Course: Electrophysiology of Heart

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Lecture 9: ECG-Normal, Technical aspects

Hello everyone. So, today we will start our next topic that is the Normalization of the Normal Aspects of ECG and the technical aspects along with this concepts we will cover that is ECG calibration, how calibration is done in the ECG machine, what are the different types of ECG leads and what is the importance of the enthalvins triangle, what are the configuration of different waves. Now, in the last lecture we had already studied the different types of waves in the ECG, we have P wave, we have QRS complex, Q wave, R wave and S wave, then we have seen the T wave. So, the 5 types of waves we have seen we will do a brief recap of whatever we had done in our last lecture. Now, this is initially the atrial depolarization, atrial depolarization means SA node travelling of the impulse from SA node to the AV node. So, atrial depolarization will give you the P wave, so this is your P wave.

So, atrial depolarization that means, after the atrial depolarization there will be contraction of the atrial musculature. So, the electrical events which is occurring in the atrial that is impulse transduction from SA node to AV node is giving rise to your P wave. Now, after the complete depolarization of the atria, we get an isoelectric line that usually constitutes the AV nodal delay, because the conduction in the AV node is very, very slow and the ECG machine cannot detect that voltage signals. So, we get an isoelectric line, so after that we get the ventricular depolarization, which occurs in three phases that is septal depolarization.

Then the whole ventricular myocardial depolarization and the last portion of the heart to get depolarized that is the basal portion. So, we get the septal depolarization from left to right direction, then we get the major vector directed towards the left lower portion that is the ventricular musculature depolarization, myocardial depolarization which occurs from inner myocardium that is endocardium to outer myocardium that is epicardium. Then the last portion of the heart to get depolarized that is the basal portion of the heart which gets depolarized and so hence we get QRS complex. Now, while getting this QRS complex, we are actually saying that the ventricular muscles are getting depolarized, when the ventricular muscles are completely depolarized we get this ST segment. So, this ST segment is also an isoelectric line followed by the T wave, T wave is nothing but ventricular repolarization, where the repolarization occurs from the opposite direction that means, from the outer portion of the myocardium that is the epicardium to the inner myocardium that is endocardium.

The reasons are all been described in the last lecture. So, what is very important to know is during the ventricular excitation or ventricular depolarization, another event is coinciding with the ventricular depolarization, which means atrial relaxation. Atrial relaxation is a mechanical event. So, we get an electrical event that is atrial repolarization. So, where does this atrial repolarization will go.

So, this atrial repolarization actually overlaps the ventricular depolarization. And since the atrial musculature is very thin. So, we do not get to see the depolarization waves, what we see is the depolarization of the ventricular waves that is QRS complex and that usually mask the atrial repolarization waves. So, if we want to stress the atrial repolarization waves. So, that will be in the negative direction.

So, this is all about your last class, which we had already described. So, now, we will move on to the calibration of ECG. So, electrocardiogram is the recording and electrocardiogram is the machine. And the process is known as electrocardiography. So, ECG paper is a strip of paper, which is a thermo sensitive paper and it contains vertical as well as horizontal lines.

Now, this horizontal lines denotes the time, which is usually represented in milliseconds or seconds. The vertical usually denotes the amplitude or the voltage, which usually represented by milli volt. So, the horizontal axis gives you the time that is represented by milliseconds or seconds. And the vertical axis gives the voltage the deflections or the amplitude. Now, in the ECG paper, what conventional ECG paper, what we see the strip of the paper is usually move at a speed of 25 millimeter per second.

We set the speed there is a other speed also we nowadays we see in the machines, we have 50 millimeter per second. But we usually keep the speed at 25 millimeter per second, which means 25 millimeter of the paper is moving in 1 second. Now, we get to see number of boxes, we get to see the large this is the large boxes or large square, it consist of 5 into 5 that means, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 5, 5, 25 other small squares also. So, 1 large square consist of 25 small squares. Now, what the calibration need to be done, how the calibration is done in the ECG, it is to be done.

