Ministry of Health of Ukraine

Kharkiv National Medical University

ELECTROCARDIOGRAPHIC EXAMINATION OF PATIENTS WITH CONDUCTIVITY FUNCTION ALTERATIONS

Methodical instructions for students

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Electrocardiographic examination of patients with conductivity function alterations.

Abnormalities of Conduction. Heart Blocks

Heart block is an electrocardiographic diagnosis arising from situations that delay or interrupt the passage of an electrical impulse into any part of conduction system of the heart. Incomplete block indicates defect, functional or organic, in the conduction system that slows, but does not interrupt, the transmission of the impulses. Complete heart block indicates defect in the conduction system that interrupt the transmission of the electrical impulses.

Depending on the site of conduction abnormalities the following heart blocks are distinguished:

1. Sinoatrial Block.
2. Atrioventricular Block.
3. Intraventricular Block.

Sinoatrial Block

Sinoatrial (SA) block indicates failure of the sinus node to form impulses or impaired conduction of the impulse from sinus node to the atrial myocardium. Since the sinus impulse itself produces no ECG deflection, a sinus block is indirectly diagnosed by the absence of one or more expected P wave with the associated QRS complex (Fig. 4.100).

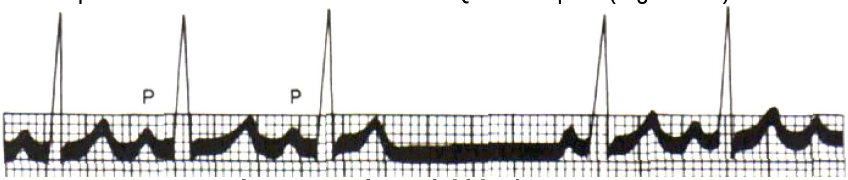

Fig. 4.100. Sinoatrial block.

The normal impulse is formed within the SA node, but is not conducted to the atrium. The regular sinus rhythm is present, after which there is a pause during which no P-QRS-T complex occurs. The pause is double the R-R interval of the beats displaying sinus rhythm.

Sinus block occur most frequently in patients with increased vagal tone and often during acute diaphragmatic myocardial infarction. Ischemia, hemorrahage, rheumatic fever, diphtheria, other acute infections, and drug toxicity (digitalis, quinidine, atropine, salicylates) may also cause SA block.

ECG signs of the sinoatrial block.

1. Periodic missing of the separate cardiac cycle (P wave and QRST complex) in the regular sinus rhythm.
2. The pause is double the P-P or R-R interval of the beats displaying sinus rhythm.

Atrioventricular Block

Atrioventricular block (AV block) is an important and frequent cause of slow rhythms. The greatest delay in normal transmission of an impulse from the atria to the ventricles occurs in the AV junctional tissues. AV blocks observe in the patients with atherosclerosis, coronary heart disease with acute myocardial infarction, rheumocarditis, and in drug toxicity.

By tradition, AV block has been divided into three degrees of block, depending on changes in the P-Q interval and relationship between the P wave and QRS complex.

The First-Degree AV Block

In the first-degree AV block the P-Q interval is prolonged over 0.21 second, but all sinus impulses are conducted to the ventricles: every sinus beat (P wave) is followed by a ventricular complex QRS. Since the ventricles are activated in the usual manner, the QRS complex is normal in configuration (Fig. 4.101). Ordinarily, the P-Q interval is constant at a given heart rate. In the normal heart, the P-Q interval tends to shorten as the rate increases. When some forms of conduction disturbances are present, the P-Q interval lengthens as the heart rate increases.

ECG signs of the first-degree AV block.

1. Prolonged P-Q interval to more than 0.21 second.
2. The QRS complexes normal in configuration.

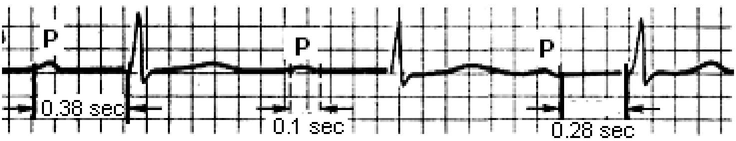

Fig. 4.101. First-degree AV block. The P-Q interval is prolonged.

First-degree AV block does not diminish cardiac output. However, it is an indicator of possible damage to junctional tissue or drug effect, especially from digitalis.

