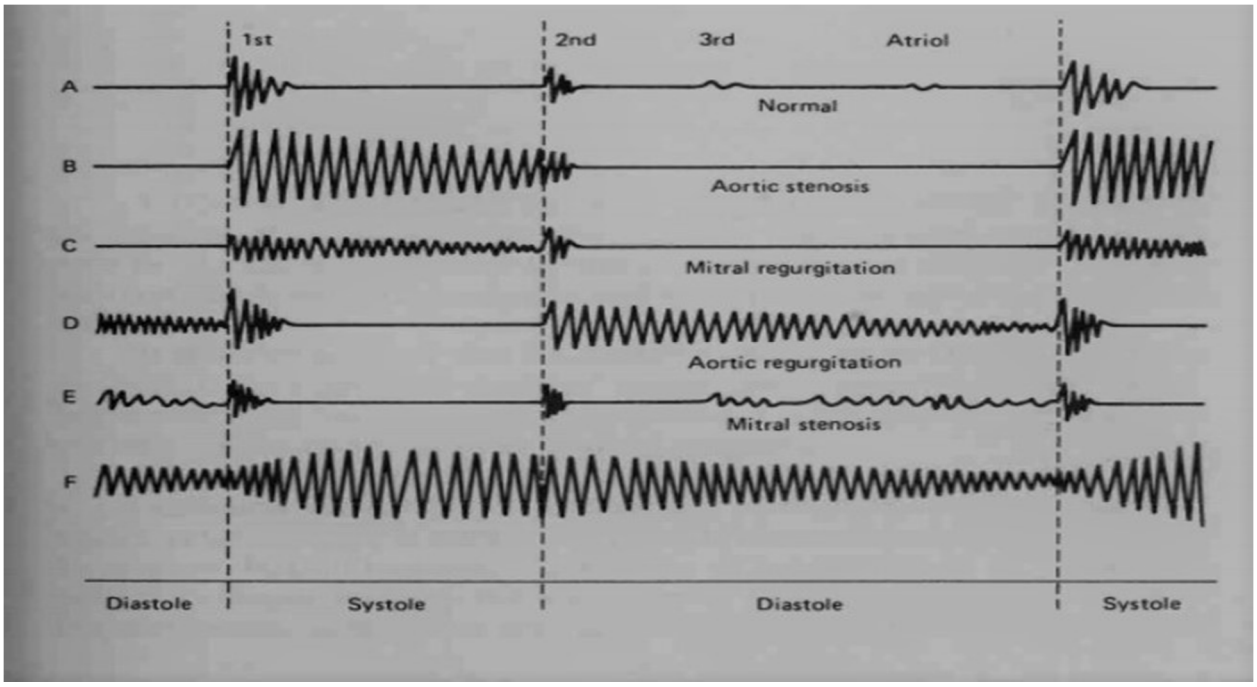


Fig 2. Record of a normal heart sounds and different types of murmurs

The frequencies between a normal and an abnormal heart sounds differ as:

1) First heart sound – 30 to 45 Hz
2) Second heart sound – 50 to 70 Hz
3) Third heart sound – below 30 Hz
4) Murmurs – 100 to 600 Hz

II. TECHNIQUES EMPLOYED FOR ANALYZING HEART SOUNDS

Although Auscultation is the principal method of detecting and analyzing heart sounds, other techniques introduced are :

1) *Vibro Cardiogram:* graphical record of sound produced by the vibrations of the side of the heart as it thumps against the chest wall.

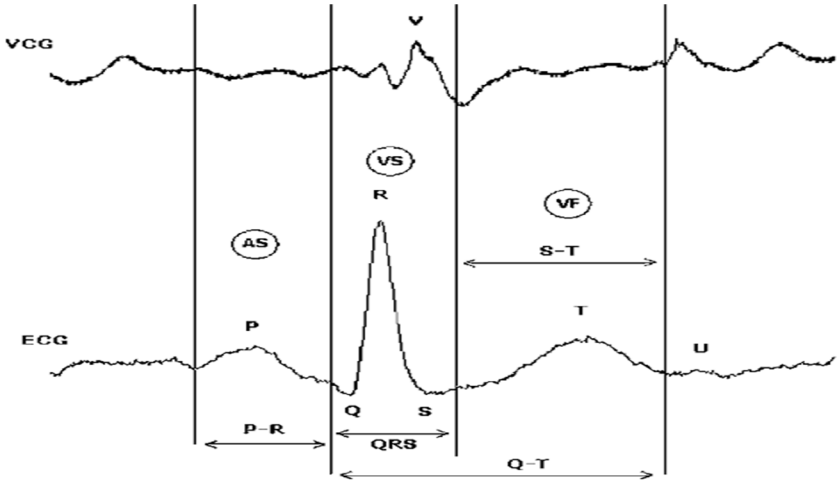


Fig 3. VCG

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2) *Apex Cardiogram:* graphical record of sound produced by tip or apex of the heart hitting the rib cage.