So, that 1 milli volt gives a deflection of 10 millimeter. Now, usually the small square which is present in the big square. So, this small square horizontally it is 1 millimeter and vertically also it is 1 millimeter. That means, the dimensions is 1 by 1, 1 into 1 millimeter square millimeter that is the area of the square. So, the vertical deflection what how it will give, so 10 millimeter the calibration is done in such a way that a voltage deflection of 1 milli volt will cross a deflection of the needle of 10 millimeter.

That means, 10 millimeter is giving a deflection of 1 milli volt. So, 1 millimeter will give a deflection of 1 by 10 that is 0.1 milli volt. So, that means, vertically if this is 1 small square, this is the vertical and this is the horizontal axis. So, vertically 1 millimeter corresponds to 1 milli volt.

And as I told you the horizontal axis gives you the that is the x axis gives you the time in milliseconds. So, how much will 1 millimeter of the square will constitute, so 25 millimeter is equal to 1 second. So, 1 millimeter will 1 by 25 that means, 0.04 seconds. So, 25 millimeter is equal to 1 second and 1 millimeter will give 0.

04 seconds, which means the horizontal axis or 1 millimeter of this square corresponds to 0.04 second. Now, this milli volt deflections this values of time duration 0.04. So, this is the time these are all important for calculating various segments, various intervals, various waves, the P waves, the QRS complexes, the T waves, what is the duration, what is the amplitude, the interval and the segments duration, so these are very important.

So, this we will learn further in the next lecture, when we will do interpretation of the ECG. So, for the time being you have to remember the speed of the paper is 25 millimeter per second, the calibration is done in such a way that the horizontal axis of 1 millimeter gives the time duration of 0.04 seconds and the vertical deflection of 1 millimeter gives a deflection of 0.1 milli volt. So, with this calibration, now we will move on to various ECG leads.

As we have seen in the previous lecture that our body is an excellent volume conductor, it is an excellent conductor of electricity. So, whatever electrical currents are generating in our body, so whichever currents since we are recording the ECG is a recording which is done extracellularly. So, on the surface of our body if we are placing the electrodes, we could easily record those currents electrical activity which are going on in our body. So, the current source say suppose the heart is present in the center, how we place various electrodes what are the reference points. So, generally we do a 12 lead ECG, in the 12 lead ECG we have 6 limb leads and 6 precordial or chest leads.

So, these precordial leads are nothing but the chest leads. Now, the limb leads they usually measure the fluctuations or various electrical activity of the heart based on the frontal plane or coronal plane. While from the front they are measuring that is the coronal plane or the frontal plane, but the chest leads they usually measure the electrical activity from the horizontal plane. So, these leads are nothing but they are the pair of electrodes which are acting like a camera. So, we have 12 camera situated superiorly, anteriorly, laterally, inferiorly.

So, they are trying to capture various electrical activity of the heart from various directions. So, we have 6 limb leads which capture the electrical activity from the frontal plane and we have 6 chest leads or precordial leads which capture the electrical activity based on the horizontal plane. Now, out of the 6 limb leads we have standard bipolar limb leads 3 which is 1, 2 and 3 lead 1, lead 2 and lead 3 these are the 3 standard bipolar limb leads. Then we have unipolar limb leads those are also 3 that is of a stands for augmented. So, we will come to that later.

So, we have AVR, AVL, AVF again 3 unipolar limb leads and we have V 1 to V 6, 6 chest leads which are located at different portions of a heart. Now, who are the inventors of these leads standard bipolar leads been discovered by William Enthoven, the unipolar leads been discovered by Goldberger and Frank Wilson had discovered the chest leads. Now, William Enthoven is a very significant name over here because this person has got Nobel prize for discovery of ECG in 1924. So, William Enthoven has discovered the standard limb leads, Goldberger the augmented unipolar limb leads and the chest leads been discovered by Frank Wilson V 1 to V 2. Now, coming to the standard limb leads as I told you the standard limb leads are nothing, but they are the bipolar leads.