Second-Degree AV Block

In second-degree AV block, some impulses are blocked and fail to reach the ventricles (some P wave are not followed by a QRS complex). The more atrial impulses blocked from reaching the ventricles, the slower the ventricular rate. Thus, second-degree AV block often causes bradycardia.

Three types of second-degree AV block have been described: Mobitz type I, Mobitz type II, and type III.

Mobitz (Wenchenbach) type I

In type I second-degree heart block involving AV node, the P-Q interval progressively lengthens until the atrial impulse fails to conduct to the ventricles (P wave not followed by QRS complex), and then the cycle repeats. The ECG sequence starting with the first conducted beat following by the ventricular pause, and ending with the next blocked atrial beat, constitutes a Samoilov-Wenchenbach period. The basic principle of the Wenchebach phenomenon is that conduction time progressively lengthens until it is blocked for a one beat, producing a pause. Following the pause the conduction time shortens and then progressively lengthens again. Since the ventricles are activated in the usual manner, the QRS complex is normal in configuration (Fig. 4.102).

Fig. 4.102. Second-degree AV block Mobitz type I illustrating the Samoilov-Wenchenbach period. After each blocked atrial beat the P-Q interval shortens, to lengthen again progressively until the next blocked beat.

ECG signs of Mobitz type I second-degree AV block.

1. The P-Q interval is progressively prolonged until P wave is completely blocked.
2. The R-R interval is progressively shortened until the block occurs.
3. The P-Q interval after the blocked impulse is shorter than P-Q interval before the blocked impulse.
4. The R-R interval following block impulse is longer than the R-R interval preceding the blocked impulse.
5. The long interval due to the blocked impulse is less than twice the preceding R-R interval.
6. The QRS complex is normal in configuration.

Mobitz type II

In this type of block, an impulse from the atria suddenly fails to conduct to the ventricles without antecedent progressive lengthening of the P-Q interval. The P-Q intervals are constant before and after the pause (Fig. 4.103).

ECG signs of Mobitz type II second-degree AV block.

1. The P-Q interval is constant.
2. Irregular missing of the ventricular QRST complex.

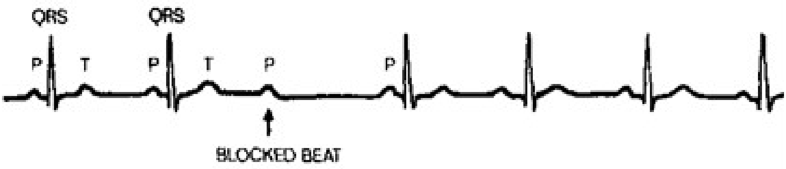

Fig. 4.103. Second-degree AV block Mobitz II illustrating blocked ventricular beat. The P-Q interval duration is constant.

Type III second-degree AV block or incomplete AV block

Type III shows a specific ratio of blocked beat. The ratio of P waves to QRS complexes varies: 2:1, 3:1, 4:1, etc (Fig. 4.104).

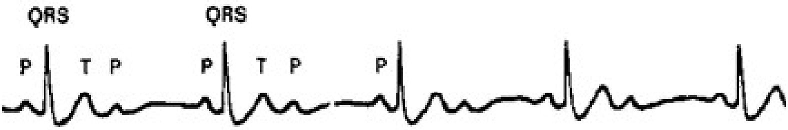

Fig. 4.104. Second-degree (incomplete) AV block type III. Group beating with block 2:1.

ECG signs of type III second-degree AV block.

1. Every second (2:1) ventricular complex is blocked, or two and more in succession (3:1, 4:1, etc).
2. The R-R intervals are regular.

Third-Degree AV block

Third-degree AV block is also called complete heart block. Inflammation, scarring, myocardial infarction, or drugs such as digitalis may cause complete heart block.

Third-degree AV block indicates a complete interruption of AV conduction. In this arrhythmia, no atrial impulses (P waves) activate the ventricles. The QRS originates from a junctional or ventricular pacemaker site. Therefore, the P waves and QRS complexes occur independently. Both the P waves and QRS complexes occur regularly, but there is no relationship between them. The atria are controlled by SA node at a rate of 70-80 per minute; the ventricular rate is 60-30 beats per minute. The lower ventricular pacemaker, the slower ventricular rate, the more bizarre the QRS complex (Fig. 4.105).

