Basic 12-Lead ECG Interpretation

15

Learning Outcomes

15.1 Discuss the anatomical views represented on a 12-lead ECG and the coronary artery that commonly supplies each region of tissue.

15.2 Identify common morphologic changes associated with ischemia, injury, and infarction.

15.3 Analyze bundle branch block and its effect on the patient including basic patient care and treatment.

15.4 Differentiate between left and right bundle branch blocks and how they relate to the 12-lead ECG.

15.5 Define axis deviation and the steps utilized to determine the presence of axis deviation.

15.6 Describe left ventricular hypertrophy (LVH) and the steps to determine the presence of LVH.

Key Terms

anatomically contiguous lead
axis deviation
bundle branch block (BBB)
hypertrophy
left bundle branch block (LBBB)
myocardial infarction (MI; heart attack)
myocardial injury
myocardial ischemia
pathologic Q wave
physiologic Q wave
QS complex
right bundle branch block (RBBB)
transcutaneous pacemaker
TP segment
underlying rhythm

15.1 The Views of a Standard 12-Lead ECG and Major Vessels

The chapter *The Electrocardiograph* discussed how the 12-lead ECG produces 12 different tracings of the heart. This chapter explains what a standard 12-lead is specifically looking at—essentially what each lead represents.

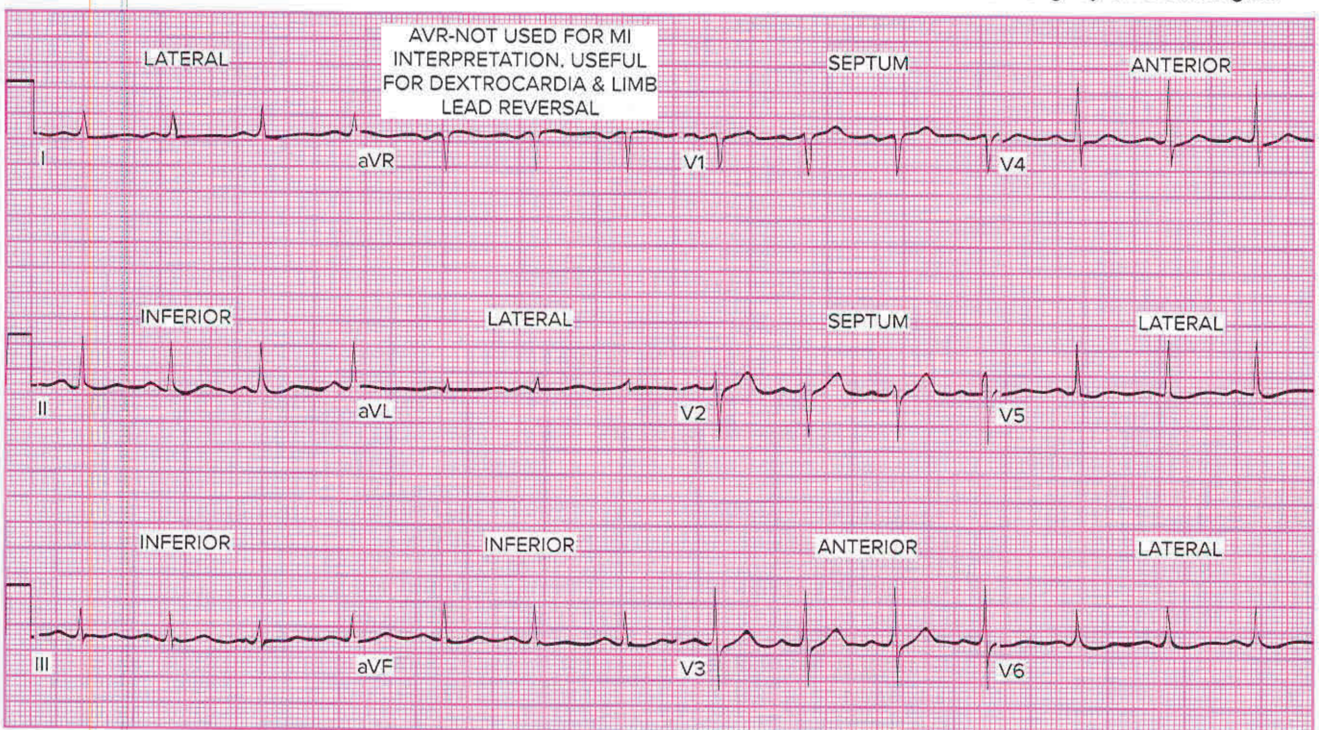
Think of each lead as a photograph, like taking a picture of a car. If you stand in front of the car and take the picture, you get the front view of the car. If you stand behind the same car and take a picture, you get a different view—the back view—of the same car.

A standard 12-lead ECG focuses directly on the left ventricle but provides images from different angles (Table 15-1 and Figure 15-1). Each lead shows the electrical activity occurring in specific regions of the heart.

TABLE 15-1 Standard 12-Lead Views

Leads	Portion of Heart Viewed	Coronary Artery and Branch
II, III, aVF	Inferior wall of left ventricle	Right coronary—Marginal branch
V1 & V2	Septal wall	Left coronary—Septal branch
V3 & V4	Anterior wall of left ventricle	Left coronary—Left anterior descending branch
I, aVL, V5, & V6	Lateral wall of left ventricle	Left coronary—Left circumflex and diagonal branches

Figure 15-1 Typically, a 12-lead ECG focuses on the left ventricle but considers the heart from slightly different angles.



In the presence of ischemia, injury, or infarction due to partial or complete blockage of coronary arteries, changes to the cardiac complex may occur that are often indicative of these problems. Consider Figures 15-2 to 15-7. Each figure identifies the area of the heart involved and the lead tracing affected by the involvement.

Checkpoint Question (LO 15.1)

1. Why do you think a doctor may order a right-side or posterior 12-lead ECG?

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Figure 15-2 Coronary circulation as it relates to specific portions of the myocardium.

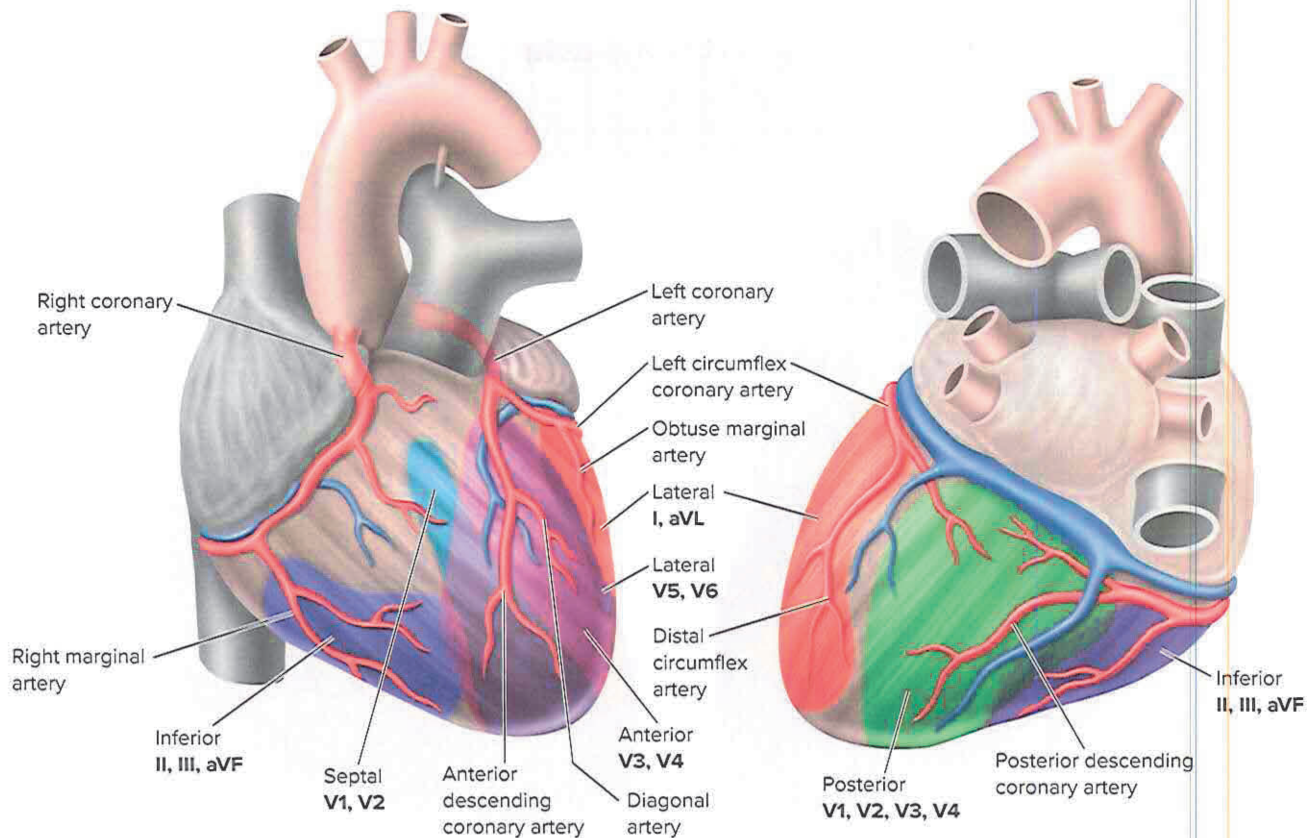


Figure 15-3 Inferior infarction. *A.* Anterior view (left). *B.* Posterior view (right).

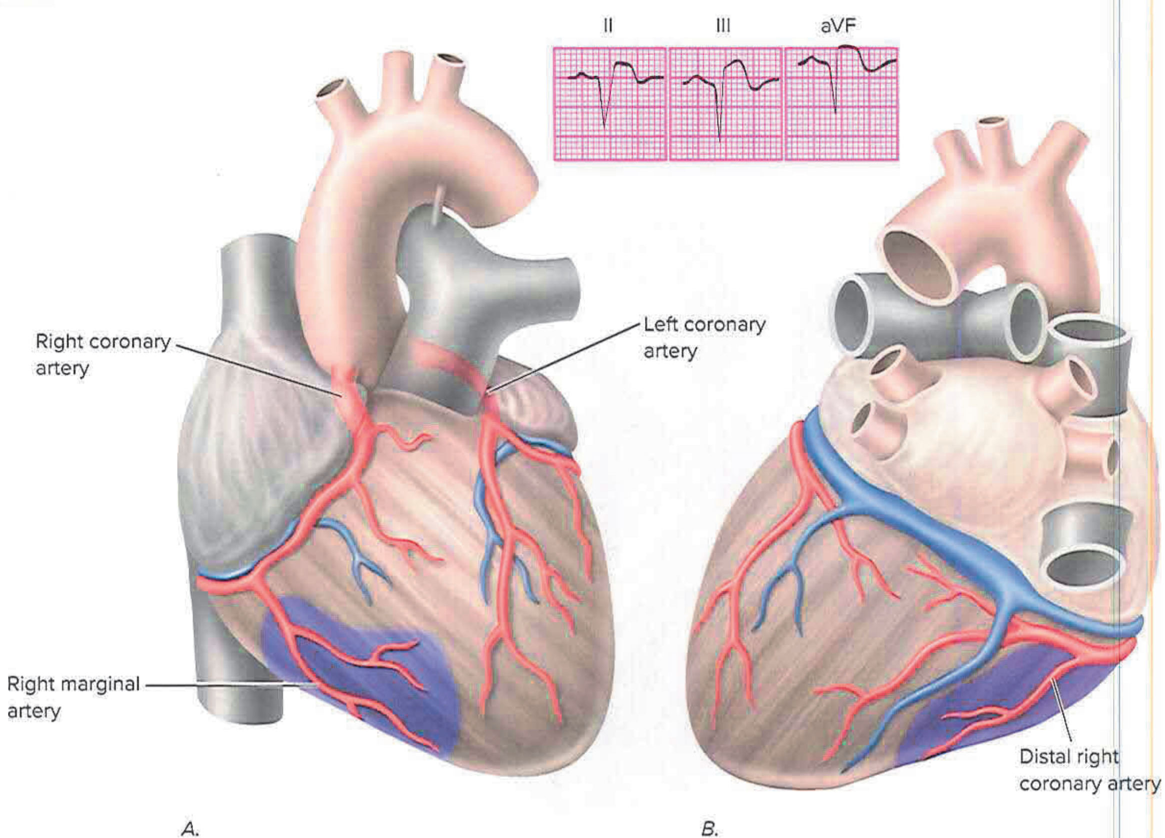


Figure 15-4 Lateral infarction. *A*. Anterior view (left). *B*. Posterior view (right).

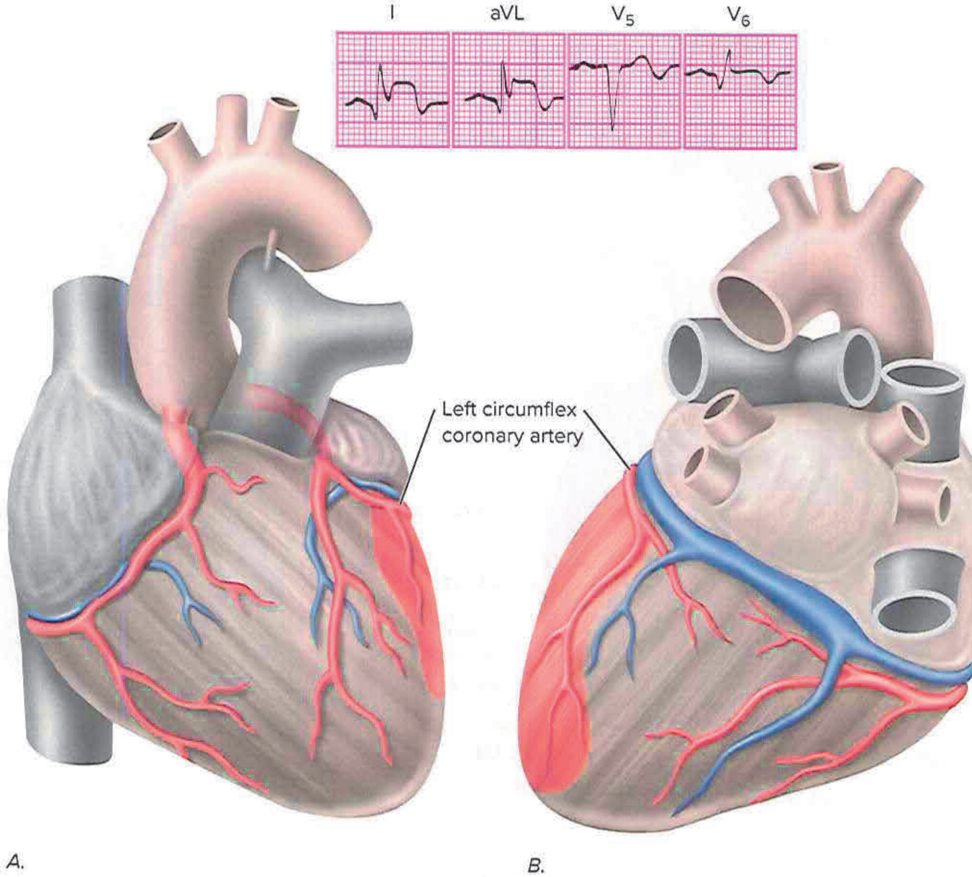


Figure 15-5 Septal infarction.

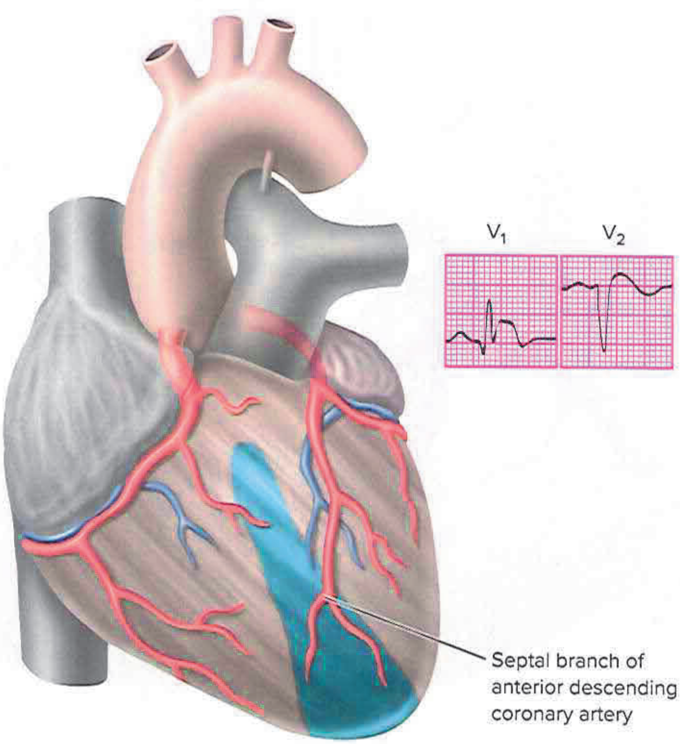


Figure 15-6 Anterior infarction.