So, what do you understand by the bipolar leads, bipolar leads means if I have a voltmeter ECG is nothing, but the they that acts on the principle of voltmeter they record the potential difference across 2 points because of the cardiac dipole which is created. So, if there is a voltmeter, so there will be one connection that is a negative terminal the other electrode will be having the positive terminal. So, this 2 if this 2 terminals or if this 2 electrodes if both are active it is known as bipolar leads which means this 2 electrodes are recording simultaneously some of the other voltage. And the lead which is constituting this 2 electrodes suppose this is the lead which will constitute this 2 electrodes will measure the potential difference across this 2 electrodes which means both of the leads both of the electrodes are active in this bipolar leads they are recording some of the other voltage and the leads will calculate the potential difference between this 2 electrodes. So, in this way we have 3 leads that is lead 1 lead 2 and lead 3 how this leads this 3 leads are connected we will see.

So, suppose we keep the electrodes we place the leads we place this at the right arm this is right arm this is left arm this is left leg and this is right leg while conducting ECG we usually place the 1 electrode in the right leg also this right leg electrode is usually placed for grounding purpose. So, other 3 references now whether you place the leads over the acromion process or you place the electrodes over the pubic symphysis it does not matter whatever electric current is generated across your current source in the body. So, this electric current whichever is generated whatever electric current is generated at the level of shoulder region or acromion process the same current you will be getting in the mid of your arm the same thing you will be getting at the level of your wrist. Similarly, whatever current is generated at the level of your left shoulder the same current you will get at the level of your left wrist whatever current is generated at the level of your pubic symphysis the same you will get at the level of your left knee or left foot. Now, it is very convenient to put the electrodes or the leads at the wrist region of the exposed part that is left right arm left arm and the left leg as compared to the placing this leads over the shoulder regions and the pubic symphysis.

So, we put since it is a volume conductor our body is a volume conductor we put the leads across the right arm left arm and left leg we put the electrodes. Now, this right arm the negative terminal if we connect a voltmeter over here how this lead is created the negative terminal of the voltmeter is connected to the right arm the positive terminal of the voltmeter is connected to the left arm this constitutes your lead 1. That means, lead 1 will calculate the potential difference between the left arm voltage and the right arm voltage. Similarly, if the negative terminal of the voltmeter is connected to the right arm and the positive terminal of the voltmeter is connected to the left leg or the left foot it usually constitutes the lead 2 which means lead 2 will calculate the potential difference between the left leg and the right arm. Similarly, if the negative terminal of the voltmeter is connected to the left arm and the positive terminal is connected to the left leg this constitutes your lead 3 which means it will calculate the potential difference between your left leg and the left arm.

So, in this way we could see this 3 leads are connected and we get an inverted equilateral triangle. So, this inverted equilateral triangle is bearing a current source that is heart at the center of it and these are the 3 leads connected. So, this triangle is nothing, but known as enthovens triangle named after the scientist William enthoven. So, with this we will see what do you understand by enthovens law enthovens law states that we will take an example suppose the electrode measurements we have got in the right arm this is right arm this is left arm this is left foot. Obviously, right foot has been rounded.

So, the voltage measured at the right arm is minus 0.2 the voltage measured at the left arm is plus 0.3 and the voltage measured at the left leg is plus 1 milli volt. So, what will be the potential difference across all this 3 electrodes that will constitutes your nothing, but 3 leads. So, lead 1 obviously, it is between the right arm and the left arm.

So, it will give the potential difference of 0.3 minus of minus 0.2 milli volt that means, 0.5 milli volt. So, it is giving a potential difference of 0.

5 milli volt. Similarly, lead 2 will give a potential difference of 1.2 milli volt how because 1 milli volt minus of minus 0.2 that will give 1.2 milli volt. Similarly, the lead 3 will give this is lead 1 this is lead 2 and this is lead 3 will give a potential difference of 0.

7 milli volt how by 1 milli volt minus 0.3 that is 0.7 milli volt. So, you can see over here that lead 2 is equal to lead 1 plus lead 3 lead 2 is having 1.2 milli volt lead 1 is having 0.