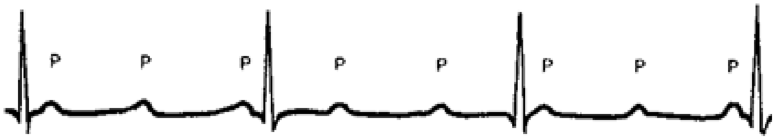

Fig. 4.105. Third-degree (complete) AV block, diagnosed as such because the regularity occurring P waves are not fixed in the ventricular cycle and the ventricular rate is regular.

ECG signs of third-degree AV block.

1. The P waves bear no relation to the QRS complexes.
2. The P wave may be before, after, or superimposed on the QRS complex or on the T wave to cause their deformation.
3. The R-R and P-P intervals are constant, but R-R intervals are longer than P-P intervals.
4. If the site of the block is high in the AV junction, the QRS complexes will be normal in configuration. The ventricular rate is not less than 45-60 beats per minute.
5. If the site of the block is below the bifurcation of the common His bundle, the QRS complex is wide and deformed because the ectopic ventricular pacemaker causes the ventricles aberrantly to be activated. The ventricular rate is not more than 40-45 beats per minute.

Abnormalities of the Ventricular Conduction.

Bundle-Branch Block.

Bundle-branch block is primarily an electrocardiographic diagnosis arising from situations that delay or interrupt the passage of an electrical impulse into, or within, the ventricles. Bundle-branch block is a condition that occurs when an electrical impulse passes through the AV node in a normal fashion, but delayed or blocked below this level, as a consequence, ventricular activation is abnormal, resulting in abnormal QRS, S-T, and T morphologies.

Bundle-branch block is an obstruction in the right or left ventricular conduction pathway (Fig. 4.106). When this occurs, the impulse travels first through the unobstructed branch and is then transmitted by nonspecialized myocardial tissue to the opposite ventricle. This aberrant pathway requires a longer time for activation of the ventricles, and the resulting QRS is greater than 0.12 second and of abnormal configuration. Origin of this beat is from the SA node. Therefore, a P wave will precede the wide QRS complex.

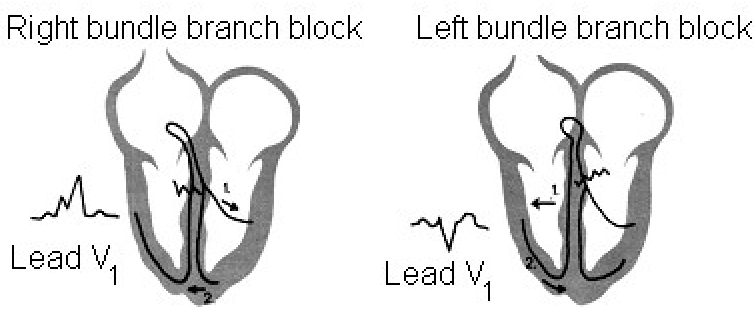

Fig. 4.106. Right and left bundle-branch block.

Right Bundle-Branch Block

When the right bundle-branch is blocked, the impulse travels first through the left ventricle. Therefore, the initial electrical activation on the left side of the heart is normal, but the right ventricle is the last portion of the heart to be activated.

ECG signs of right bundle-branch block (Fig. 4.107).

1. The M-shaped QRS complex in leads V_1, V_2 (rarer in leads III, aVF), where R’>r. R’ – is produced by delayed onset of ventricular activation in a rightward direction, r – activation of the left

ventricle.

2. A decidedly slurred, broad S wave, produced by the late right ventricular and septal activation, in leads V_5, V_6, I, aVL.
3. QRS widened to more than 0.12 second. The prolongation of the QRS interval is due to the delayed onset of right ventricular activation and the slow conduction in the right ventricle due to muscle cell-to-cell conduction through the septum and the right ventricular wall.
4. S-T segment and T wave changes in the leads over the right ventricle. The right precordial leads V_1, V_2 (rarer lead III) show depressed S-T segment and an inverted T wave. The course of activation is altered, with a resultant change in the course of repolarization. In general, the T wave is opposite in direction from the terminal part of the QRS complex.