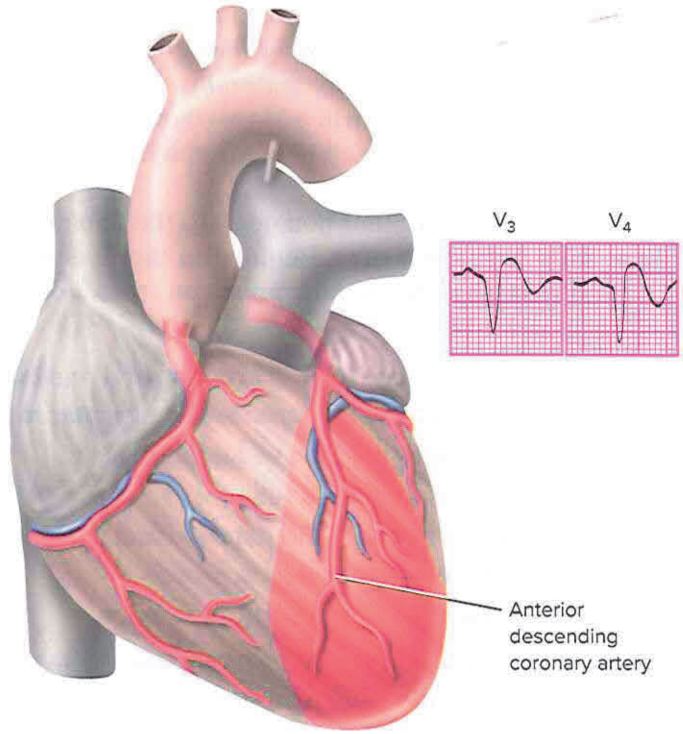
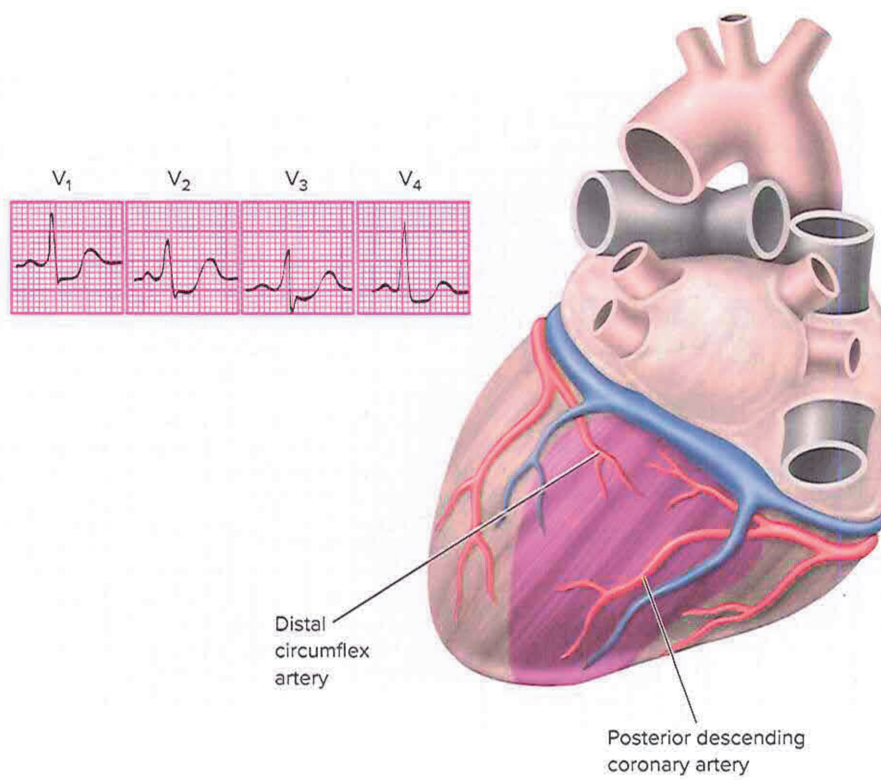


Figure 15-7 Posterior infarction. A posterior wall infarction may result from occlusion of the posterior descending artery, which is formed by the right coronary artery in 90% of the population. Much less frequently, occlusion of the distal portion of the left circumflex artery (10% of the population) may also cause a posterior wall MI.



15.2 Ischemia, Injury, and Infarction

When learning how to interpret a rhythm strip, the specific five-step process described in the *Rhythm Strip Identification* chapter is followed regardless of how complicated the dysrhythmia may be. In this chapter, you will still use the five steps, but you will add two more steps to the process, making a total of seven steps. Presented here are the basics for you to build your skill and competence quickly.

It is important that you get into the habit of analyzing the 12-lead ECG the same way each time. Begin with the five-step process discussed in the chapter *Rhythm Strip Interpretation*, then add two additional steps for a total of seven steps:

Step 1: Determine the ECG rhythm and regularity.

Step 2: Determine the atrial and ventricular rates.

Step 3: Identify the P wave morphology.

Step 4: Measure the PR interval.

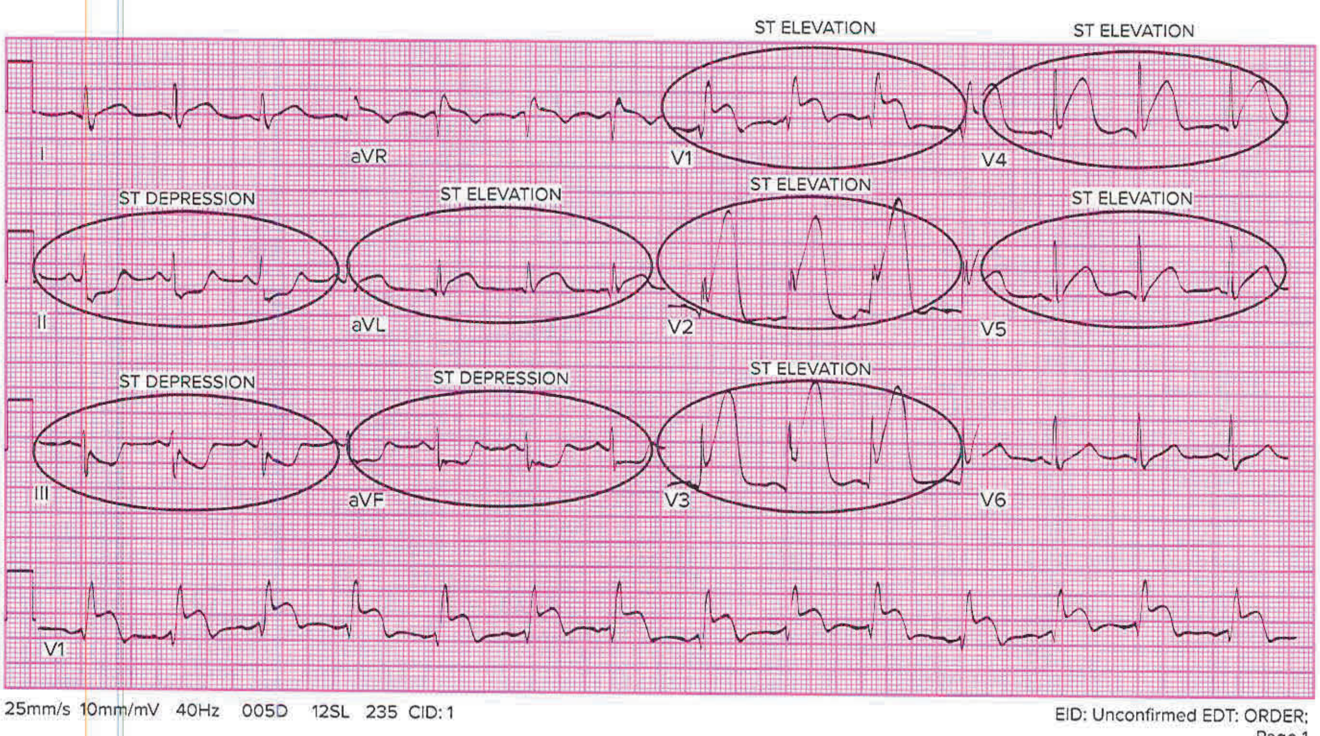
Step 5: Measure the QRS duration and analyze the morphology.

Step 6: Evaluate the leads in groups.

Step 7: Identify morphological changes.

To perform step six and seven, view the leads in groups, looking at the same part of the heart and reading from left to right. Focus on ischemia, injury, and infarction; these often cause morphologic changes to the cardiac complexes. Ischemia and injury often cause a delay in repolarization. This delay is represented by ST segment depression or elevation (Figure 15-8). Recall that the ST segment is normally in line with the isoelectric line or baseline.

Figure 15-8 12-lead ECG with ST deviation.



myocardial ischemia A reduction or interruption in blood flow and oxygen to the myocardium for a short period of time.

anatomically contiguous lead Two or more leads looking at the same part of the heart, or numerically consecutive chest leads.

TP segment The segment of a waveform that extends from the end of the T wave to the point of initiation of the following cardiac complex, typically the P wave.

Think of ischemia, injury, and infarction as a dangerous continuum of worsening cardiac conditions when blood flow to the myocardium is decreased or interrupted for even a few minutes. When seen in two or more anatomically contiguous leads, ST segment depression of 1 mm or more is indicative of **myocardial ischemia.** An **anatomically contiguous lead** is defined as two or more leads "looking" at the same part of the heart, or numerically consecutive chest leads. For example, leads II and III look at the inferior wall of the left ventricle, and V3 and V4 are numerically consecutive chest leads that look at the anterior wall of the left ventricle. Examples of anatomically contiguous leads include

- II + III, III + aVF
- I + aVL
- V1 + V2, V2 + V3, V3 + V4, V4 + V5, V5 + V6 (Figure 15-9)

When analyzing the ST segment, it is important to compare the PR segment, ST segment, and TP segment. The **TP segment** is the third segment used for the analysis of cardiac complexes. It extends from the end of the T wave to the point of initiation of the following cardiac complex (typically the P wave). This will provide you with information about the segments before and after the ST segment. This step is critical for the purpose of analysis. Taking a straight-edge or cardiac ruler and lining up the segments will assist in identifying any deviation of the ST segment from the isoelectric line.

Another indicator of ischemia is T wave inversion. T waves are normally a positively deflected waveform. In some cases of ischemia, the T wave becomes negatively deflected, or inverted. T wave inversion may be seen by itself, as shown in Figure 15-10, but most often T wave inversion is seen with concurrent ST segment elevation (Figure 15-11).

Myocardial ischemia occurs when there is a reduction or interruption in blood flow and oxygen to the myocardium for just a short period. If this

Figure 15-9 Anatomically contiguous leads are two leads that are numerically consecutive or look at the same part of the heart. For example, leads V3 and V4 are numerically consecutive and look at the anterior wall of the left ventricle.

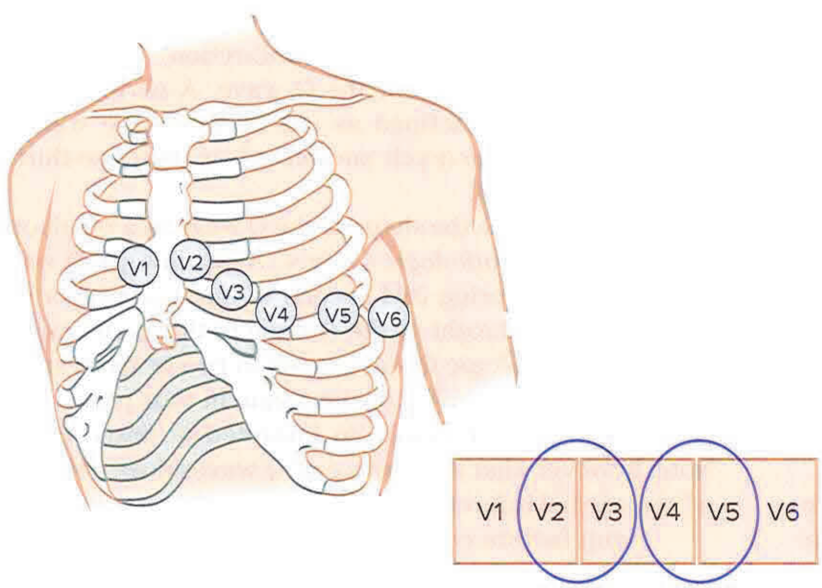
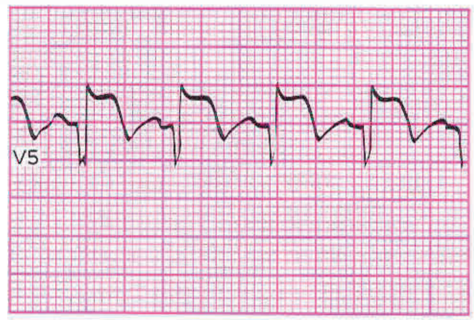


Figure 15-10 T wave inversion.

Figure 15-11 T wave inversion with ST elevation.



myocardial injury Injury to the cardiac muscle caused by prolonged reduction or interruption of blood flow.

physiologic Q wave A normal Q wave, measuring less than 0.04 second in duration and less than one-third the height of the R wave in that lead.

pathologic Q wave A Q wave that measures 0.04 second or wider in duration and/or is one-third or more the height of the R wave in that lead.

myocardial infarction (MI) (heart attack) Occlusion (blockage) of one or more of the coronary arteries causing lack of oxygen to the heart and death of the muscle tissue.

reduction or interruption of blood flow persists for more than a few minutes, the affected myocardium enters a more serious state referred to as **myocardial injury.** ST segment elevation is morphologic evidence of acute injury pattern. ST segment elevation of 1 mm or more that is seen in two or more anatomically contiguous leads is indicative of myocardial injury. ST segment elevation may be accompanied by T wave inversion.

When ST segment elevation is seen on a 12-lead ECG, it is referred to as *myocardial injury, acute injury pattern,* or *acute MI (AMI). When you see ST elevation, it means the problem is happening right now, and the tissue is **not** dead yet!* It is in that state between ischemic and dead—"stunned" would be a good way to describe it. Unless immediate and effective intervention is established, the tissue will begin to die.

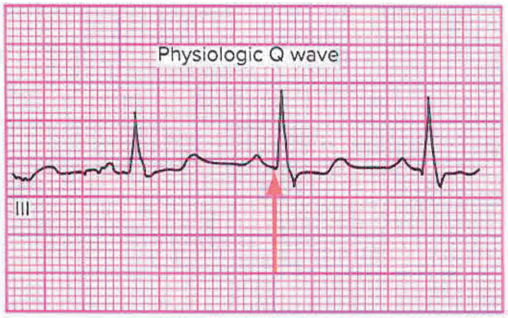
Evidence of tissue death (infarction) is often seen as a change in the width and/or depth of the Q wave. A normal or **physiologic Q wave** (Figure 15-12*A*) is defined as one in which the width measures less than 0.04 second and the depth measures less than one-third of the height of the R wave in that lead.

The change in the shape of the Q wave as a result of tissue death (infarction) is called a *pathologic Q wave.* A **pathologic Q wave** (Figure 15-12*B*) is defined as measuring 0.04 second in duration and/or greater than or equal to one-third the height of the R wave in that lead tracing. This indicates tissue death. Pathologic Q waves seen in two or more anatomically contiguous leads indicate that some of the tissue in that part of the heart is now dead **(myocardial infarction).** So infarcted = tissue necrosis = tissue death. Note, however, that an absence of Q waves does not eliminate the possibility of myocardial infarction. Not all patients have Q wave infarctions.

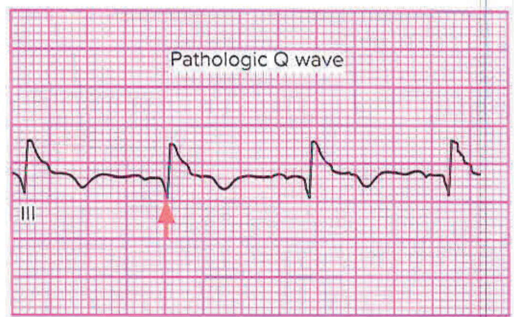
Many factors combine to determine how dangerous the infarction will be and the potential for recovery. A few factors include the involved coronary

Figure 15-12 Q waves. *A.* Physiologic Q wave. *B.* Pathologic Q wave.

