

4th Lecture

Arrhythmia

Physiology Team - 430

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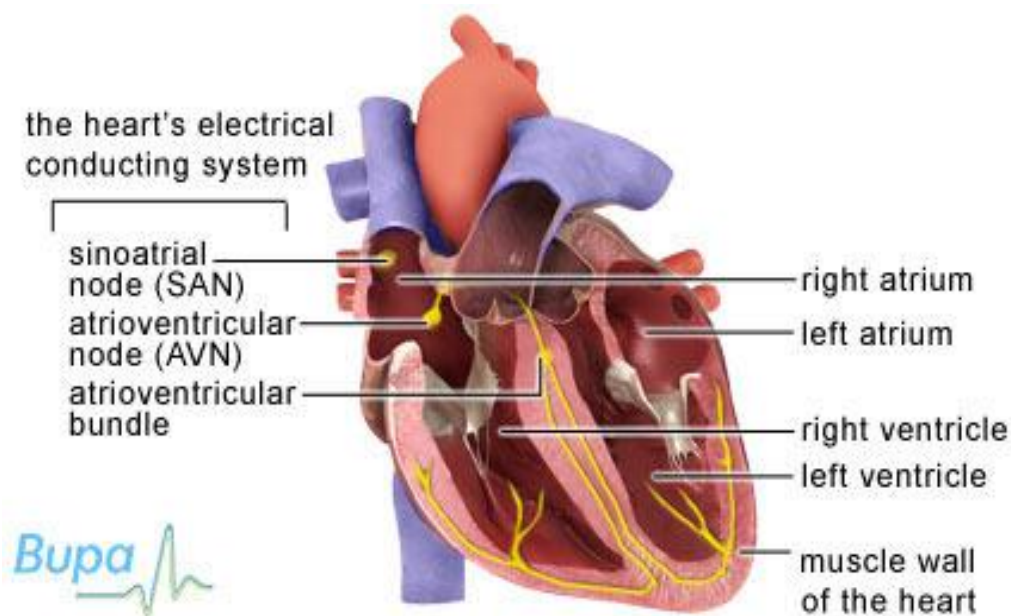
Definition

Arrhythmia is defined as **irregular impulse** (heartbeat) formation in the form of rate, conduction or change in interrelationship of timing of R-R interval.

Caused by:

(one or a combination of the following abnormalities in the rhythmicity-conduction system) :