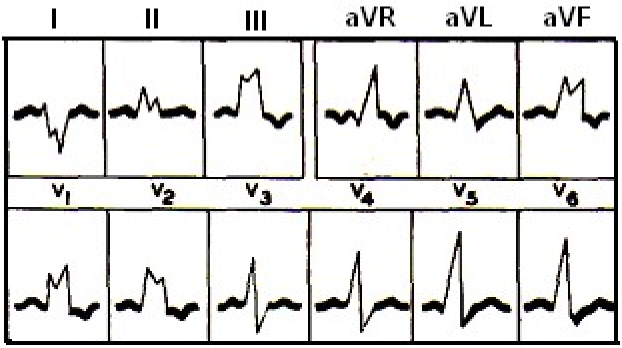

Fig. 4.107. Complete right bundle-branch block.

Left Bundle-Branch Block.

If the entire left bundle-branch is blocked, the impulse first depolarizes the right side of the heart and then through aberrant pathways – the left ventricle.

ECG signs of left bundle-branch block (Fig. 4.108).

1. Increased amplitude of ventricular complex QRS with notched or slurring peak of the R wave in leads V_5, V_6, I, II, aVL. Because left ventricular stimulation is delayed, unopposed by right ventricular activation, the resultant potential is of greater than normal magnitude.
2. A wide and deep ventricular complex by QS type with a slurred, broad S wave in leads V_1, V_2, III, aVF.
3. QRS widened to more than 0.12 second. The late arrival of the depolarization wave at the left ventricle produces this change.
4. S-T segment and T wave changes in the leads over the left ventricle. The left precordial leads V_5, V_6, and leads I, aVL have depressed S-T segment and an inverted T wave, because abnormal depolarization results in abnormal repolarization. In general, the S-T segment and T wave are discordant (opposite) in direction from the terminal part of the QRS complex.

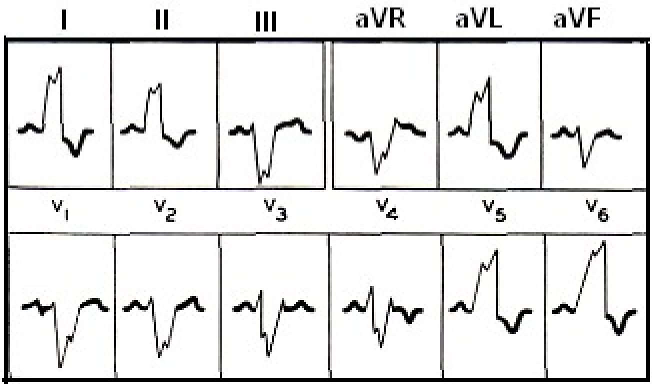

Fig. 4.108. Complete left bundle-branch block.

Ventricular Preexcitation Syndromes

Ventricular preexcitation has been defined as a conduction abnormality in which ventricular muscle is activated earlier than would be expected had the impulse reached the ventricles via the normal AV conducting system. Early activation of the ventricles occurs because of bypass tracts from atria to ventricles.

Syndrome of Shortened P-Q Interval or CLC Syndrome

The syndrome carries the names of physicians who described it in 1938. In Clerk-Levy-Critesko (CLC) syndrome, impulses enter the ventricles prematurely through specialized anomalous conduction pathway called the fibers of James. These fibers bypass the AV node to cause ventricular preexcitation. As ventricles are activated in usual manner, the QRS complexes are of normal configuration.

ECG signs of CLC syndrome.

1. The P-Q interval duration is less than 0.12 second.
2. The QRS complexes are of normal configuration.

Wolf-Parkinson-White (WPW) Syndrome

In this syndrome, impulses enter the ventricles prematurely through specialized anomalous conduction pathways called the bundles of Kent. These bundles are formed outside the conduction system. The Bundle of Kent connects the conduction system of atria to either ventricle, bypassing the AV node. The impulses do not travel through the AV node and thus avoid the normal conduction delay that occurs there.

ECG signs of WPW syndrome.

1. A short P-Q interval (less than 0.12 second).
2. A slurred upstroke on the QRS complex (delta wave).
3. A wide QRS complex (greater than 0.10 second).