A.



B.



artery or arteries, location and extent of the infarction, vital structures involved, and amount of time.

When viewing a 12-lead ECG, look for the changes (ST depression, ST elevation, T wave inversion, and pathologic Q wave previously described). It is most important to remember that these changes must be seen in at least two anatomically contiguous leads in order to qualify as indicators of ischemia, injury, or infarction.

Not all patients will present with the classic morphologic changes discussed in this chapter. Some patients will not present with any changes at all. In these cases, testing is necessary to determine the presence of muscle injury or death. Refer to the chapter *Clinical Presentation and Management of the Cardiac Patient* for more information about these tests. Also when analyzing a 12-lead ECG include bundle branch block assessment (discussed in the next two sections).

Safety & Infection Control

ST Segment Elevation

Not every instance of ST segment elevation is indicative of myocardial injury. Time, experience, and further training will help you learn what those instances are. The bottom line is the safety of the patient. ST segment elevation of any kind must *always* be reported.

Checkpoint Questions (LO 15.2)

1. Consider wandering baseline. Why is it important to eliminate this type of artifact from a 12-lead tracing?

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2. Define myocardial ischemia.

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3. What morphologic change provides evidence of myocardial injury?

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4. Describe anatomically contiguous leads.

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5. What is a pathologic Q wave?

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15.3 Introduction to Bundle Branch Block

bundle branch block (BBB) The electrical impulses that control the heartbeat cannot move properly throughout the heart (ventricles specifically). A block in the branches causes the impulses (within the ventricles) to travel slower than normal.

right bundle branch block (RBBB) Block that occurs in the right bundle branch, so that the current has to travel down the left bundle branch to activate the ventricles.

left bundle branch block (LBBB) Blockage of the left bundle branch, so that the current has to travel down the right bundle branch to stimulate first the right ventricle, then the septum, and then the left ventricle.

underlying rhythm The heart rhythm that would be present if the abnormal impulses were ignored or removed from the tracing.

Bundle branch blocks occur when one or both of the ventricular pathways are damaged or the impulse is delayed due to cardiac disease, drugs, or other conditions. When an area of one of the bundle branches is damaged, depolarization cannot travel through that tissue to reach the myocardial cells within the ventricles. Depolarization travels down the good bundle and activates the myocardial tissue in that corresponding ventricle only. The other ventricle receives the impulse as depolarization travels from one cell to the next until the entire myocardial depolarization occurs. It is similar to knocking down a line of dominoes, where each domino represents a cardiac cell. The cell will not contract until the next cell delivers the energy.

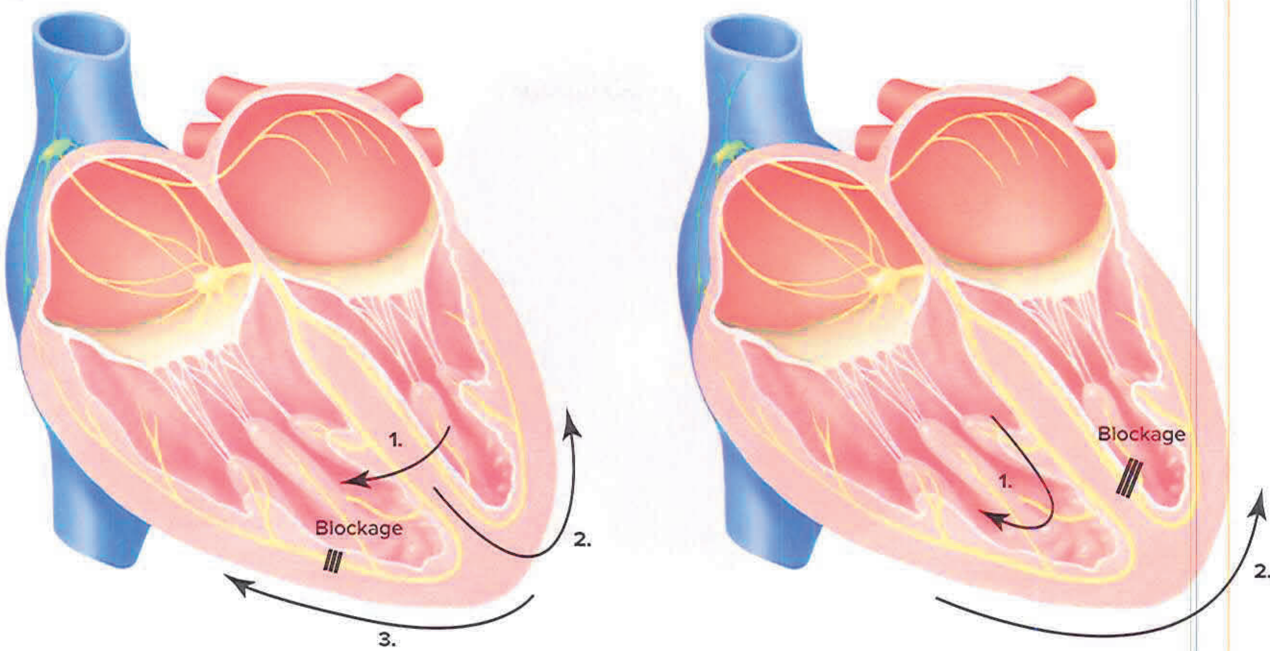
Depolarization traveling via cell-to-cell takes longer resulting in a wider than normal QRS. This longer time frame is similar to driving a car to a specific destination and having to find an alternate route or detour when the road is closed. This is what happens to the current traveling through the heart's conduction pathway when it has a blocked bundle branch. The increased length of time is reflected in a wider than normal QRS. Remember that the QRS duration is a measurement of how long it takes for current to travel through ventricular myocardial tissue (depolarization).

When a patient has a **right bundle branch block (RBBB),** the impulse starts normally via the SA and AV nodes and through the bundle of His. Depolarization then continues through the left and right bundles and at the point of the right bundle branch block, the depolarization continues with a cell-to-cell to depolarize the right ventricle, and through the left bundle normally. The cell-to-cell depolarization shifts the waveform of depolarization from right to left to right, creating the RSR on the ECG tracing. This can also be referenced as "bunny ears" in the precordial lead I (Figure 15-13*A*).

In **left bundle branch block (LBBB),** the left conduction pathway is blocked. Current travels down the right bundle branch to cause the right ventricle, the septum, and then the left ventricle to depolarize (Figure 15-13*B*). This results in a wider than normal and negatively deflected QRS when viewed in V1.

In bundle branch block (BBB), typically the **underlying rhythm** is a rhythm that originates from above the ventricles. Any rhythm (sinus, atrial, junctional) that normally has a narrow QRS complex can be affected

Figure 15-13 Right and left bundle branch block ventricular conduction.



A. Ventricular conduction with RBBB

1. The septum is depolarized normally.
2. The left ventricle is activated.
3. The current travels to the right ventricle until there is complete ventricular contraction.

B. Ventricular conduction with LBBB

1. Current travels down the right bundle branch to cause right ventricle contraction.
2. The current moves to the left ventricle, causing the septum to be activated abnormally in a right-to-left fashion.

by the BBB. The BBB classification is extra data that must be included with the basic rhythm interpretation.

The presence of BBB causes a widened QRS complex due to the delay of the electrical impulse as it spreads throughout the ventricles. The discovery of a wide QRS complex is the clue to further investigate for the presence of bundle branch block. For example, the patient may be experiencing sinus rhythm with a left bundle branch block (SR with LBBB). The basic rhythm must always be determined and specified along with the RBBB or LBBB (see Figure 15-14).

Interpret-TIP

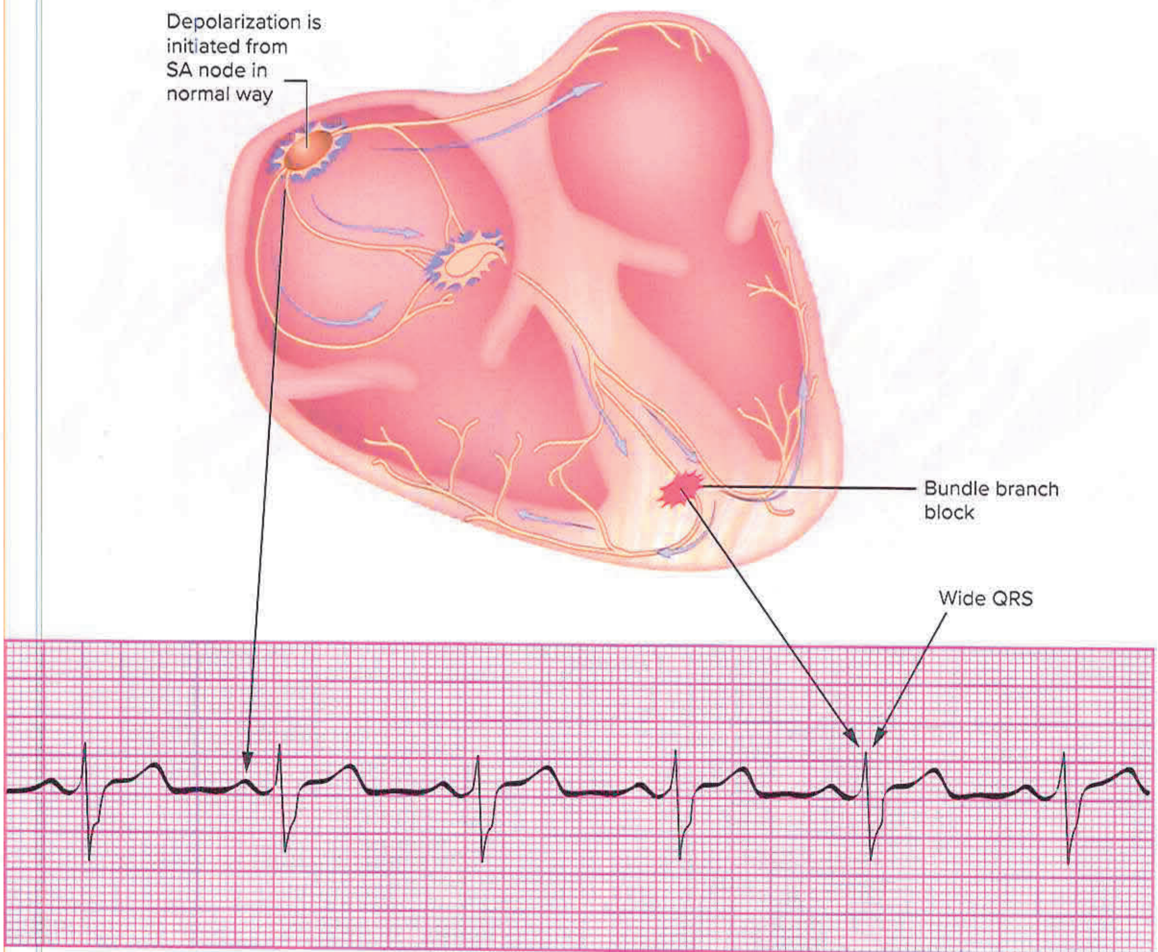
Branch Bundle Blocks

The underlying rhythm has a P wave, and the QRS complex measures 0.12 second or greater.

Criteria for Classification

Characteristics of right and left bundle branch block are similar over monitoring leads I, II, and III. Specific characteristics of a right or left bundle branch block can only be determined using the precordial 12-lead ECG leads V1 and V6.

Figure 15-14 The presence of a P wave preceding each QRS complex indicates the rhythm is arising from the SA node. The wide QRS complexes result from a conduction defect through the ventricles, indicating a bundle branch block.



- ***Rhythm:*** The regularity or irregularity depends on the underlying rhythm. Sinus or atrial is usually the underlying rhythm, with both regular and irregular rhythm patterns possible.
- ***Rate:*** The atrial and ventricular rates depend on the basic rhythm.
- ***P wave morphology:*** The morphology, deflection, and coordination with the QRS complex depend on the basic rhythm.
- ***PR interval:*** The PR interval has a normal measurement of 0.12 to 0.20 second.
- ***QRS duration and morphology:*** The QRS measurement is 0.12 second or greater in length. The widening of the QRS duration indicates the presence of a bundle branch block (see Figure 15-14).

How the Patient Is Affected and What You Should Know

The patient will exhibit the normal effects of the basic rhythm they are experiencing. For example, if the rhythm is sinus tachycardia, the patient will exhibit the signs and symptoms of a fast heart rate. A bundle branch block condition can further deteriorate to the development of another bundle branch block.

If the current becomes totally blocked and current cannot reach the myocardium, this is considered a complete heart block.

Bundle branch block alone is not considered to be life threatening, but the condition that causes bundle branch block (e.g., a myocardial infarction) can be life threatening. Initially, you will observe a widening of the QRS complex, which indicates the presence of a bundle branch block. This should be reported to a licensed practitioner immediately. The patient will need to be monitored further by the licensed practitioner to determine whether RBBB or LBBB is present, and the patient's condition should be observed for deterioration. All patients must have a 12-lead ECG to document the bundle branch block. If further degeneration of the conduction system occurs, treatment is a temporary pacemaker known as a **transcutaneous pacemaker.** The patient may end up requiring emergency cardiac care and/or needing a permanent pacemaker.

transcutaneous pacemaker A type of pacemaker applied to the external skin for a temporary condition for only 24 hours at a time.

Checkpoint Questions (LO 15.3)

1. What happens when one or both of the ventricular pathways are not functioning properly due to damage or a delay from cardiac disease, drugs, or other conditions?

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2. Describe the electrical conduction for RBBB and LBBB.

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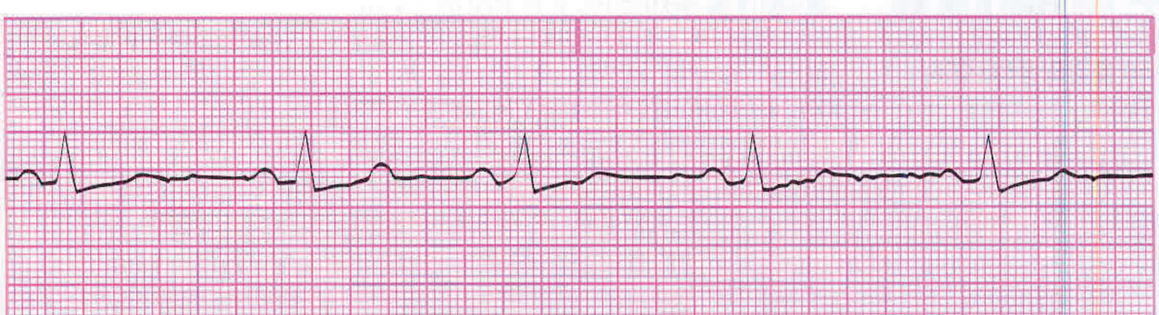
3. Using the criteria for classification, select the rhythm that most closely resembles a rhythm containing bundle branch block.

A.



B.

Which distinguishing feature(s) led you to make the selection?

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15.4 LBBB vs. RBBB

Many people are born with BBB every day and do not even know they have it until much later in life. Bundle branch block, as discussed, occurs when one or both of the ventricular pathways are damaged or delayed. It can be due to congenital defects, pulmonary and cardiac diseases, and myocardial infarction (MI). The bundle branch block alone is typically not considered life threatening. What *can* be life threatening is the cause of the BBB, such as myocardial infarction. The development of BBB during MI is a cause for significant concern. When an area of one of the bundle branches is damaged, electric current cannot travel through that tissue to reach the myocardial tissue in its usual fashion.

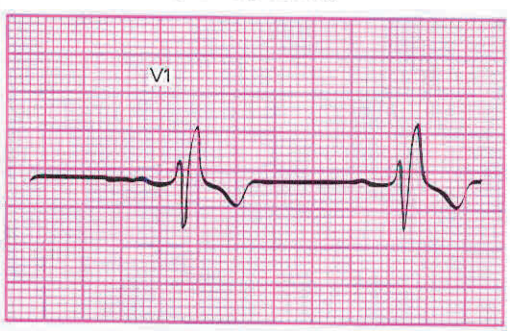
When monitoring leads I, II, and III, the characteristics of LBBB and RBBB are similar. When interpreting a tracing from one of these leads, your interpretation will not be specific to which bundle branch is blocked. Your interpretation will include the underlying rhythm with a comment on ventricular conduction delay or simply "wide" QRS.

QS complex A deep Q/S wave with no preceding R wave. Can indicate a left bundle branch block. Depolarization of the ventricles without the presence of the positive R wave typically seen. This results in the joining of the two negative wave forms (Q & S) of the QRS complex.