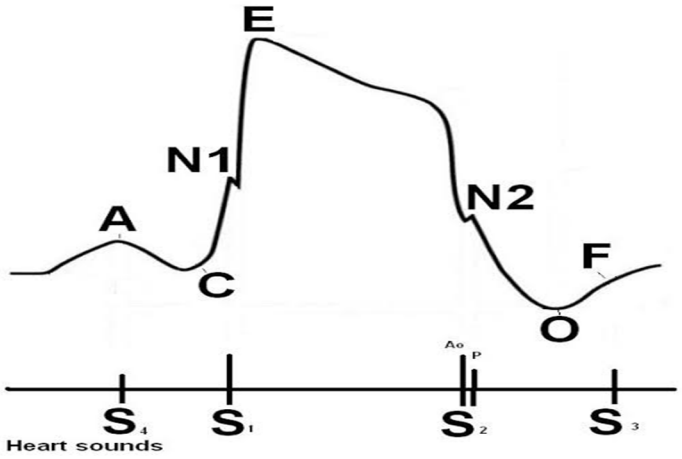


Fig 4. ACG

3) *Ballisto Cardiogram:* graphical record produced as a result of dynamic forces of the heart as it beats and pumps blood into the major arteries. The information provided by ballistocardiogram cannot be obtained by any other measurement.

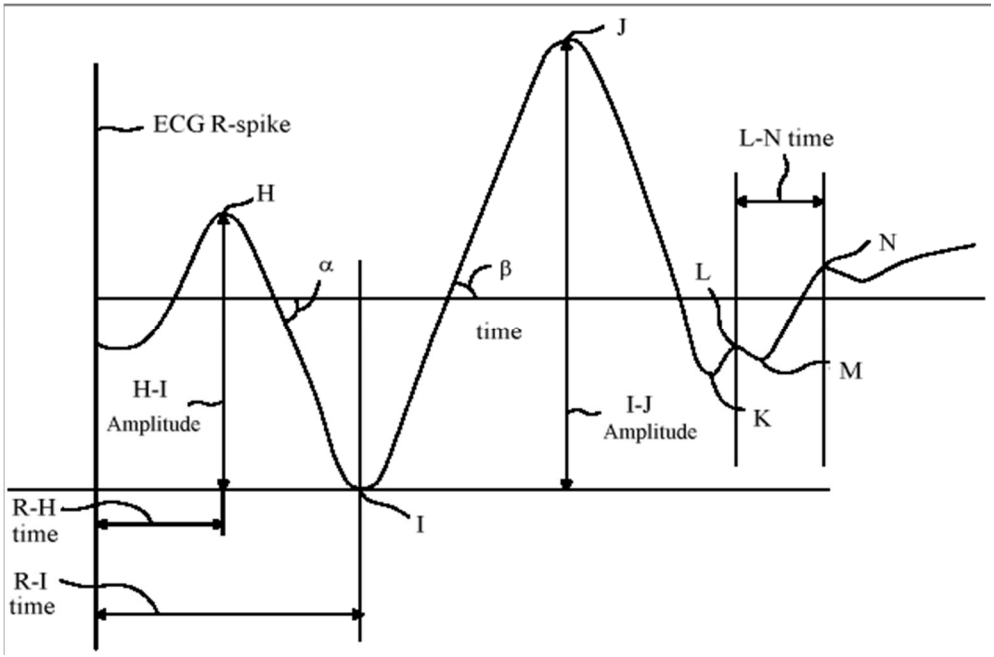


Fig 5. BCG

4) *Phono Cardiogram:* Graphical record of the sound produced by pumping action of the heart. These sounds produce an indication of the heart rate and its rhythmicity. They give also useful information regarding effectiveness of blood pumping and valve action.

The phono cardiogram depends extensively on the technical design of the microphone used, since it does not transform the acoustic oscillations into the electrical potential uniformities for all the frequencies. Based on principle of operation , microphones are categorized into

a) *Crystal microphone:* It contains a wafer of piezo electric material, which generates potentials when subjected to mechanical stresses due to heart sounds. They are smaller in size and more sensitive.

b) *Dynamic Microphone:* It consists of moving coil having a fixed magnetic core inside it. The coil moves with the heart sounds and produces a voltage because ot its interaction with the magnetic flux.

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A. Acoustic Sensor Used In Phonocardiography

The acoustic sensors enhances the audibility of heart sounds and enables recording of qualitative acoustic spectral data. This device is a polymer based adherent differential output sensor, which is only 1 mm thick.The device can be used in phonocardiography, ling sounds and the detection of Korotkoffs sounds. The device is not a microphone and does not detect acoustic pressure.