4. Secondary S-T and T wave changes.

TEST CONTROL

1. What conductivity complex QRS reflects?
A. Atrioventricular;
B. Intraatrial;
C. Intraventricular;
D. The conductivity of the left Hiss bundle branch;
E. Conductivity on the right Hiss bundle branch.
2. Which is normal duration of P wave:
A 0.02-0.03 sec
B. 0.03-0.04 sec;
C. 0.04-0.06 sec;
D. 0.06-0.10 sec;
E. 0.12-0.18 sec.
3. What is the speed of the impulse transmission through AV node?
A 0.02-0.05 mm / sec;
B. 0.08-0.10 mm / sec;
C. 0.30-0.80 mm / sec;
D. 1.0-2.0 mm / sec;
E. 3.0-4.0 mm / sec.
4. What ECG element reflects impulse pathway in atria?
A. P-Q segment;
B. P-Q interval;
C. P wave;
D. T wave;
E. QRS complex
5. What is the speed of the pulse conduction in Hiss bundle branch block?
A 0.02-0.05 mm / sec;
B. 0.08-0.10 mm / sec;
C. 0.30-0.80 mm / sec;
D. 1.0-2.0 mm / sec;
E. 3.0-4.0 mm/ sec.
6. What ECG element reflects impulse conduction through AV node?

A. P-Q segment;
B. P-Q interval;
C. P wave;
D. T wave;
E. QRS complex
7. What ECG element reflects impulse conduction through Hiss bundle branch?
A. P-Q segment;
B. P-Q interval;
C. P wave;
D. T wave;
E. QRS complex
8. Which QRS complex duration is normal?
A 0.02-0.05 sec;
V. 0.06-0.10 sec;
S. 0.16-0.20 sec;
D. 0.21-0.30 sec;
E. 0.30-0.40 sec.
9. Electrical axis of the heart deviation to the left ECG signs:
A. The highest R wave in lead I, the deepest S wave in lead III;
B. The highest R wave in lead III, the deepest S wave in lead I;
C. The deepest S wave in aVR lead;
D. The highest R wave in lead I;
E. The highest R wave in lead III.
10. What is normal P-Q interval duration?
A 0.08-0.10 sec;
B. 0.03-0.04 sec;
C. 0.04-0.08 sec;
D. 0.06-0.10 sec;
E. 0.12-0.18 sec.
11. Electric axis of the heart normal position ECG signs:
A. The highest R wave in lead I, the deepest S wave in lead III;
B. The highest R wave in lead III, the deepest S wave in lead I;
C. The highest R wave in lead I;
D. The highest R wave in lead II;
E. The highest R wave in lead III.

12. What is the value of the alpha angle in right axis deviation ECG characteristic?
A. 0 - 30
B. 30 - 70
C. 70 - 90
D. 90 - (+ 180)
E. 0 - (- 180)
13. What is the value of the alpha angle in left axis deviation ECG characteristic?
A. 0 - 30
B. 30 - 70
C. 70 - 90
D. 90 - (+ 180)
E. 0 - (- 180)
14. Right axis of the heart deviation is observed in:
A. Sinoatrial block;
B. Intra-atrial block;
C. Atrioventricular block;
D. Intraventricular block;
E. Left posterior His bundle branch block;
15. Left axis of the heart deviation to left to the left rejected when:
A. Sinoatrial block;
B. Intra-atrial block;
C. Atrioventricular block;
D. Left anterior His bundle branch block;
E. Left posterior His bundle branch block;
16. Which heart block is characterized by elongation of P-Q interval duration?
A. Intra-atrial block;
B. Sinoatrial block;
C. Incomplete AV block;
D. Left bundle branch block;
E. Right bundle branch block.
17. The main sign of His bundle branch block?
A. Elongation of P-Q interval;
B. The increase in the QRS complex with deformation;

C. The increase in the QRS complex without deformation;
D. Reducing of the P-Q segment duration;
E. S-T segment displacement.
18. Primary ECG sign of 1 degree AV block?
A. The constant increase in the duration of the P-Q interval;
B. Periodic increase in the duration of the P-Q interval;
C. Periodic loss of complex QRS;
D. Periodic loss of complex PQRST;
E. Permanent increase in QRS duration.
19. Which heart block is characterized by P wave elongation?
A. Intra-atrial block;
B. Sinoatrial block;
C. Incomplete AV block;
D. Left bundle branch block
E. Right bundle branch block
20. The main ECG sign of intraventricular block:
A. Extending the P-Q interval;
B. The increase in the QRS complex with deformation
C. The increase in the QRS complex without deformation
D. Reducing the length of the P-Q segment
E. S-T segment displacement

Standards of answers: 1C, 2D, 3A, 4E, 5E, 6A, 7E, 8B, 9A, 10E, 11D, 12D, 13A, 14E, 15D, 16C, 17B, 18A, 19A, 20B

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