5 and lead 3 is having 0.7 milli volt. So, this is nothing, but your enthalvens law that means, the summation of the vectorial summations of the voltage or the potential difference of lead 1 and lead 3 is equal to the lead 2 voltage. So, this is your enthalvens law. Now, coming to the augmented limblids as I told you augmented limblids are known as unipolar leads. Now, what does unipolar leads mean? Bipolar leads mean the 2 electrodes are active across the voltmeter. Now, again in case of voltmeter if 1 is connected to the negative the other is connected to the positive.

Suppose, this negative electrode is inactive and this positive electrode is active or it is also known as exploding electrode which will record the voltage at particular point. Now, negative electrode is inactive means this is made inactive by keeping it fixed. A very specific term can be used that is a fixed that means, the voltage is fixed and this voltage is usually made close to not at exactly equal to 0, but it is made close to 0 milli volt by combining it with high resistance. So, when we combine the this electrode terminals with high very high resistance of say suppose 5000 ohms. So, we get the voltage across this that is equivalent to 0 practically or mathematically we do not get 0, but we get the values close to 0.

So, it is better to use fixed term in this case. So, the other electrode is active and the positive electrode is active or the exploding electrode whereas, the negative electrode is inactive. So, augmented limblids are usually again 3 we have AVR, A stands for augmentation. AVR means the augmentation of the right arm voltage, AVL is the augmentation of the left arm voltage, AVF is the augmentation of the left foot or the left leg voltage which we have already seen in the limblids. And generally this augmentation is 50 percent, how much the voltage is increased that means, the amplitude of this voltage is increased by 50 percent. Suppose in the limblid if we get the voltage of 10 milli volt at right arm.

So, we will get by augmentation we will get 15 milli volt at right arm. So, this 15 milli volt is the augmentation done this augmentation is done for prominent recording. So, how this augmentation is done we will see with this AVL. So, AVL means I have to keep my active electrode or the positive electrode at the left arm. And the negative electrode or the inactive electrode how I will combine, I will combine this right arm and this left leg with high resistance, this resistance is around 5000 ohms.

So, mathematically the voltage if we calculate over here it will be V that is voltage of right arm plus voltage of left leg divided by 2. So, this voltage will be so minimum that it will become close to 0 milli volt. And that is why in this way this is considered as to be the negative electrode. So, the positive electrode is left arm where it is connected to the voltmeter. And this will this is also called as exploring electrode in this way AVR is also augmented and AVF is also augmented.

In AVR right arm is connected to the your active electrode whereas, high resistance is connected with the left arm and the left foot. And in case of AVF the left leg is connected to the active electrode whereas, the right arm and the left arm is connected with the help of high resistance to the negative or the inactive electrodes that is made inactive. So, in this way unipolar leads or augmentation of the leads is done by 50 percent. So, this unipolar leads as well as the standard limb leads the 6 leads they constitutes the hexaxial reference system which means they are located at a certain angle. We have already seen lead 1 to be at 0 degree, lead 2 is at 60 degree, lead 3 is at 120 degree.

These are the standard limb leads angle orientation lead 1 0 degree, lead 2 60 degree, lead 3 120 degree which means in the downward portion the deflection goes it is a positive whereas, the upward portion is negative. That is why we see AVL to be minus 30 degree AVR is minus 150 degree and AVF is 90 degree. So, these are the angles we have to remember for the hexaxial reference system of the limb leads whether it is standard limb leads as well as the unipolar augmented limb leads. Now, what are the how what the configuration of various waves in this hexaxial reference system. So, first we will see about the P wave now P wave is only the 1 wave it is the atrial depolarization.

So, we can see various instant vectors are travelling from SA node to AV node we get various vector which travels from SA node to AV node. So, in this way, but our ECG records the mean of all this vector which is known as mean instantaneous vector. So, we have seen that the mean instantaneous vector. So, the direction of the mean instantaneous vector is this one from SA node to AV node. Now what we if we put this on the reference of the hexaxial axial system what we see whichever leads are present at this direction they will give the positive deflection whichever lead is present at this direction they will give the negative deflections.