Specific characteristics of the right or left bundle branch will be present when monitoring with leads V1 to V6. Although bundle branch block is seen in the precordial leads, to distinguish RBBB from LBBB, lead V1 is referenced (Figure 15-15). If the majority of ventricular depolarization is positively deflected, it is RBBB. RBBB often has a classic RSR pattern in V1 and is often referred to as "bunny ears" or "bunny branch block." If the majority of ventricular depolarization is negative or a QS complex is present, it is an LBBB. A **QS complex** is a deep Q/S wave with an absence R wave.

Figure 15-15 Bundle branch blocks. *A.* RBBB. Note that the QRS is positively deflected. *B.* LBBB. Note that either the QRS is negative or a QS complex is present.

A.



B.

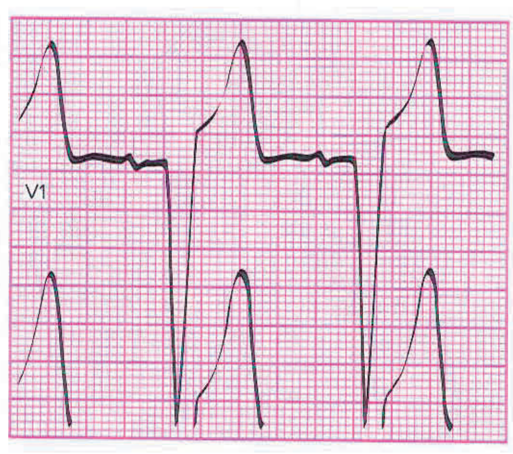
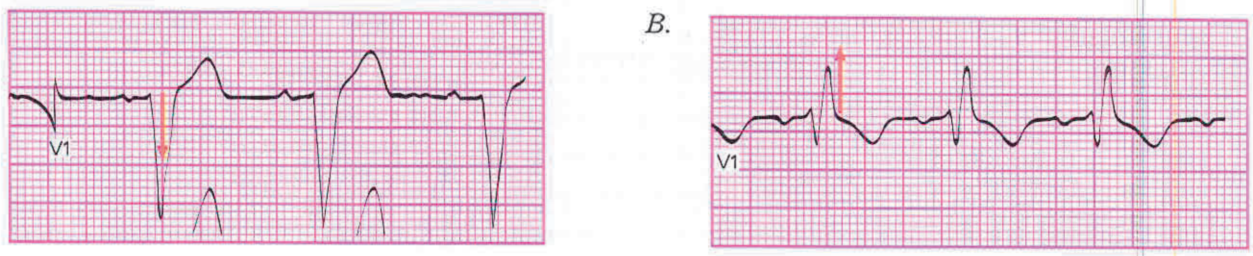


Figure 15-16 Bundle branch blocks. *A.* Left bundle branch block (LBBB). *B.* Right bundle branch block (RBBB). Note the arrow direction in *A* and *B*.

A. *B.*



When analyzing V1 to determine the presence of bundle branch block, look for the following:

1. Evidence of atrial activity (P wave). Remember, the problem is within the ventricles, so we must see a P wave to tell us that the electrical activity was initiated above the ventricles.
2. QRS complex that measures 0.12 second or more in duration.

The question now becomes "in which direction is the QRS going and how do you determine this?" Starting at the J point of the QRS, move backward into the ventricular depolarization. If it is going down (negative), it is a left bundle branch block (Figure 15-16*A*). If it is going up (positive), it is a right bundle branch block (Figure 15-16*B*).

Communicate & Connect

BBB—What the Patient Should Know

Although in most people BBB does not cause symptoms, in some cases, a BBB can cause patients to have syncope (fainting) or feel like they are going to faint (pre-syncope). Patients who have been diagnosed with BBB may need to carry a medical alert card in case they need emergency care. There are many causes for BBB; however, specific risk factors that patients should be aware of include increasing age, high blood pressure, and heart disease.

Checkpoint Questions (LO 15-4)

1. Review the following tracings, identify the type of BBB, and then explain how you determined your answers.

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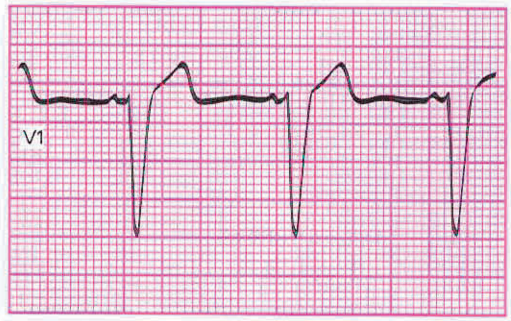
A.



B.

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15.5 Electrical Axis

axis deviation Changes that occur on a 12-lead ECG due to the orientation or position of the heart within the chest.

hypertrophy Abnormal thickening of the ventricular wall due to chronic pressure overload; often caused by hypertension.

The electrical axis is a representation of the overall electrical depolarization of the heart. Depolarization begins in the upper right (right atrium) and generates downward and to the left, ending with depolarization of the left ventricle. (Review the location of the heart in the chest). This electrical axis (wavefront of depolarization) can be shifted in certain circumstances and is reflected in the QRS complex. This shift is known as electrical **axis deviation.** If you imagine a circle divided into four large, equal quadrants superimposed over a person's chest, the patient's heart is located in the lower left quadrant (Figure 15-17).

Several things may cause the heart to deviate from its normal axis of depolarization. Some specific conditions include pregnancy, birth defects, and left ventricular hypertrophy. During pregnancy, the large third-trimester fetus temporarily displaces the heart toward the upper left quadrant. Once the baby is delivered, the heart typically returns to its normal location. With congenital defects, the depolarization waveform may be permanently shifted to the superior or inferior axis. Left ventricular **hypertrophy** is abnormal thickening of the ventricular wall due to chronic pressure overload. Because of the increased size of the ventricular muscle, the increased voltage(mass) of the ventricle shifts the axis to the left.

Figure 15-17 Quadrants used to identify axis deviation with the impact on QRS complex orientation and morphology.

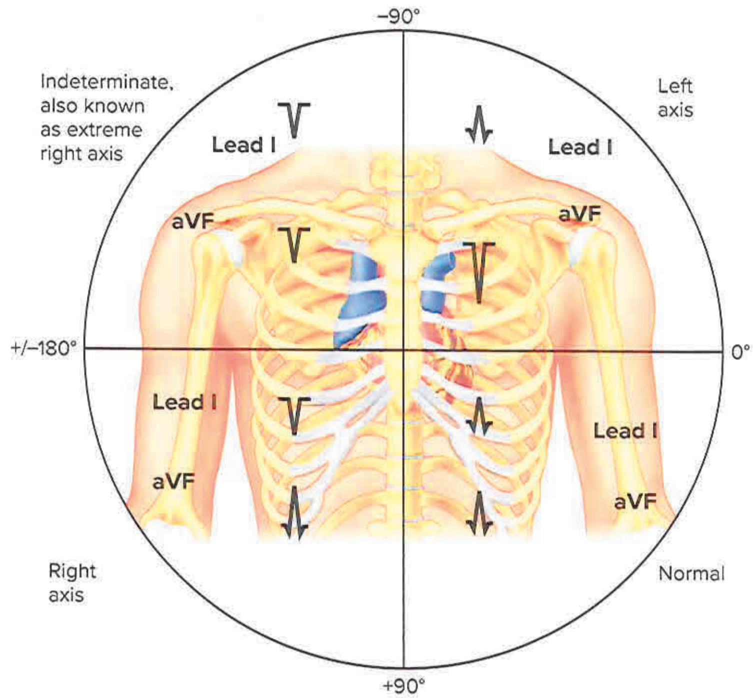
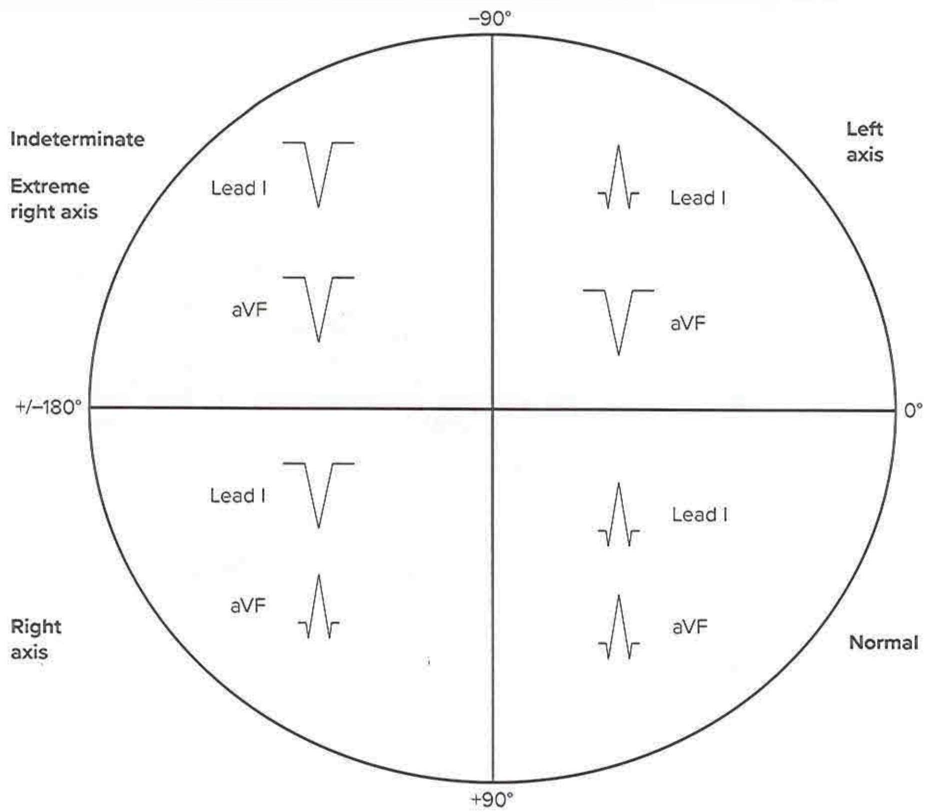


TABLE 15-2 Causes of Axis Deviation

Deviation	Possible Cause
Left axis deviation (most common)	Left ventricular hypertrophy Pregnancy Obesity Emphysema Hyperkalemia
Right axis deviation	Right ventricular hypertrophy Anterolateral wall MI *Note:* Right axis deviation is considered normal in children and tall, thin adults.
Extreme right axis deviation (referred to as indeterminate, NW territory, or No Man's Land)	Situs transversus or dextrocardia (the heart is on the right side of the chest) Pacemaker rhythms Patients with chronic obstructive pulmonary disease (COPD) Hyperkalemia *Note:* Extreme right axis deviation may also indicate lead reversal.

The axis of depolarization, or alignment, of the heart may deviate to the right or to the left. Left axis deviation is the most common. Other types of deviation are less common but do occur. Table 15-2 provides examples.

Figure 15-18 Axis deviation.



Axis deviation changes the direction of ventricular depolarization. A simple way to determine the presence of axis deviation is to refer to leads I and aVF. When "normal," both of these leads have a predominantly positive QRS complex. If either or both of these leads have a prominently negative ventricular depolarization, the electrical axis is considered abnormal. Focus on the QRS complex when referring to leads I and aVF. Review Figure 15-18 and use these guidelines.

1. If lead I is positive and aVF is also positive, the axis is normal.
2. If lead I is positive and aVF is negative, the patient has left axis deviation.
3. If lead I is negative and **aVF** is positive, the patient has right axis deviation.
4. If lead I is negative and aVF is also negative, the patient has extreme right axis deviation (also referred to as indeterminate).

Checkpoint Questions (LO 15.5)

1. What are the two leads we refer to when determining the presence of axis deviation?

____

____

2. When determining the electrical axis, on which portion of the cardiac complex should attention be focused?

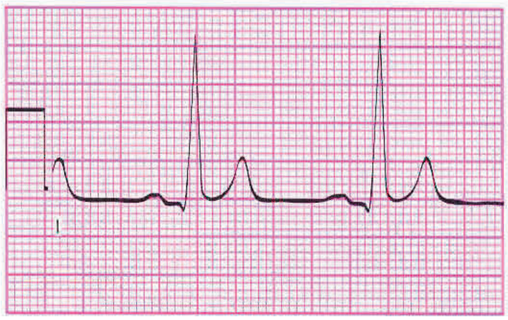
____

____

3. Use the two views below from the 12-lead ECG tracing to determine the electrical axis.

____

____



A.

B.

15.6 Left Ventricular Hypertrophy

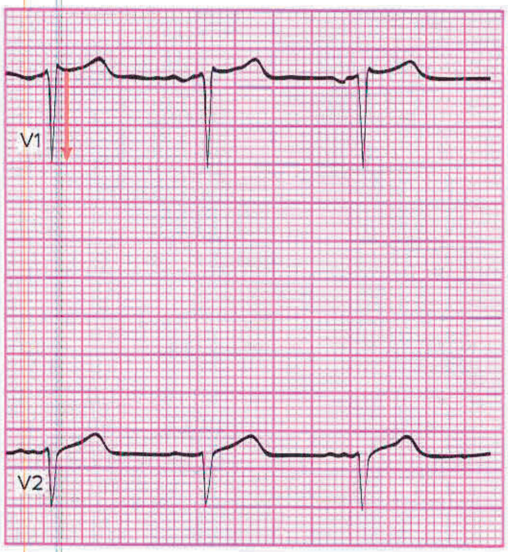
As discussed earlier, left ventricular hypertrophy (LVH) is the thickening of the ventricular wall due to chronic pressure overload. The effort the heart must exert in order to maintain normal cardiac output is increased due to increased peripheral vascular resistance. This is the same process that would occur if you went to the gym every day and lifted weights: Over time, your muscles would become thicker. As the wall thickens, the depth and height of the ventricular depolarization will increase. More muscle equals more electricity, which is shown as greater amplitude of the QRS complex. This means taller and deeper ventricular depolarization waves will be seen.

When determining the presence of left ventricular hypertrophy, follow these steps (Figure 15-19).

1. Refer to V1 and V2. Select and measure the deeper of the two views. Measure from the isoelectric line down to the tip of the deepest QS complex, count the millimeters, and write down this number.
2. Refer to V5 and V6. Select and measure the taller of the two views. Measure from the isoelectric line to the tip of the tallest R wave, then count the number of millimeters and write it down.
3. Add the two numbers together. If they add up to 35 or more millimeters, clinically you would suspect left ventricular hypertrophy.

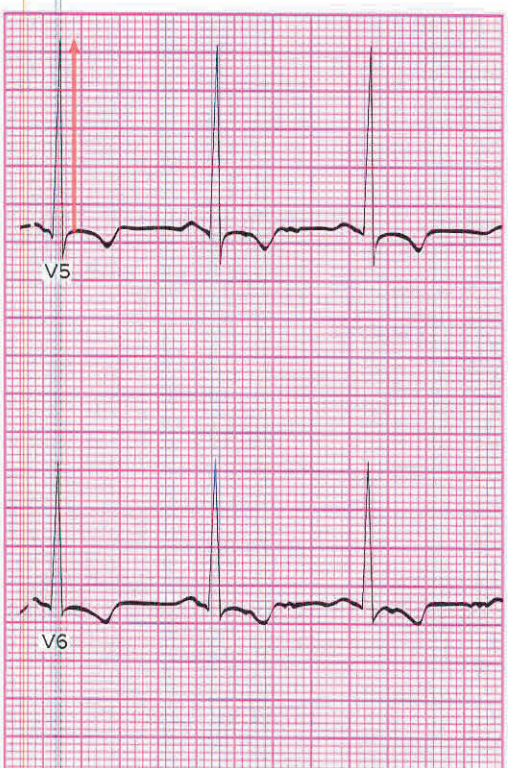
Figure 15-19 Assessing for the presence of left ventricular hypertrophy.

A.



Step 1: Analyze V1 and V2. Measure from the isoelectric line down to the tip of the deepest QS complex. The image to the left measures 12 mm. Write down that number. — 12 mm

B.