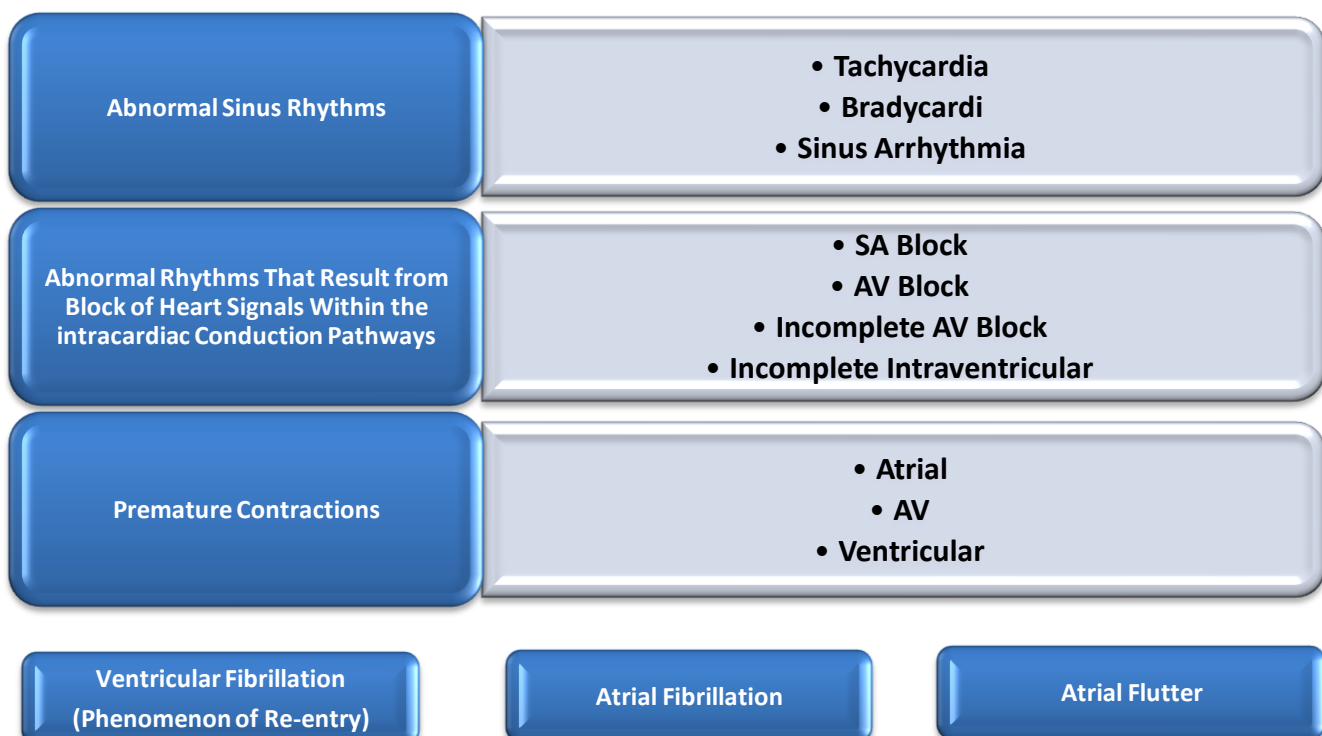
1. **Abnormal rhythmicity of the pacemaker**
2. **Shift of the pacemaker from the sinus node to the another place in the heart**
3. **Blocks at different points in the spread of the impulse through the heart**
4. **Abnormal pathways of impulse transmission through the heat**
5. **Spontaneous generation of spurious impulses in almost any part of the heart**



General Terms:

- Normal sinus rhythm - heart rhythm controlled by sinus node at a rate of 60-100 beats/min; each P wave followed by QRS and each QRS preceded by a P wave.
- **Bradycardia** - a heart rate that is lower than normal.
- **Tachycardia** - a heart rate that is higher than normal.
- **Paroxysmal** - an arrhythmia that suddenly begins and ends.
 - normally beat 60 - 100 times a minute.

All Classifications of Arrhythmia :



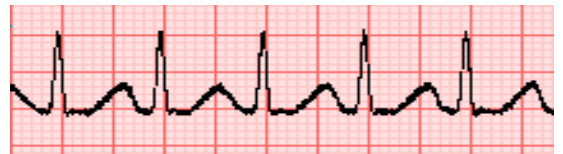
■ Abnormal sinus rhythms

1- Sinus Tachycardia:

This is when your **heartbeat is still regular**, but **faster than usual** (more than 100 beats per minute).

- **During exercise**
- Fever
- Body temperature increases
- Toxic conditions
- Overactive **thyroid gland** or **anemia**.
- Sympathetic stimulation.

All the R-R intervals are shorter than normal



Why high temperature causes Tachycardia?

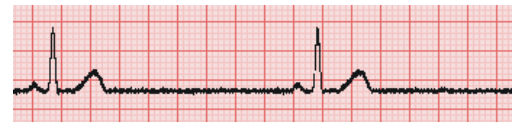
Because increased temperature increases the rate of metabolism of the sinus node, which increases its excitability and rate of rhythm

2- Sinus Bradycardia:

This is when your **heartbeat is still regular**, but **slower than usual** (fewer than 60 beats per minute).

- Common in athletes
- Exposed to the cold
- A low body temperature
- Parasympathetic dominance at rest ("vagal tone").