That means, when the wave of depolarization it has already been told is moving towards your recording electrode it will give a positive deflection. And when the wave of depolarization is moving away from your recording electrode it will give a negative deflections. Now the deflection depends on the angle of the lead situation of your leads for example, in this case SN out to AV node means atrial depolarization we will get P wave which means we be in the lead 2 as we can see the green direction it is almost parallel. So, it will give a deflection say suppose of 10 milli volt, but in case of lead 1 it will give a deflection it will definitely give a positive deflection, but this deflection may not be of the 10 milli volt or which we had seen in the lead 2 it will give a deflection of suppose plus 2 milli volt. Similarly, in case of lead 3 or AVF we can see the deflection of P wave may be of plus 5 milli volt.

So, the amplitude of the deflection varies along with the situations or the positions of the leads based on their angles. So, we can see the P wave how we have got. So, AVR is the lead which is giving the negative deflections of the P wave because it is situated just opposite to this direction of the wave of depolarization. Now, coming to the ventricular depolarization we get 3 waves we will see how this ventricular depolarization fits in the hexaxial system. Now, this is the lead 1 lead 2 and lead 3 standard limb leads this is lead 1 0 degree this is 60 degree and this is 120 degree lead 3.

These are the leads of the of the of the mainted limb leads AVL minus 30, AVF plus 90 and minus 150 degree that is AVR. Now, ventricular depolarization occurs in 3 parts the first is the septal depolarization, the second is the maximum myocardial ventricular depolarization and then we have the basal depolarization of the heart. So, the directions are different this is the left to right direction of the septal depolarization which means the septal depolarization is moving from left side to right side. So, this is left and this is right. So, whatever whichever leads are present on the right side they will give the positive deflection and whichever leads are present on the left side they will give the negative deflection.

So, based on the rules we get the these are the Q wave which we see in the QRS complex. The AVR is giving a positive deflection lead 3 is giving a positive deflection AV is giving a positive deflection while AVL 1 and 2 these are giving the negative deflection. So, negative deflection means this is the Q wave the positive deflection means this is not the Q wave because the first positive deflection after P wave is R wave. So, these are the R waves not the Q waves. The next ventricular depolarization is the maximum ventricular vector which we get towards the lower and the lateral side.

And according to this vector what is the R wave configuration we get we see whichever way whichever leads are present as per according to this towards this vector or wave of depolarization they are giving positive waves. That means, AVL 1 2 AVF and AV 3 again the deflection as I told you the amplitude of this deflections depends on the angle of the leads. And AVR is of course, since it is the in opposite direction to the wave of depolarization it is giving the negative deflection. Now the last depolarization is the basal portion depolarization. So, obviously, the leads which are present this inferiorly this will give the negative waves.

That means, the negative this is the S wave whereas, the wave the leads which is present towards the this wave of depolarization thus the basal portion of the heart depolarization that will give the positive deflection which is usually seen in case of AVR. So, what we can see in this is whole about the configuration of the QRS complexes in the hexaxial system. So, we can see there are no Q waves or the first negative wave in case of AVR and lead 3 and also AVF. So, now, we will see what are the chest leads chest leads are also known as precordial leads and this is also unipolar leads these are also known as unipolar chest leads. As I told you unipolar means the one of the electrode which is connected this will be active the other electrode which is connected to the negative terminal that will be inactive.

So, we have V 1 to V 6 the 6 chest leads are placed at the different portions of the heart. So, for example, if I want to measure I have I want to measure the voltage or record the potential difference across the V 1 chest lead. So, this how I will measure the positive terminal of the voltmeter I will connect to the V 1 and the negative terminal of this voltmeter will be connected to a terminal known as Wilson's terminal. As you remember the chest leads been discovered by Frank Wilson.