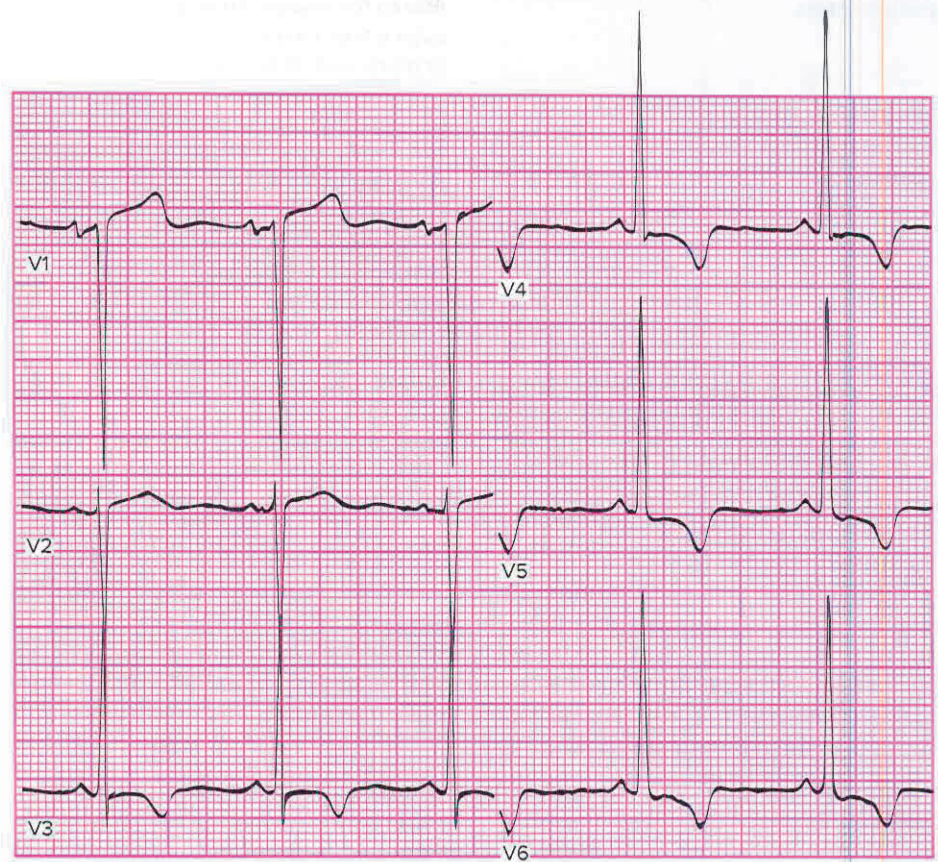


Step 2: Analyze V5 and V6. Measure from the isoelectric line up to the tip of the tallest R wave. The image to the left measures 24 mm. Write down that number. — 12 mm

Step 3: Combine the deepest QS complex measurement with the tallest R wave measurement. If the numbers measure 35 mm or greater when combined, clinically you must suspect left ventricular hypertrophy. — 12 + 24 = 36 mm

Checkpoint Question (LO 15.6)

1. Review the following tracing. Do you suspect left ventricular hypertrophy? Explain how you determined your answer.



____

____

Chapter Summary

Learning Outcomes	Summary	Pages
15.1 Discuss the anatomical views represented on a 12-lead ECG and the coronary artery that commonly supplies that region of tissue.	Leads II, III, and aVF represent the inferior wall of the left ventricle. Leads V1 and V2 represent the lateral wall of the left ventricle.	**363–367**

(Continued)

Learning Outcomes	Summary	Pages
15.2 Identify common morphologic changes associated with ischemia, injury, and infarction.	Think of ischemia, injury, and infarction as a dangerous continuum of worsening cardiac conditions when blood flow to the myocardium is decreased or interrupted for even a few minutes. ST segment depression of 1 mm or more seen in two or more anatomically contiguous leads for a short period of time is indicative of myocardial ischemia. ST segment elevation of 1 mm or more seen in two or more anatomically contiguous leads for a longer duration is indicative of myocardial injury. The change in the shape of the Q wave as a result of tissue death is called a pathologic Q wave. Pathologic Q waves seen in two or more anatomically contiguous leads indicate that some of the tissue in that part of the heart is now dead (myocardial infarction).	**368–372**
15.3 Analyze bundle branch block and its effect on the patient including basic patient care and treatment.	Bundle branch blocks (BBB) can occur in one or both bundles. Bundle branch block may be congenital, or due to pulmonary or cardiac disease and myocardial infarction. Depolarization will travel via the normally conducting bundle to depolarize the associated myocardium. The affected myocardium will be depolarized via cell-to-cell conduction. This is a much less efficient and time-consuming depolarization. The fact that it takes more time results in a wider than normal QRS complex with an abnormal duration and morphology. The rhythm has all the basic properties of sinus rhythms, atrial dysrhythmias, or junctional dysrhythmias with the exception of a wide QRS complex. The patient will exhibit the normal effects of the basic rhythm they are experiencing. BBB should be reported to a licensed practitioner immediately. The patient will need to be monitored further to determine whether RBBB or LBBB is present, and the patient's condition should be observed for deterioration.	**372–376**
15.4 Differentiate between left and right bundle branch blocks and how they relate to the 12-lead ECG.	Refer to lead V1 to differentiate between right and left BBB. • LBBB presents with a P wave and a negatively deflected QRS. • RBBB presents with a P wave and an R wave that often has two points, or "bunny ears." It also has a positively deflected QRS.	**376–378**
15.5 Define axis deviation and the steps utilized to determine the presence of axis deviation.	Electrical axis on the 12-lead ECG is a reflection of overall wave-front depolarization. Axis is determined using leads II and aVf. A normal axis is a positive QRS complex in both of these leads. Axis deviation can be caused by disease, pregnancy, or congenital defects.	**378–381**
15.6 Describe left ventricular hypertrophy (LVH) and the steps to determine the presence of LVH.	Left ventricular hypertrophy is an abnormal thickening of the ventricular wall due to pumping against increased vascular resistance over a period of time. As the wall thickens, the depth and height of the ventricular depolarization will increase. More muscle equals more electricity and thereby greater amplitude of the QRS complex. This means taller and deeper ventricular depolarizations will be seen.	**381–383**

Chapter Review

Matching

Match the terms on the left with their definitions on the right.

_______ 1. axis deviation (LO 15.3)
_______ 2. contiguous leads (LO 15.3)
_______ 3. hypertrophy (LO 15.4)
_______ 4. bundle branch block (LO 15.4)
_______ 5. myocardial infarction (LO 15.2)
_______ 6. myocardial injury (LO 15.2)
_______ 7. myocardial ischemia (LO 15.2)
_______ 8. left bundle branch block (LO 15.4)
_______ 9. pathologic Q wave (LO 15.3)
_______ 10. physiologic Q wave (LO 15.3)
_______ 11. right marginal branch (LO 15.1)
_______ 12. QS complex (LO 15.4)
_______ 13. right bundle branch block (LO 15.4)
_______ 14. underlying rhythm (LO 15.4)

a. abnormal thickening
b. reduction or interruption in blood flow and oxygen to the myocardium
c. measuring 0.04 second and/or greater than or equal to one-third the height of the R wave
d. supplies blood to both surfaces of the right ventricle
e. tissue death in the heart muscle
f. measures less than 0.04 second, and the depth measures less than one-third of the height of the R wave
g. ST segment elevation of 1 mm or more seen in two or more anatomically contiguous leads
h. ECG changes due to the position of the heart
i. looks at the same part of the heart or numerically consecutive chest leads
j. Rhythm with ventricular depolarization measuring 0.12 second or greater with a negatively deflected (QS) complex
k. Rhythm that often has an RSR pattern that is commonly called "bunny ears"
l. Rhythm in which the wave of depolarization is delayed or blocked within one of the bundle branches of the normal conduction pathway
m. Basic rhythm present in addition to BBB
n. Ventricular complex that has no R wave and may indicate BBB

Multiple Choice

Circle the correct answer. More than one answer can apply.

15. Which leads look at the lateral wall of the left ventricle? (LO 15.1)
- **a.** II, III, and aVF
- **b.** V1 and V2
- **c.** V3 and V4
- **d.** I, aVL, V5, and V6

16. Which leads look at the septal wall of the left ventricle? (LO 15.1)
   a. II, III, and aVF
   b. V1 and V2
   c. V3 and V4
   d. I, aVL, V5, and V6

17. Which leads look at the inferior wall of the left ventricle? (LO 15.1)
   a. II, III, and aVF
   b. V1 and V2
   c. V3 and V4
   d. I, aVL, V5, and V6

18. Which leads look at the anterior wall of the left ventricle? (LO 15.1)
   a. II, III, and aVF
   b. V1 and V2
   c. V3 and V4
   d. I, aVL, V5, and V6

19. Which major coronary artery and vessel supply the inferior wall of the left ventricle? (LO 15.1)
   a. Left main and circumflex artery
   b. Left main and left anterior descending
   c. Left main and septal
   d. Right main and right acute marginal branch

20. Which major coronary artery and vessel supply the septal wall of the left ventricle? (LO 15.1)
   a. Left main and circumflex
   b. Left main and left anterior descending
   c. Left main and septal
   d. Right main and right acute marginal branch

21. Which major coronary artery and vessel supply the lateral wall of the left ventricle? (LO 15.1)
   a. Left main and circumflex artery
   b. Left main and left anterior descending
   c. Right main and septal
   d. Right main and right acute marginal branch

22. Which major coronary artery and vessel supply the anterior wall of the left ventricle? (LO 15.1)
   a. Left main and circumflex artery
   b. Left main and left anterior descending
   c. Right main and septal
   d. Right main and right acute marginal branch

23. Signs of myocardial ischemia may include (LO 15.2)
   a. ST segment elevation.
   b. ST segment depression only.
   c. ST segment depression and T wave inversion.
   d. pathologic Q wave.

24. Signs of myocardial injury may include (LO 15.2)
   a. ST segment elevation.
   b. ST segment depression only.
   c. ST segment depression and T wave inversion.
   d. pathologic Q wave.

25. Which of the following is the most common sign on a 12-lead ECG that an infarction has occurred? (LO 15.2)
   a. ST segment elevation
   b. ST segment depression only
   c. ST segment depression and T wave inversion
   d. Pathologic Q wave

26. What two views are referred to when determining electrical axis? (LO 15.5)
   a. V1 and V2
   b. V3 and V4
   c. I and aVF
   d. III and aVR

27. When determining axis deviation, if lead I and lead aVF both have predominantly positive QRS complexes, the patient has (LO 15.5)
   a. normal axis.
   b. left axis deviation.
   c. right axis deviation.
   d. extreme right axis deviation.

28. When determining axis deviation, if the QRS complex in lead I is predominantly negative and the QRS in lead aVF is predominantly positive, the patient has (LO 15.5)
   a. normal axis.
   b. left axis deviation.
   c. right axis deviation.
   d. extreme right axis deviation.

29. When determining axis deviation, if lead I and lead aVF both have predominantly negative QRS complexes, the patient has (LO 15.5)
   a. normal axis.
   b. left axis deviation.
   c. right axis deviation.
   d. extreme right axis deviation.

30. When determining axis deviation, if the QRS complex in lead I is predominantly positive and the QRS in lead aVF is predominantly negative, the patient has (LO 15.5)
   a. normal axis.
   b. left axis deviation.
   c. right axis deviation.
   d. extreme right axis deviation.

31. Which leads are referred to when analyzing a 12-lead ECG for the presence of left ventricular hypertrophy? (LO 15.6)
   a. V2, V3, V5, and V6
   b. I, aVL, II, and III
   c. V1, V2, V5, and V6
   d. I, aVL, aVR, and V4

32. When totaled, how many millimeters is the minimum necessary to clinically suspect hypertrophy? (LO 15.6)
   a. 3
   b. 5
   c. 35
   d. 350

33. You observe a wide QRS complex while continuously monitoring a patient in lead II. Which lead placement is referenced to evaluate the location of blockage in the bundle branch system? (LO 15.4)
  a. Lead I
  b. Lead V4
  c. Lead III
  d. Lead V1

34. The labeling of the ECG rhythm strip for documentation of the bundle branch block should include what other information besides the bundle branch designation? (LO 15.3)
  a. Symptoms the patient is experiencing
  b. Blood pressure reading
  c. Presence of an MI diagnosis
  d. Patient's inherent rhythm pattern

35. Which of the following most accurately describes the difference between LBBB and RBBB when viewing lead V1? (LO 15.4)
  a. The QRS complex is less than 0.12 second for RBBB and greater than 0.12 second for LBBB.
  b. The majority of the ventricular depolarization is positive for LBBB and negative for RBBB.
  c. Ventricular depolarization measures 0.12 second or greater for both, with QS complex for LBBB and RSR complex for RBBB.
  d. The QRS complex is greater than 0.12 second for RBBB and less than 0.12 second for LBBB.

36. Why do the QRS complexes in bundle branch block have a longer-than-normal duration of more than 0.12 second? (LO 15.3)
  a. Ventricular depolarization in the affected side is from cell to cell.
  b. The electric current is delayed between the SA and AV nodes.
  c. The electric impulse is generated by the AV node.
  d. The electric impulse is conducted through the atria only.

37. Which of the following rhythms cannot be an underlying rhythm in patients with bundle branch block? (LO 15.3)
  a. Accelerated junctional rhythm
  b. Atrial flutter
  c. Sinus bradycardia
  d. Ventricular tachycardia

Short Answer

38. List two major causes of ischemia within the heart. (LO 15.2)

____

____

39. Define *anatomically contiguous.* (LO 15.2)

____

____

40. Compare what happens to the QRS complex of a bundle branch block tracing versus a tracing that indicates hypertropy. (LO 15.4)

____

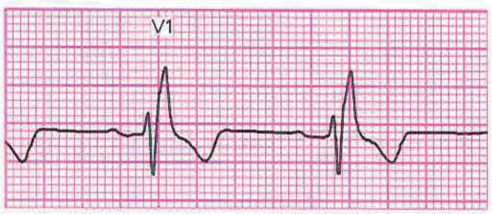
____

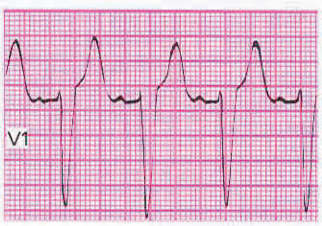
41. What are the two criteria for determining the presence of bundle branch block? (LO 15.4)

42. What is a left BBB is determined by? (LO 15.4)

43. What is a right BBB is determined by? (LO 15.4)

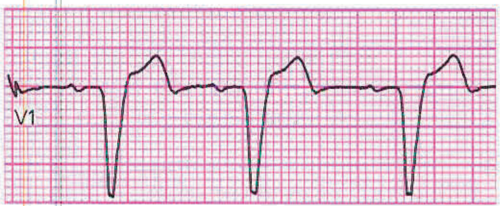
Matching II

44. 

45. 

46. 

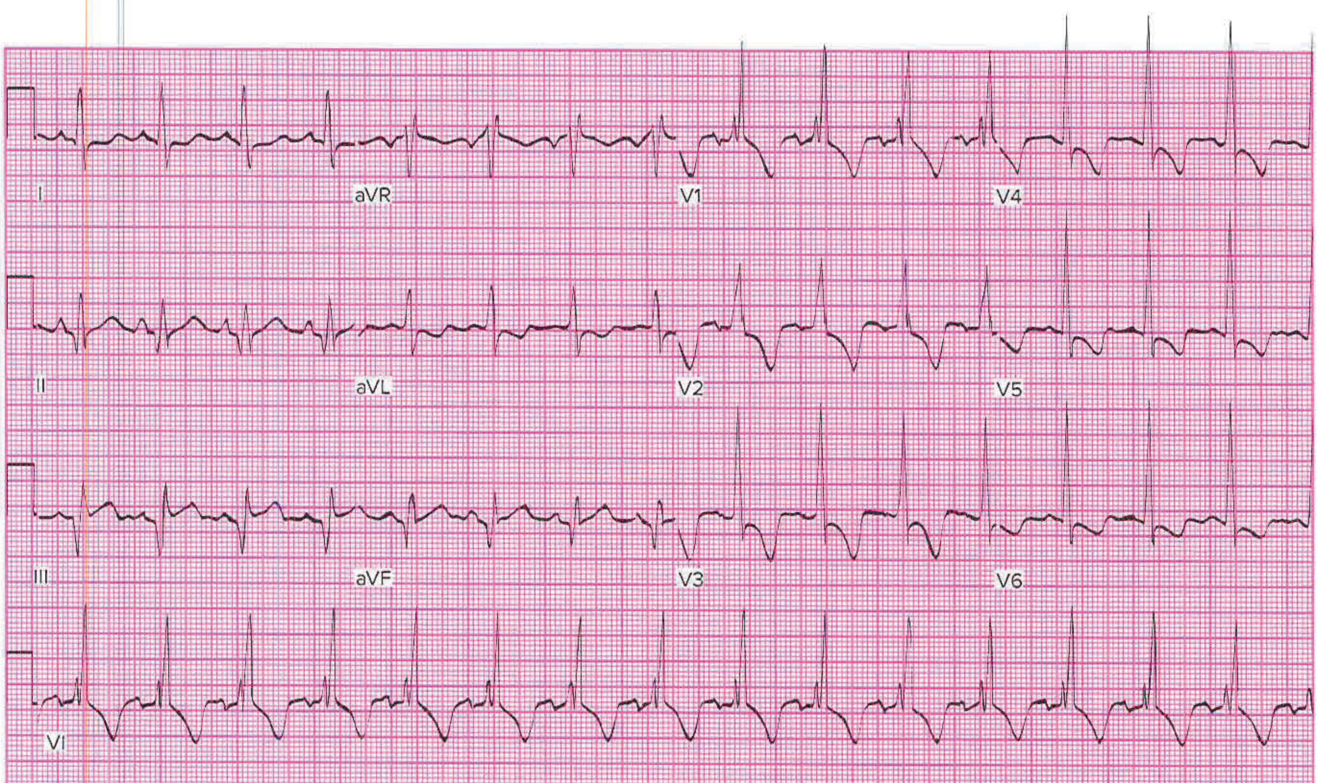
47. 