All the R-R intervals are longer than normal



Vagal stimulation is a cause of Bradycardia.

Any circulatory reflex that stimulates the vagus nerves causes release of Acetylcholine at the vagal endings in the heart → giving a parasympathetic effect

Note:

Sinus means from the Sinoatrial node.

3- Sinus Arrhythmia:

A normal phenomenon of mild acceleration and slowing of the heart rate that occurs with breathing in and out (Respiration).

This can also be present during meditation breathing exercises that involve deep inhaling and breath holding patterns.

[Inspiration → heart rate increase
 Expiration → heart rate decrease]

■ Abnormal Rhythms That Result from Block of Heart Signals Within the intracardiac Conduction Pathways

1- Sinoatrial block:

In rare instances, the impulse from the sinus node is blocked before it enters the atrial muscle.

The ventricles pick up a new rhythm, the impulse usually originating spontaneously in the (AV) node, so that the rate of the ventricular QRS-T complex is slowed BUT not otherwise altered.

2 - Atrioventricular block:

A block of the impulse conduction in the AV bundle (bundle of His).

Causes:

- Ischemia of the AV node

Inadequate blood supply to the A-V node

- Compression of the AV node

By scar tissue or a calcified part of the heart

- Inflammation of the AV node

E.g. in myocarditis and rheumatic fever

- Strong vagal stimulation

Vagal excitation results in people with carotid sinus syndrome

3– Incomplete AV Block:

Note: (Normal P-R interval = 0.16 – 0.20 second)

Type	P-R interval	Features
1 st Degree Block	> 0.20 sec	<ul style="list-style-type: none"> - prolonged - a delay of conduction from the atria to the ventricles BUT not actual blockage of conduction
2 nd Degree Block	0.25 – 0.45 sec	<ul style="list-style-type: none"> - only few impulses pass to the <u>ventricles</u> - atria beat faster than <u>ventricles</u> - dropped beat of <u>ventricles</u> (there will be an atrial "P" wave BUT no "QRS-T" wave)
3 rd Degree Block ⚡		<ul style="list-style-type: none"> - complete AVN block - Complete dissociation of P wave and QRS waves
Stokes-Adams Syndrome (Ventricular Escape)		<ul style="list-style-type: none"> - the total AV block comes and goes

-The first type is less dangerous than other types

⌘ **Note: (3rd Degree Block)**

There is no relation between the rhythm of the “P” waves and that of the “QRS-T” complexes because the ventricles have “escaped” from control by the atria, and that are beating at their own natural rate (by AVN or Bundle of His)

→ **Stokes-Adams Syndrome (Ventricular Escape)**

The dropped beat is a result of fail of conduction from the atria to the ventricles

4– Incomplete Intraventricular Block:

- At the Purkinje system.
- In Tachycardia because, Rapid → impossible for some portions of the Purkinje system to recover from the previous refractory period quickly enough to respond during every heartbeat.

■ Premature Contractions

A contraction of the heart before the time that normal contraction would have been expected. (Extrasystole)

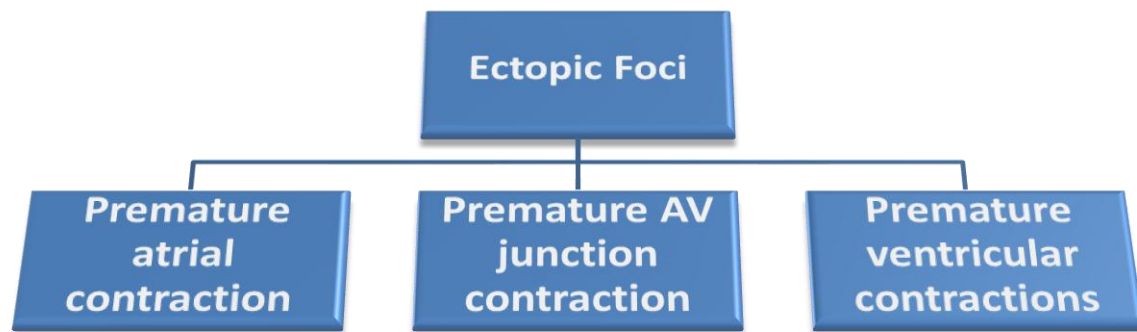
Caused by:

Ectopic foci that generate abnormal cardiac impulses during the normal impulse.