So, this terminal is named after Frank Wilson. So, Wilson's terminal Wilson's terminal is nothing, but it is a terminal where the right arm left arm and the left leg these are joined at this 3 electrodes are joined at high resistance of 5. So, this terminal is 5 ohm each and this is connected to the Wilson's terminal or the negative terminal of the voltmeter. So, actually mathematically this voltage of right arm voltage of left arm voltage of left leg divided by 3 should give the voltage of this negative terminal Wilson's terminal which is considered to be equivalent or close to 0. So, in this way we get the chest leads measurement or recording if you want to measure V 1 we will connect the positive terminal to V 1. If it we want to measure the volt potential difference of the voltage activity electrical activity of V 2 we will connect it to V 2 in this way the positive electrode is connected to V 3, V 4, V 5, V 6.

Now, we will see how these leads are placed. Now, on the chest leads generally we have 3 reference point this is known as mid clavicular line it runs between the two third and the one third of your clavicle bone it runs vertically. Then, we have the anterior axillary line it starts from your anterior portion of the axilla anterior axillary line then we have the middle axillary line we have the mid axillary line. Now, this 3 references are very important in placing the electrode we will place the electrode V 1 at the level of fourth left right fourth intercostal space just lateral to the sternum. So, this is the sternum. So, we are placing this is the right and this is the left portion of the heart we are placing the alpha V 1 at the level of fourth intercostal space at the right side of the sternum.

V 2 is placed at the level of fourth intercostal space on the left side of the sternum, V 3 is placed between V 2 and V 4. V 4 is placed at the level of fifth intercostal space in the mid clavicular line, V 5 is placed at the level of left fifth intercostal space in the anterior axillary line, V 6 is placed again at the level of left fifth intercostal space along the mid axillary line. Now, the question comes how I will determine the intercostal space, how I will know what which one is left third intercostal space, fourth intercostal space or fifth intercostal space. Now, for that we have to palpate the jugular notch, then this is the jugular notch from jugular notch we will palpate the sternal angle, sternal angle of Lewis or angle of Lewis. This sternal of angle of Lewis usually corresponds to the second intercostal space.

And if we just see the second intercostal space, if we just like correlate with the sternal angle, then we can usually easily count which one is second, third, fourth, fifth and in this way we can place the leads accordingly. So, in this way the chestlets or the precordial leads are placed we have to remember the location of this leads. Now, how this chest leads are depicting the various waves, now this V 1 to V 6 they are placed in I told you the horizontal plane, chest leads is measuring the it is capturing the electrical activity from the horizontal plane. So, V 1 and V 2 measure the septal activity, V 3 and V 4 anterior activity of the heart and V 5 and V 6 lateral activity of the heart. So, we can see the septal the first septal depolarization which occurs from left to right that means, the V 1 and V 2 will give the positive deflection and that is what it is giving the positive deflections, we get the r wave we do not get to see the q wave over here.

And this r wave generally because of the ventricular maximum ventricular depolarization which occurs in this direction, we see an r progression r wave progression we can see this r wave amplitude is increasing at the maximum to the V 5 level. So, this is known as r wave progression it is very important phenomenon to look for whenever we are interpreting ECG. So, r wave progression occurs from V 1 to V 6 there are no q waves present in V 1 and V 2, V 3 is generally giving a biphasic waves and V 4, V 5, V 6 generally gives the maximum or the tall r waves. Now, this hexaxial system along with the chest leads they denote the various activity of the heart from different level. So, the septal leads the septal portion is denoted by V 1 and V 2, the inferior portion of the heart is denoted by lead 2, lead 3 and AVF this is the inferior portion.

The lateral portions and the anterolateral portion is denoted by anterior portion specifically V 3 and V 4, the lateral portion is V 5, V 6, lead 1, AVL and AVR. Now, why this so many leads and different portions are important because whenever we get a disease pathological condition myocardial infarction, we need to know which portion of the heart has been damaged. So, that is why so many cameras and so many leads are required to view the electrical activity of heart. So, as per the QRS nomenclature we must remember the first negative deflection which occurs after P wave that is Q wave, it can be small q, it can be large q, it is depend depends on the amplitude of the deflection. If the amplitude of the wave is less than 3 small squares generally we refer to as the smaller alphabetical letter.