48. 

49. 

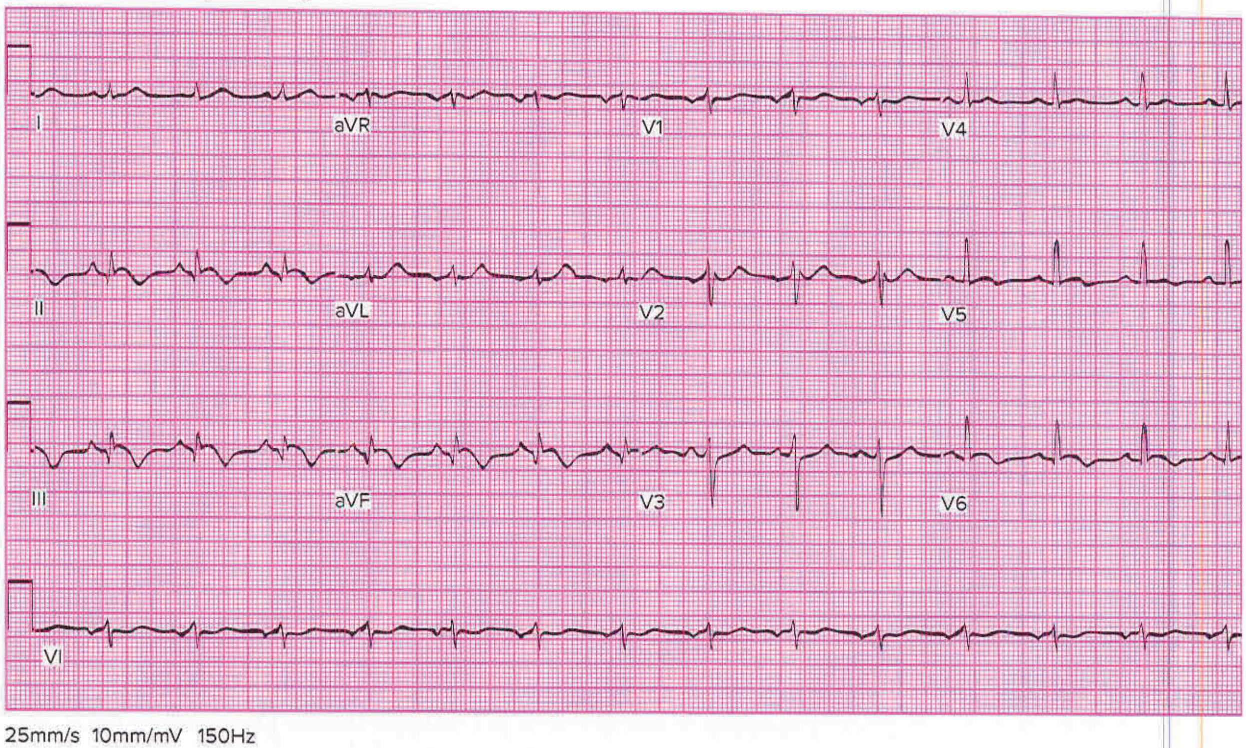
Critical Thinking Application *Rhythm Identification*

50. Identify the leads and surface of the heart showing ischemic changes on this 12-lead ECG, and explain your answer. (LO 15.2)

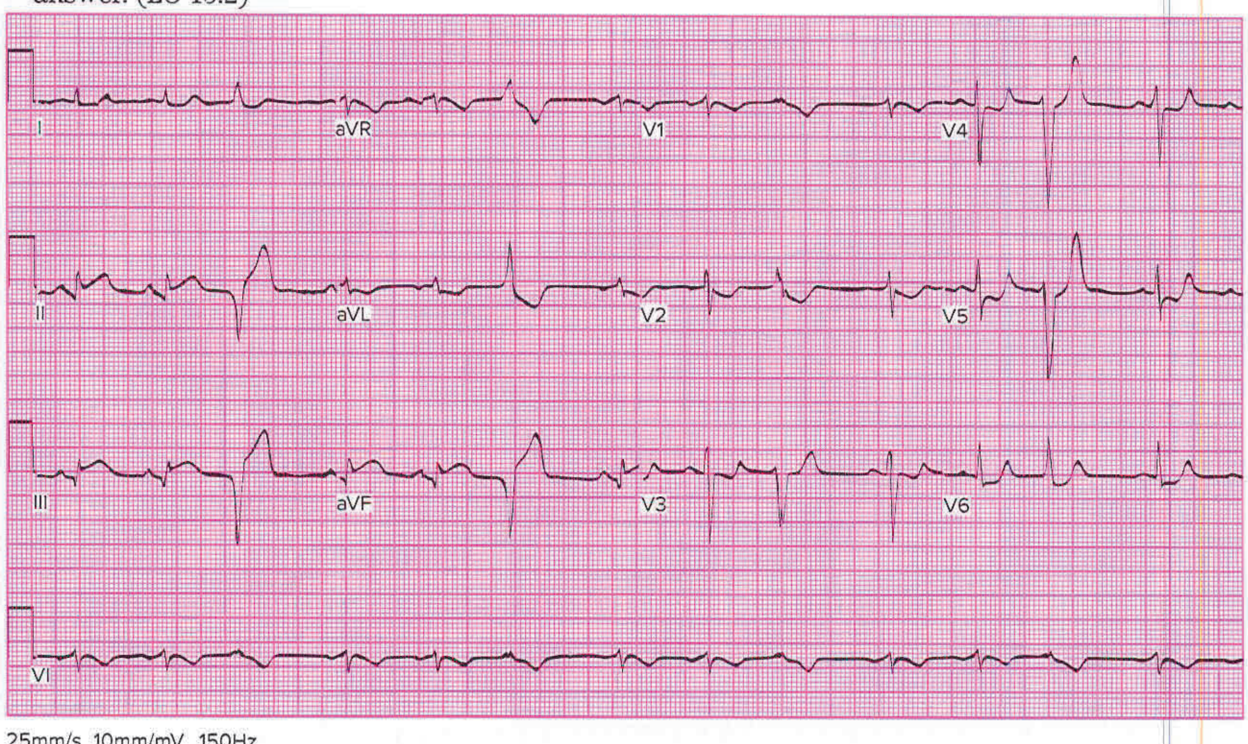


25mm/s 10mm/mV 150Hz

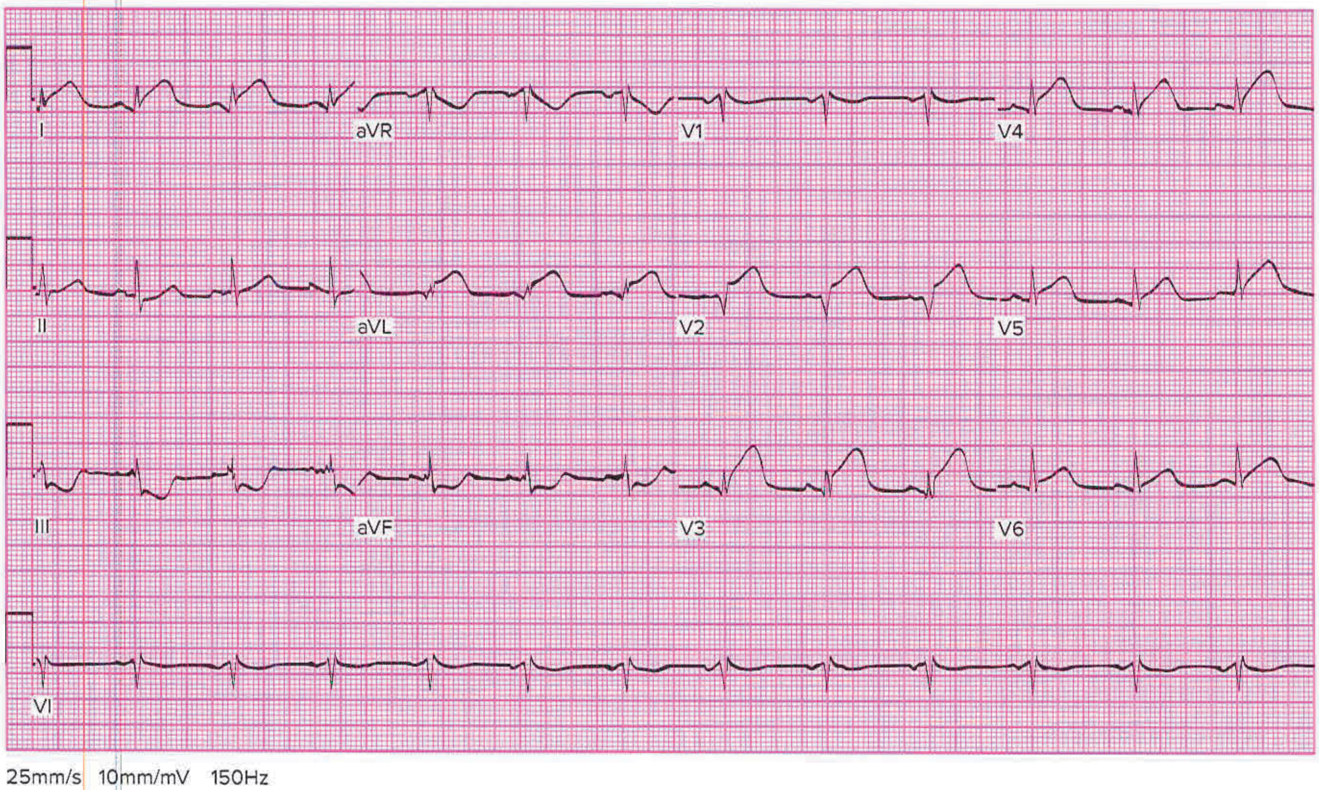
51. Identify the leads and surface of the heart showing the infarction on this 12-lead ECG, and explain your answer. (LO 15.2)



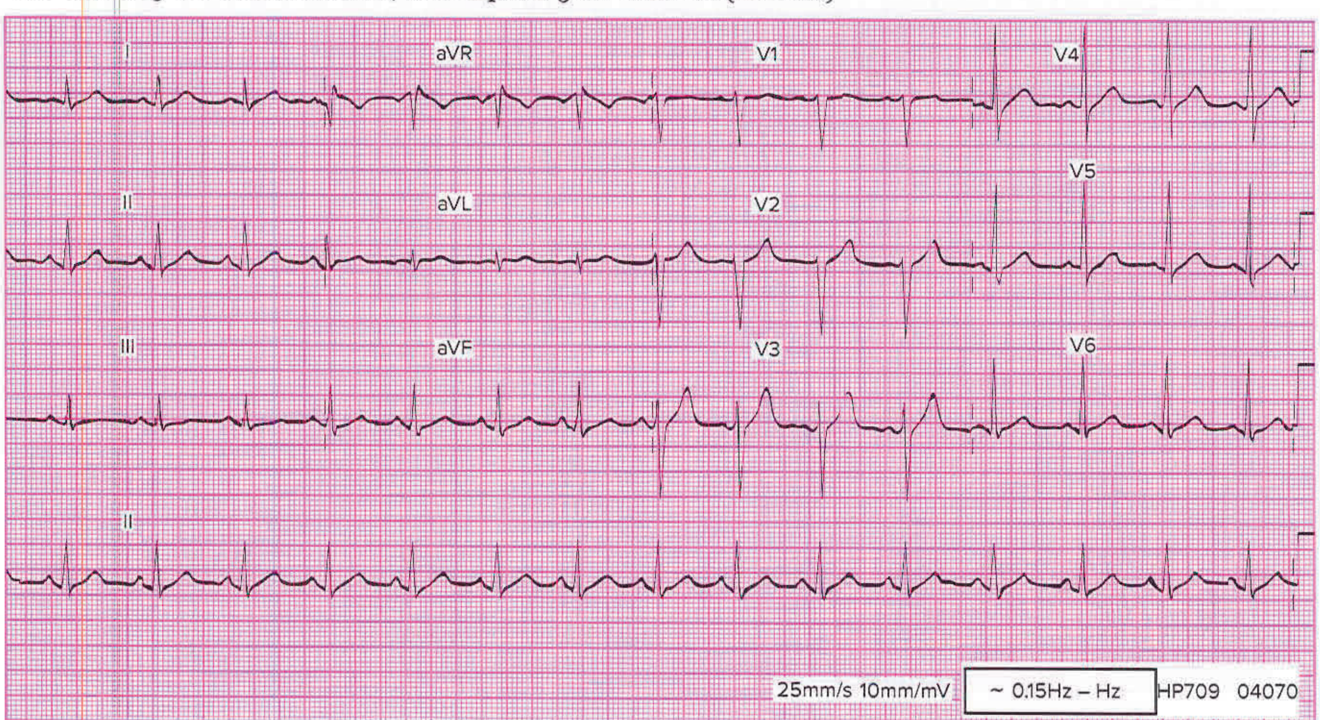
52. Identify the leads and surface of the heart showing the AMI on this 12-lead ECG, and explain your answer. (LO 15.2)



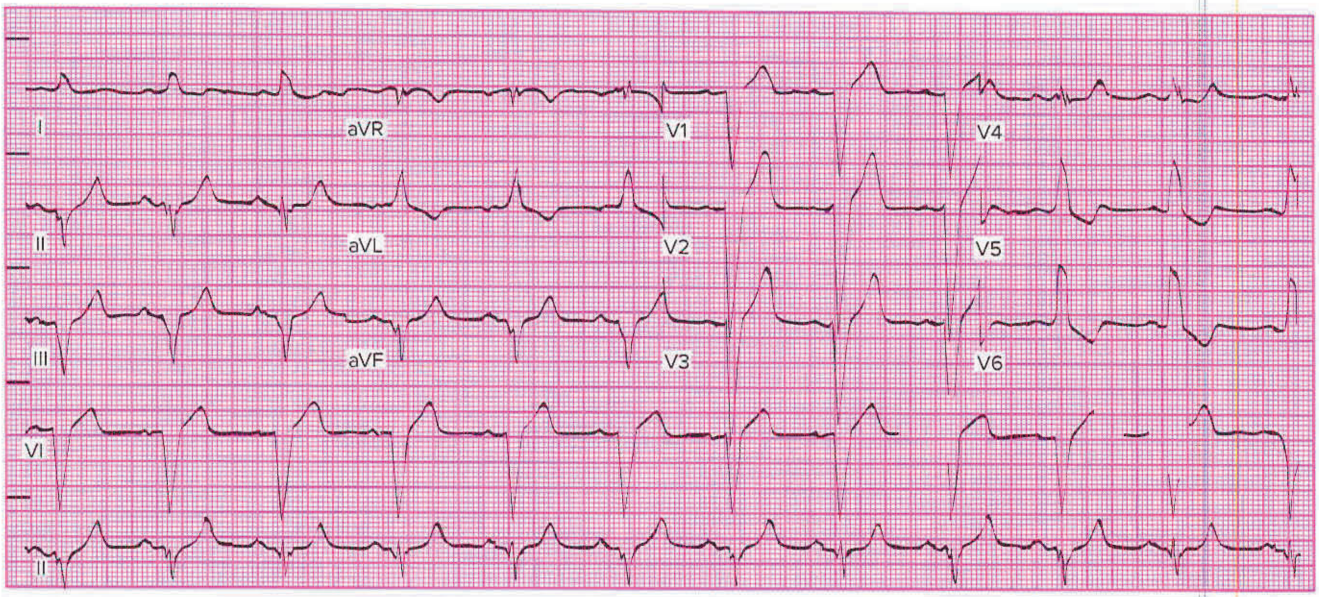
53. Identify the leads and surface of the heart showing the AMI on this 12-lead ECG, and explain your answer. (LO 15.2)