Causes of ectopic foci:

- Ischemia
- Irritation of cardiac muscle by calcified foci
- Toxic irritation by Drugs like caffeine



1 - Premature atrial contraction:

Short P-R interval depending on how far the ectopic foci from the A-V node.

The "P" wave of this beat occurred too soon → short P-R interval → ectopic foci is in the atria near the A-V node.

* يعني انها تسوي نبضة في الأذنين في منطقة تبعد عن الـ SAN فالنبضة هذه تمشي في عضلة الأذنين و تسوي انقباض للأذنين قبل الـ SAN.

Pulse deficit

If there is no time for the ventricles to fill with blood (happens when the ectopic foci is very close to the ventricles)

2 - Premature AV junction contraction:

Missing P wave (the atrium did not contract)

The **closer** the ectopic foci to the A-V node, the **shorter** the P-R interval will be.

3 - Premature ventricular contractions:

Ectopic foci at ventricle

****PVCs cause specific effects:**



- Prolonged QRS complex (because the impulse is conducted through the muscles of the ventricles instead of the Purkinje system.)

- Increase QRS complexes voltage (because one side of the heart depolarizes ahead of the other)

- After all PVCs, the T wave has an electrical potential polarity exactly opposite to that of the QRS complex (because the slow conduction of the impulse causes the muscle fibers that depolarize first also to repolarize first)

■ Ventricular Fibrillation (Phenomenon of Re-entry)

The ventricular fibrillation is the **most serious** of all arrhythmias.

Caused by:

Cardiac impulses that stimulate one portion of the ventricle and then another portion and another, until it goes back to where it started and stimulate the same ventricle muscle again and again –never stopping.

This is called circus movement. (Phenomenon of Re-entry)(Will be discussed later)

Causes:

- Tachycardia
- Irregular rhythm (R-R intervals)
- Broad QRS complex (cannot be identified in the ECG)
- No P wave

■ Atrial Fibrillation

The mechanism is identical to that of ventricular fibrillation, **except that the process occurs only in the atrial muscle mass instead of the ventricular mass.**

A frequent cause of atrial fibrillation is atrial enlargement resulting from heart valve lesions that prevent the atria from emptying adequately into the ventricles, or from ventricular failure with excess damming of blood in the atria.

Causes:

- Tachycardia
- Irregular rhythm (R-R intervals)
- No P wave

Explanation: (Must Read)

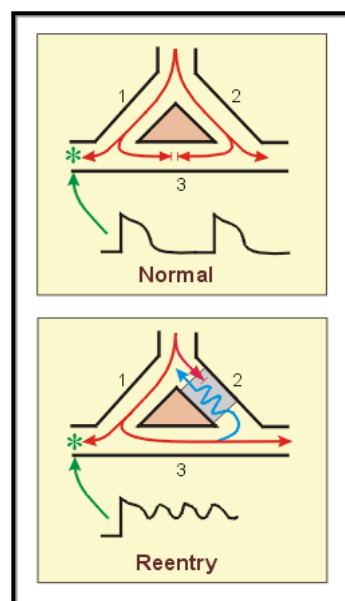
(Phenomenon of Re-entry)

Reentry can take place within a small local region within the heart. For reentry to occur, certain conditions must be met that are related to the following:

1. The presence of a unidirectional block within a conducting pathway
2. Critical timing
3. The length of the effective refractory period of the normal tissue