Then the first positive deflection is R wave, it can be small r, it can be large r depends on the amplitude. The negative deflection after R wave is S wave, the positive deflection after R wave is R prime. So, suppose this is your normal QRS complex, this is your normal QRS complex, this is the first negative deflection which is q, this is the R positive deflection in the QRS complex. The first positive deflection in the QRS complex and this is the negative deflection after the R wave, so this is S wave. So, suppose we get an wave like this, so this is the first positive deflection, so this is the first positive deflection, so this is R wave after P wave, but this is the negative deflection which we got after R wave.

So, this is this would not be Q wave, this will be S wave. Similarly, if we get the second positive deflection after R wave, so this will be R prime, so these are the QRS nomenclature you have to remember. We have till now we have seen unipolar chest leads, we also have bipolar chest leads which is known as Lewis chest leads. This Lewis chest leads are nothing these are the bipolar chest leads which is usually placed to record the atrial flutter. So, this is the summary of your ECG, we can see this is the 12 lead ECG lead 1, lead 2 and lead 3 these are usually biphasic. The augmented chest the augmented leads AVR, AVL, AVF, AVR is giving almost all the waves negative deflections.

This is very important point to look whether you have placed your leads correctly or not. Then AVL and AVF biphasic V 1 and V 2 we can see deep S waves the negative deflections, but we do not see Q waves V 3 and V 4 biphasic and V 5, V 6 we see tall R waves and small Q waves. Before concluding an extra edge to this topic is his bundle electro gram. Now, what is this his bundle electro gram, suppose this is a S N node and this is the AV node. Now, whenever we want to if we want to see any activity in the AV node or the bundle of his after bundle of his there is a depolarization of the ventricles which is done by the left right bundle branch and the left bundle branch conducting system.

But we do not get the recording of AV node and the his bundle in the normal conventional ECG. At that time we have to do an invasive procedure that is cardiac catheterization where we put the insert the catheter with an electrode on the tip through a peripheral vein close to the tricuspid valve to measure the activity of AV node. So, whenever impulses travelling to the AV node whenever it comes to the AV node tip we get the AV node activation. After that when it comes from tip of the AV node to the tip of the bundle of his that means, when it activates the depolarizes the bundle of his we get H wave in the his bundle electro gram. After that when this whole bundle of his is depolarized and it starts the ventricular depolarization we get this V wave. See if we just correlate this his bundle electro gram with the ECG we can see this A wave corresponds to the mid of the P wave.

This H wave comes in between the A and the Q segment or the R in between the P and the R segment P and the R wave that is middle of some out somewhere in middle of the PR interval. And this ventricular wave V wave corresponds to the Q wave obviously, which gives the onset of the ventricular depolarization. So, which means the A the conduction from SA node to AV node is your the conduction from SA node to AV node is around your 30 milliseconds. Now, this conduction has already been told in the conducting system chapter. Then the time taken from AV through the AV nodal conduction this AV nodal conduction is nothing, but this AH this is your AV nodal delay.

So, this is around 100 milliseconds and the HV conduction is your bundle of his conduction this is around 40 milliseconds. So, if I say the P wave onset you can see this is the P wave onset this P wave obviously, it will occur before the P wave. So, this PA interval is 30 milliseconds. So, this PA interval plus AH interval plus HV interval will give nothing, but your PR interval. So, if we want to pin point where is your block in the heart whether it is at the level of AV node or bundle of his then we have to do this study invasive procedure of cardiac catheterization that is his bundle electrocardiogram.

Otherwise in only ECG the block will be detected as prolonged PR interval it would not be able to say where the exactly the block is located whether it is at the level of AV node or the bundle of his. So, with this we conclude today's topic. So, these are the references from where I had taken the lecture. Thank you.