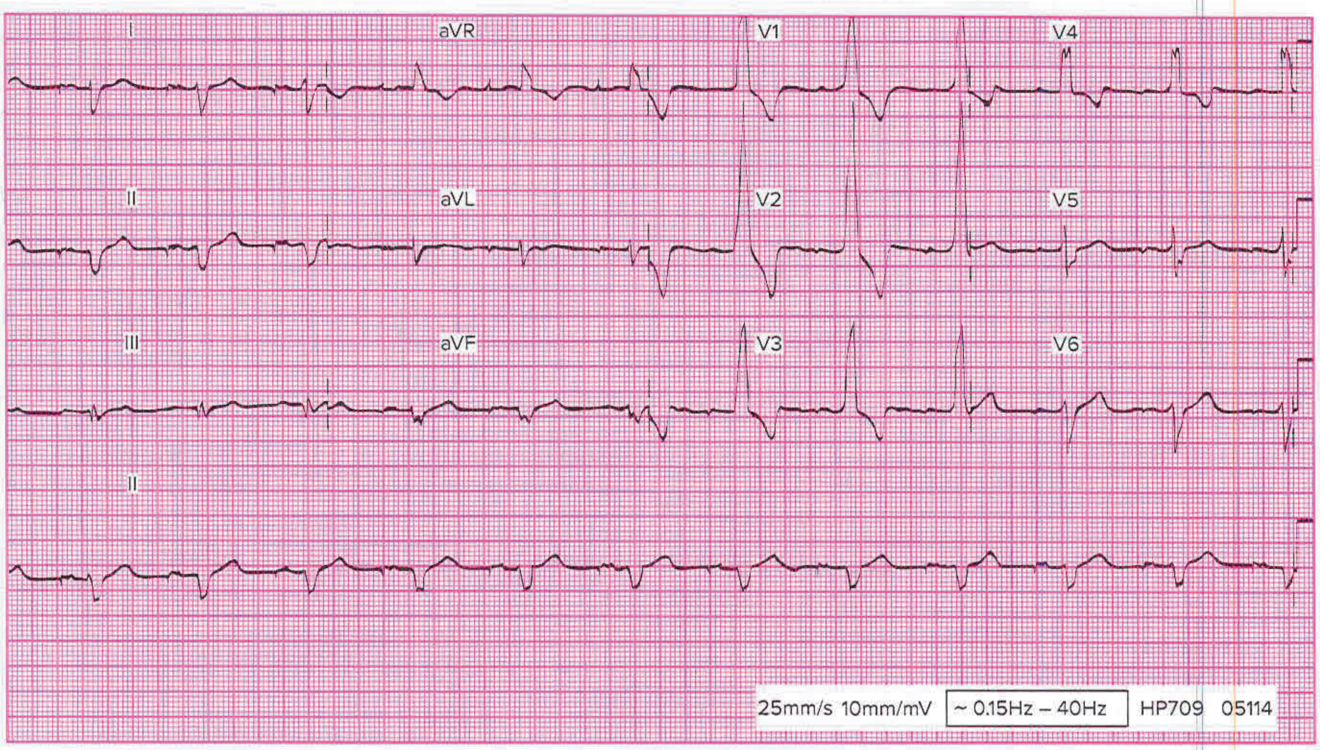
54. Identify the electrical axis, and explain your answer. (LO 15.5)



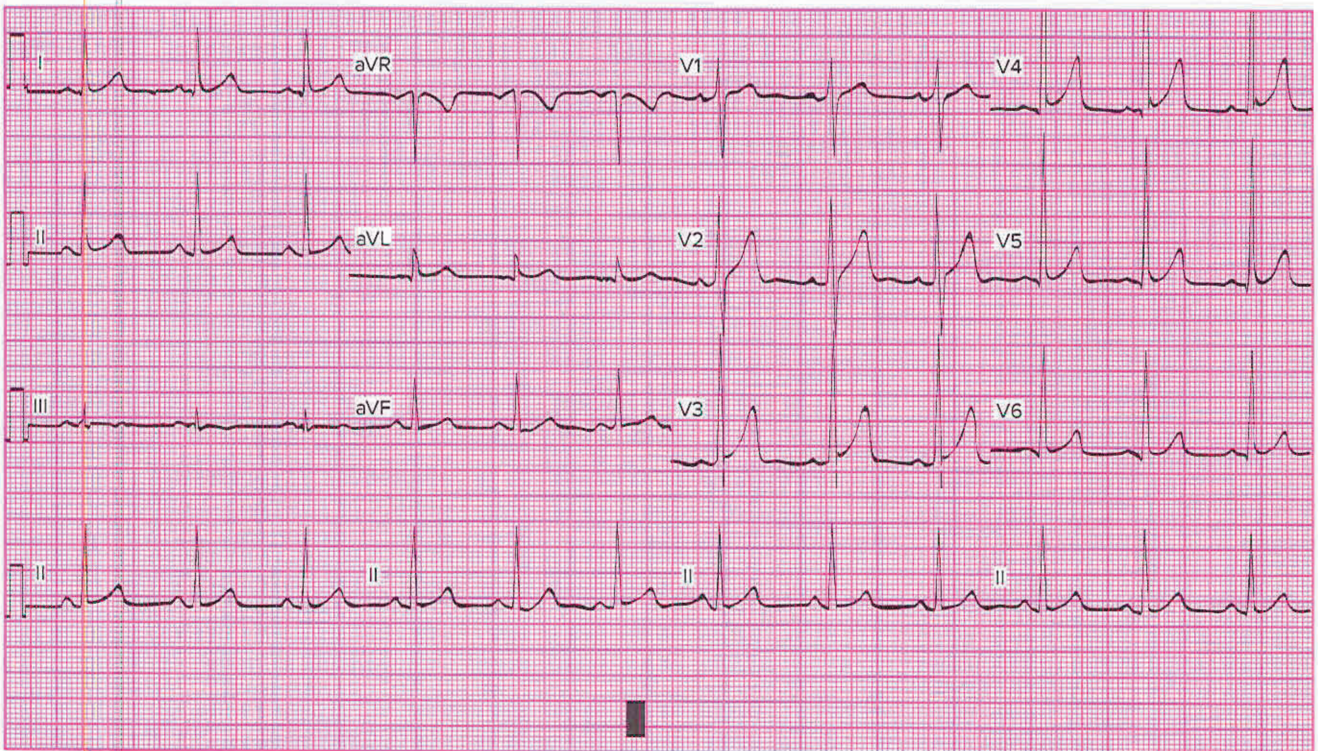
55. Identify the electrical axis, and explain your answer. (LO 15.3)



56. Identify the electrical axis, and explain your answer. (LO 15.3)



57. Review the figure and determine if left ventricular hypertrophy is present. Explain your answer. (LO 15.6)



____

____

Review the V_1 tracings pictured next and, using the criteria for classification provided in the chapter as clues, identify each rhythm and provide what information you used to make your decision. (LO 15.3, 15.4)

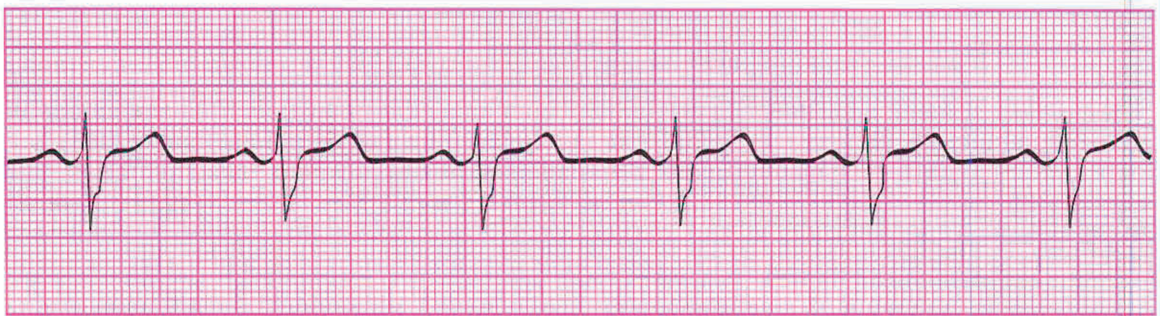
58.

Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

59.

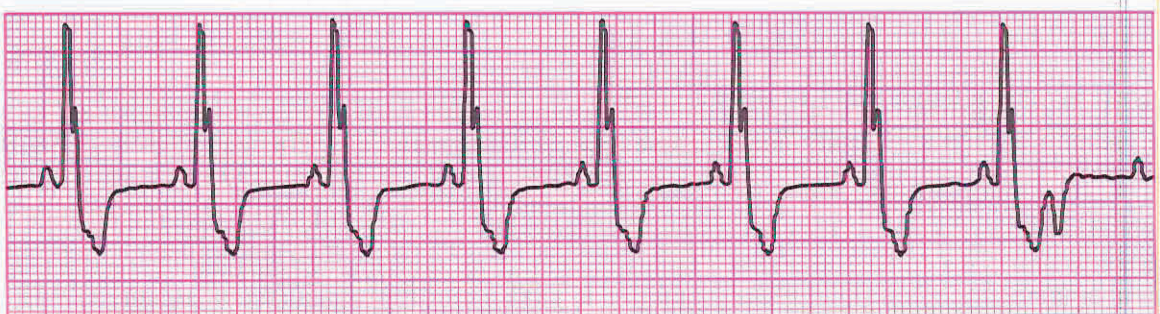


Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

60.

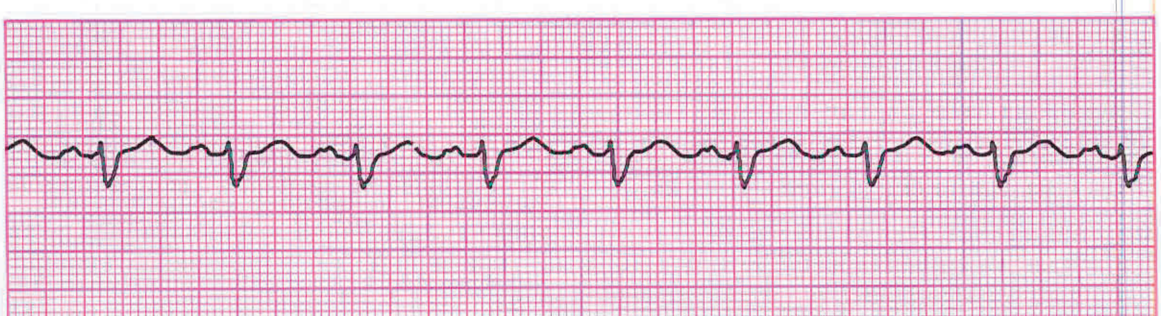


Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

61.



Rhythm (regular or irregular): ____________ PR interval: ____________

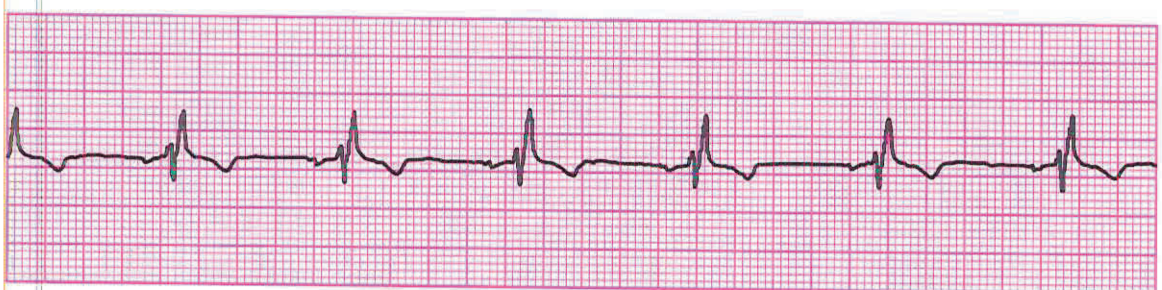
Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

62.

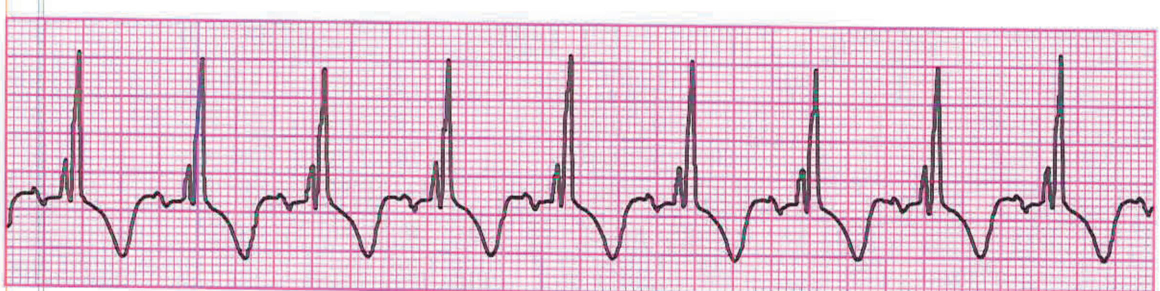
Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

63.



Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

64.

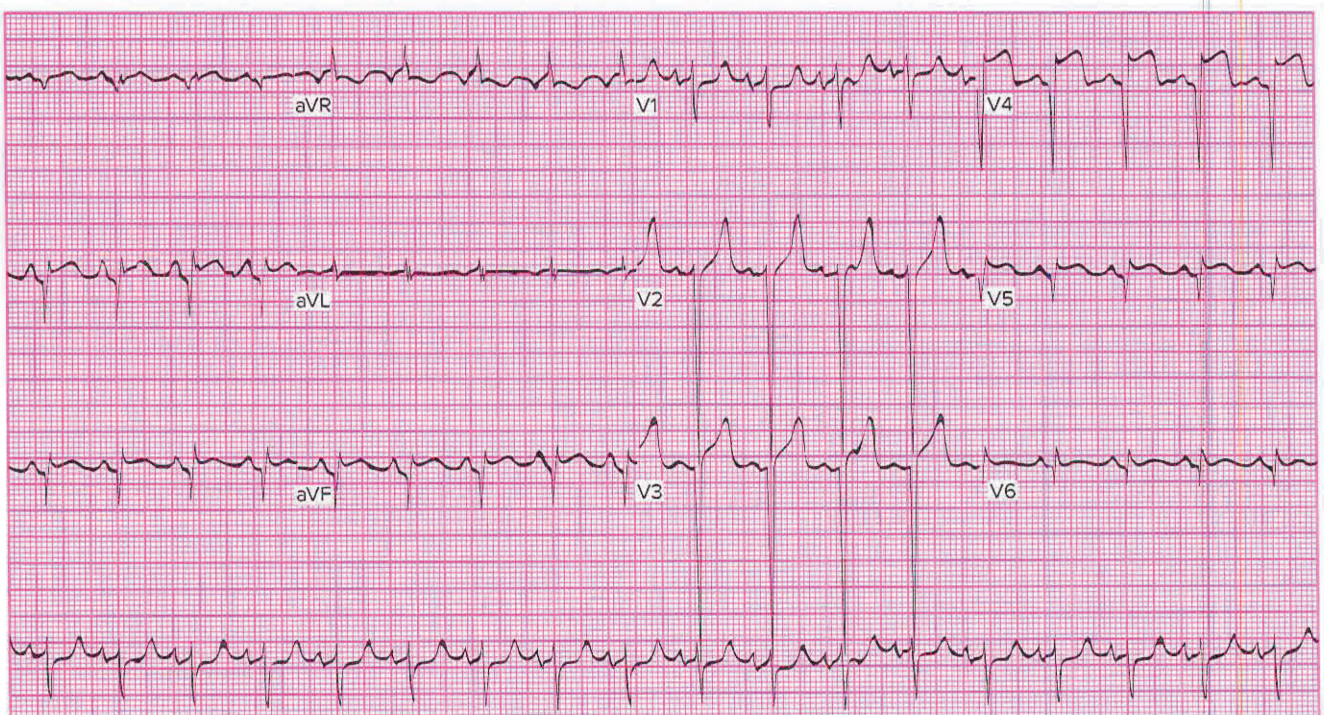


Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

Mc Graw Hill connect® Now that you have completed the material in the textbook, go to Connect and complete any chapter activities you have not yet done.