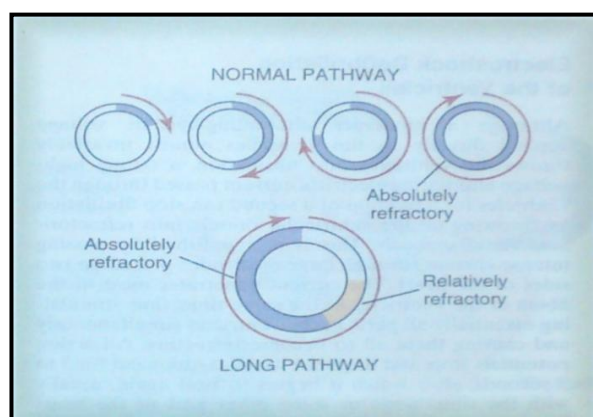
A model for reentry is shown to the right. In normal tissue (top panel of figure), if a single Purkinje fiber forms two branches (1 & 2), the action potential will travel down each branch. An electrode (*) in a side branch off of branch 1 would record single, normal action potentials as they are conducted down branch 1 and into the side branch. If branches 1 & 2 are connected together by a common, connecting pathway (branch 3), the action potentials that travel into branch 3 will cancel each other out.

Reentry (bottom panel) can occur if branch 2, for example, has a unidirectional block. In such a block, impulses can travel retrograde (from branch 3 into branch 2) but not orthograde. When this condition exists, an action potential will travel down the branch 1, into the common distal path (branch 3), and then travel retrograde through the unidirectional block in branch 2 (blue line). Within the block (gray area), the conduction velocity is reduced because of depolarization. When the action potential exits the block, if it finds the tissue excitable, then the action potential will continue by traveling down (i.e., reenter) the branch 1. If the action potential exits the block in branch 2 and finds the tissue unexcitable (i.e., within its effective refractory period), then the action potential will die. Therefore, timing is critical in that the action potential exiting the block must find excitable tissue in order for that action potential to continue to propagate. If it can re-excite the tissue, a circular (counterclockwise in this case) pathway of high frequency impulses (i.e., a tachyarrhythmia) will become the source of action potentials that spread throughout a region of the heart (e.g., ventricle) or the entire heart.



What makes it go in circles?

- If the pathway around the circle is too long.
- If the velocity of conduction becomes decreased.
- If the refractory period of the muscle becomes greatly shortened.



■ Atrial Flutter

Caused by:

One wave that travels around in one direction which causes one side of the atrium contract while the other relaxes

Treatment:

Electrical shock to stop circus activity

Ischemia and ECG:

ECG is commonly used in the assessment of chest

Ischemia: inadequate blood supply to the myocardium

There are two types of ischemia:

- 1- Reversible: angina
- 2- Irreversible: myocardial infarction

ECG in :

- **Myocardial infarction** → Deep Q waves
- **Injury** → Elevated St Segment
- **ischemia** → Inverted T waves



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Inverted T waves

Type of Arrhythmia	ECG finding
1-Abnormal sinus rhythm:	
Tachycardia	Short RR interval
Bradycardia	Long RR interval
2-Heart Block:	
First degree block	Prolong P-R interval
Second degree block	P-R interval > 0.25 second "dropped beat"
Third degree block	Complete dissociation of P wave and QRS waves
Stokes-Adams Syndrome-ventricular escape	AV block comes and goes
3-Types of premature contraction	
Premature atrialcontraction	Short P-R interval Prematurecontraction (pulse deficit)
Premature AV junctioncontraction	Missing P wave
Premature ventricular contractions (PVCs)	ProlongQRS IncreaseQRS voltage
4-Ventriculartachycardia	<ul style="list-style-type: none">•Tachycardia•Irregular rhythm•Broad QRS complex•No Pwave
5-AtrialFibrillation	<ul style="list-style-type: none">•Tachycardial•Irregular rhythm (R-R interval)•No P wave

Good Luck