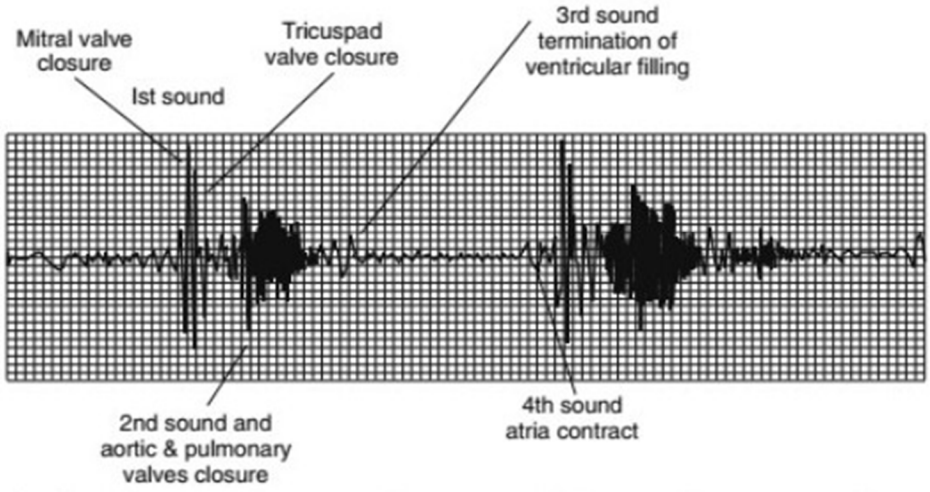


Fig 6. PCG

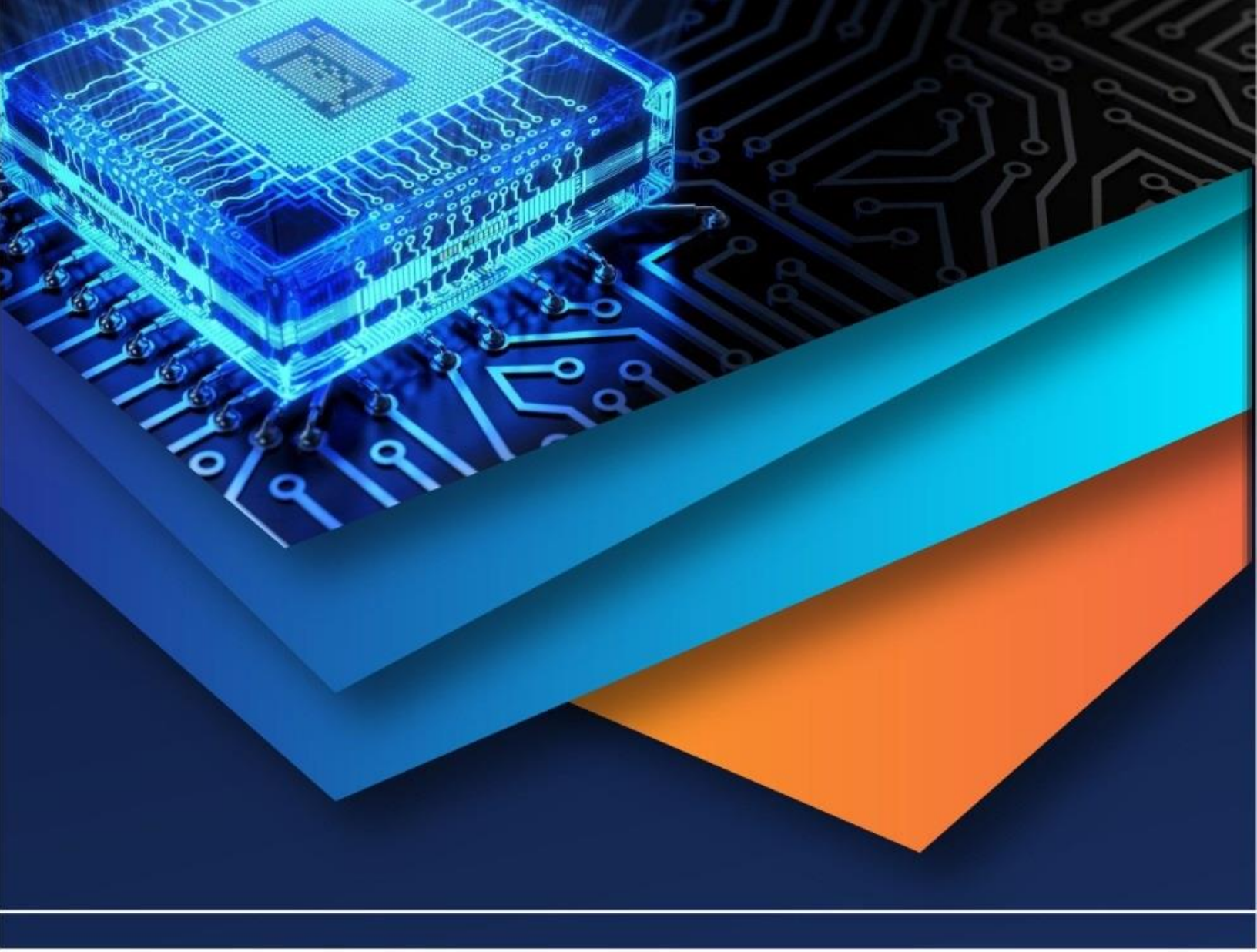
III. CONCLUSION

In this paper we made an attempt to line up the techniques to analyze the heart sounds (the representation of mechanical activity of cardiohaemic system) to reduce chances of cardiovascular diseases. These sounds can be acquired digitally and analyzed automatically. These have application in improvement of cardiac monitoring, diagnosis and therapeutic devices. These sounds can also act as diagnostic tool to detect pathological murmurs in the heart of newborns.

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