Putting It All Together

1. Circle the correct words and fill in the blanks to identify the following:



10mm/mV 150Hz

Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

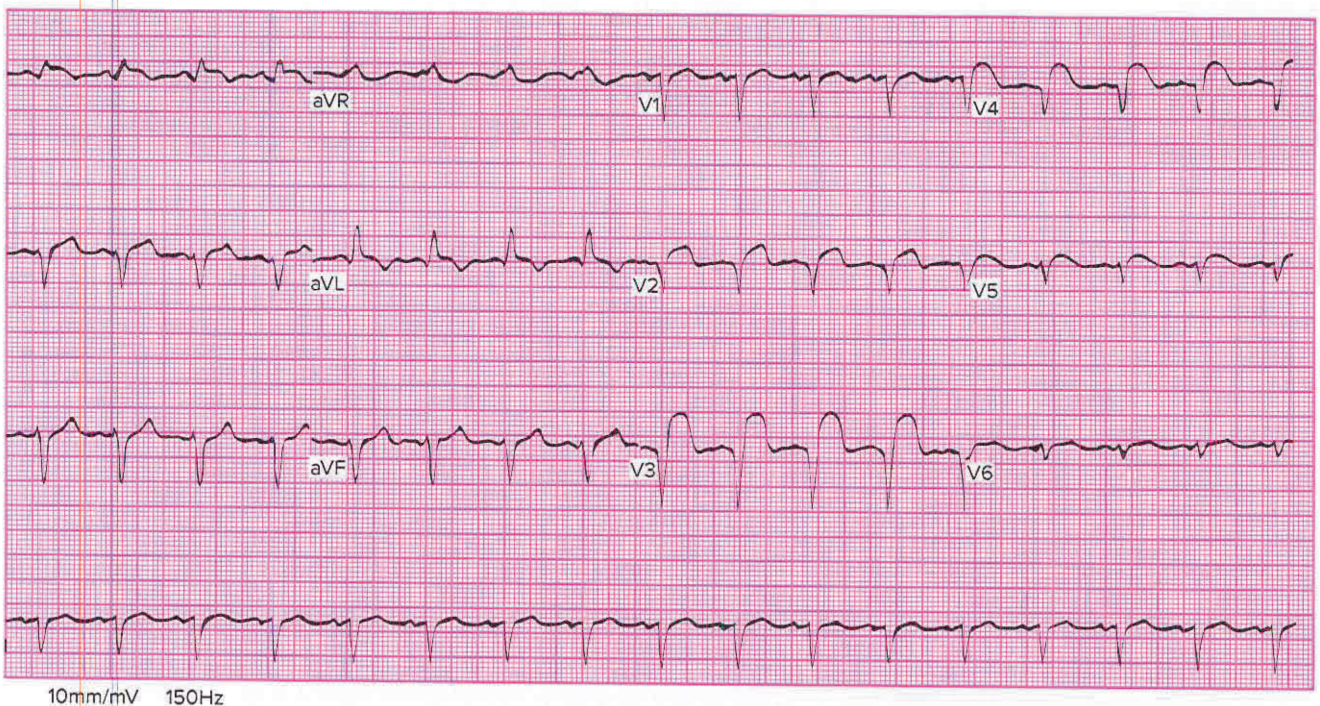
LVH: Normal or LVH (with mm measurement) __________

Leads with ST depression, T wave inversion, or none: __________

Leads with ST elevation or none: __________

Interpretation: __________

2. Circle the correct words and fill in the blanks to identify the following:



Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

Leads with ST elevation or none: __________

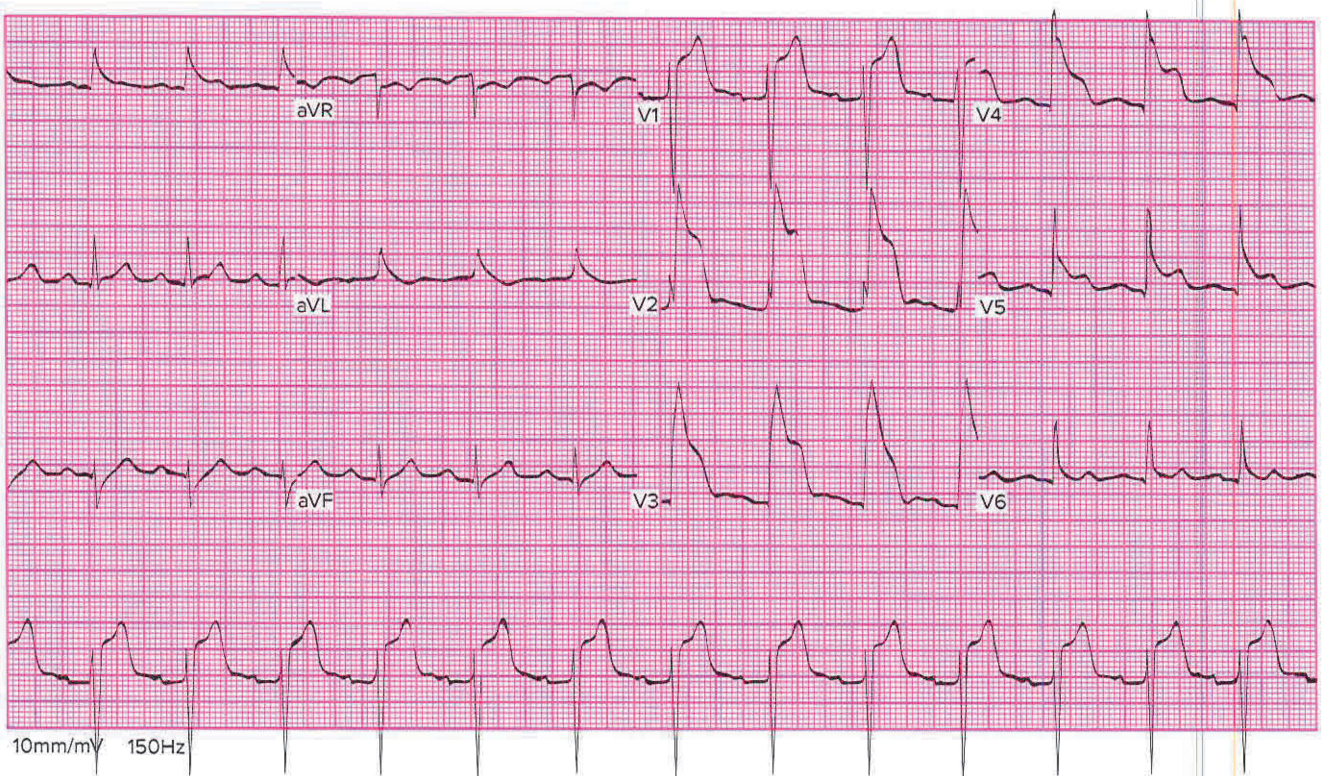
LVH: Normal or LVH (with mm measurement) __________

Leads with ST depression, T wave inversion, or none: __________

Leads with ST elevation or none: __________

Interpretation: __________

3. Circle the correct words and fill in the blanks to identify the following:



Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

Leads with ST elevation or none: ________

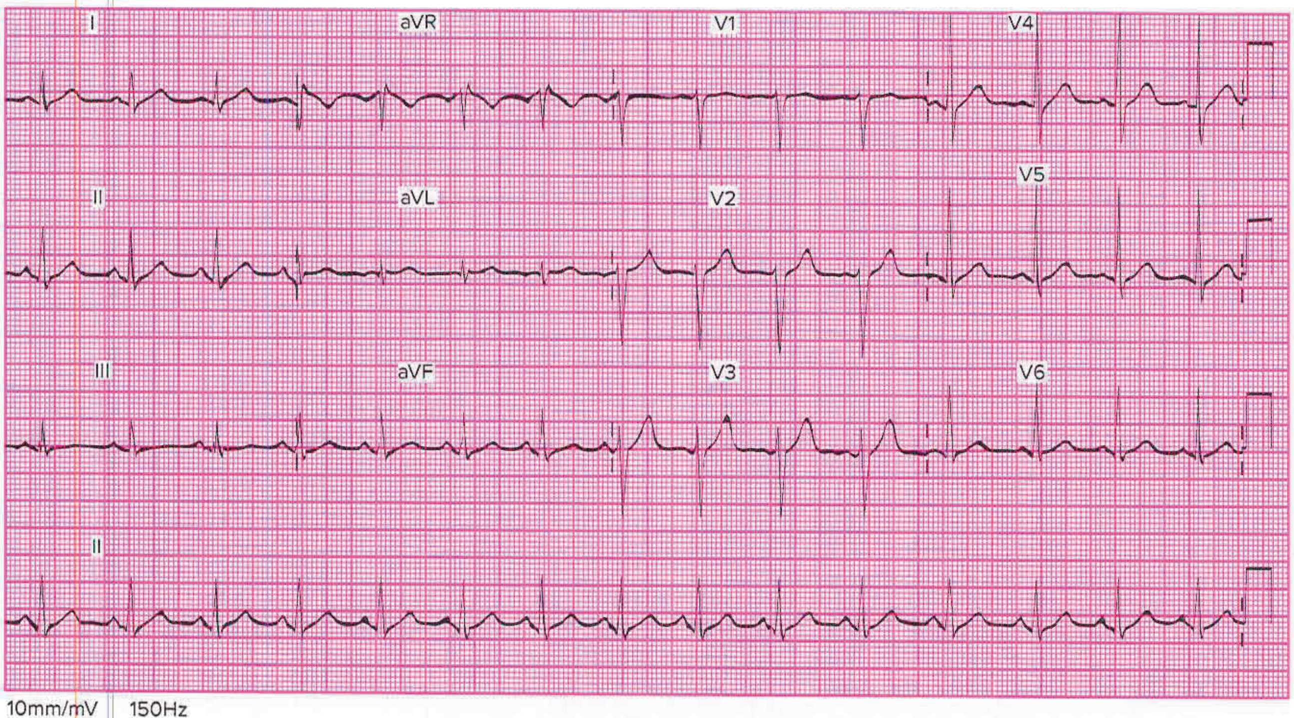
LVH: Normal or LVH (with mm measurement) ________

Leads with ST depression, T wave inversion, or none: ________

Leads with ST elevation or none: ________

Interpretation: ________

4. Circle the correct words and fill in the blanks to identify the following:



Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

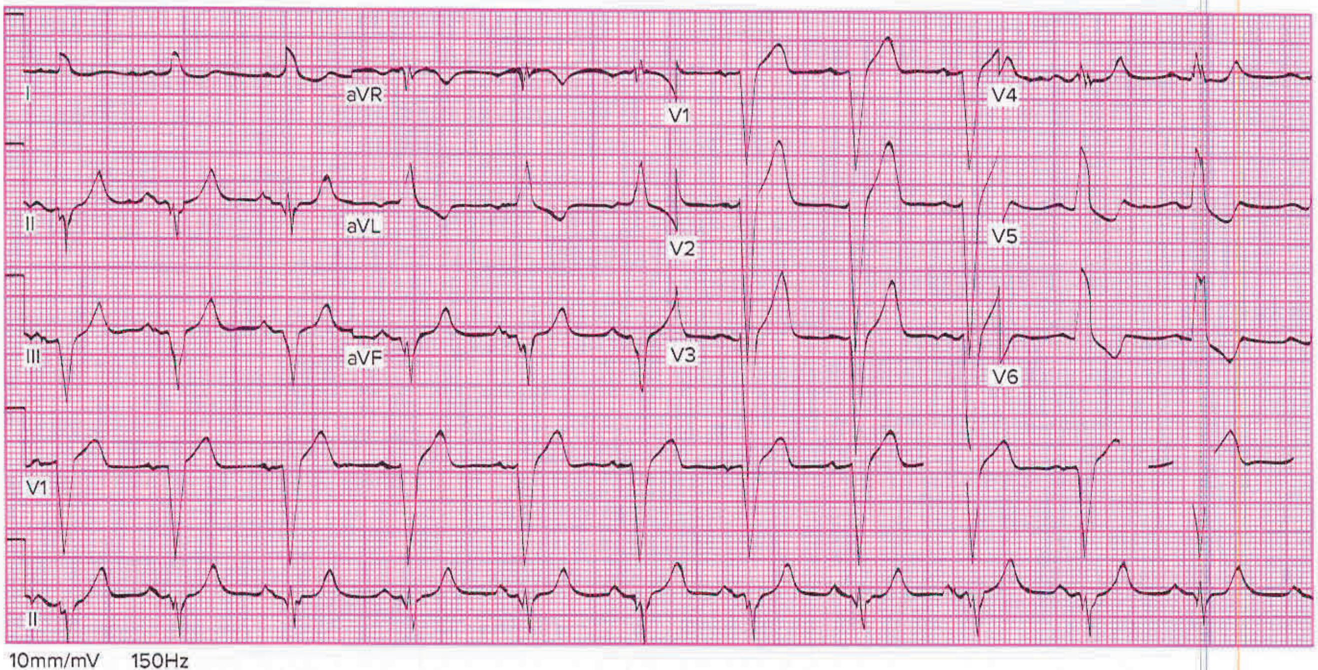
LVH: Normal or LVH (with mm measurement) __________

Leads with ST depression, T wave inversion, or none: __________

Leads with ST elevation or none: __________

Interpretation: __________

5. Circle the correct words and fill in the blanks to identify the following:



Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

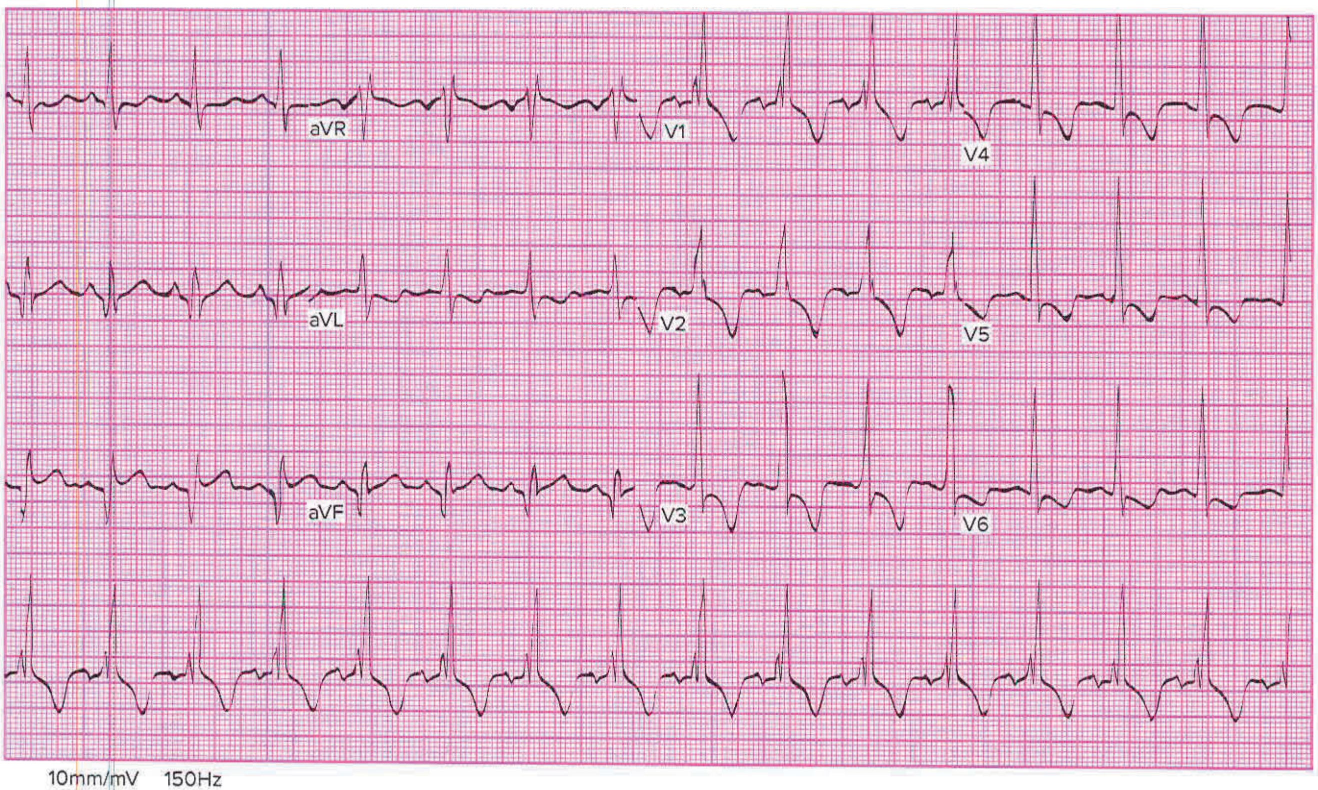
LVH: Normal or LVH (with mm measurement) __________

Leads with ST depression, T wave inversion, or none: __________

Leads with ST elevation or none: __________

Interpretation: __________

6. Circle the correct words and fill in the blanks to identify the following:



Electrical axis: Normal Left Right Extreme

BBB: Normal Right BBB Left BBB

LVH: Normal or LVH (with mm measurement) __________

Leads with ST depression, T wave inversion, or none: __________

Leads with ST elevation or none: __________

Interpretation: __________

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