

Physiology sheet

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CARDIAC CYCLE & HEART SOUNDS

The cardiac cycle

- generator of the heart beat

-It is the period from the end of one heart contraction to the end of the next.

-It starts by systole of both atria followed by systole of both ventricles and then diastole of the whole heart.

-The cycle is initiated by S.A. node. Heart cycle started by “pacemaker”

- Its place in right atrium

The action potential travels rapidly through the atria and then through the AV bundle into the ventricles.

Action potential travels through wall 2 atria (anterior, posterior, middle)

-However there is a delayed period of 0.1 seconds in the A.V. node allows the atria to pump before the ventricular contraction.

If the delayed period didn't occur it will be described as pumping of blood from ventricle to atrium

The ventricle wait 0.1 seconds to give enough time to be filled the ventricle with the blood (if they contract at the same time —> the ventricle is stronger and the blood will return to the atrium and cause disease)

-The complete cardiac cycle last about 0.8 sec if the heart rate is 75 beat/minute.

* The ventricular systole 0.3 sec. The ventricular diastole 0.5 sec

* The atrial systole 0.1 sec. The atrial diastole 0.7 sec

When the heart rate increases, the cycle shortens, especially the diastole.



There are 4 heart sound in the cardiac cycle:

- three of them can be heard by ear, and one can be heard by sonocardiograph
- First and second sound any one person can hear it
- Third one , the cardiologist can hear it.
- The fourth sound can't be heard by ear, it's heard by sonocardiograph

Cardiac cycle phases are 8 phases :

- two of them known as isometric, both of them are related to heart sound...

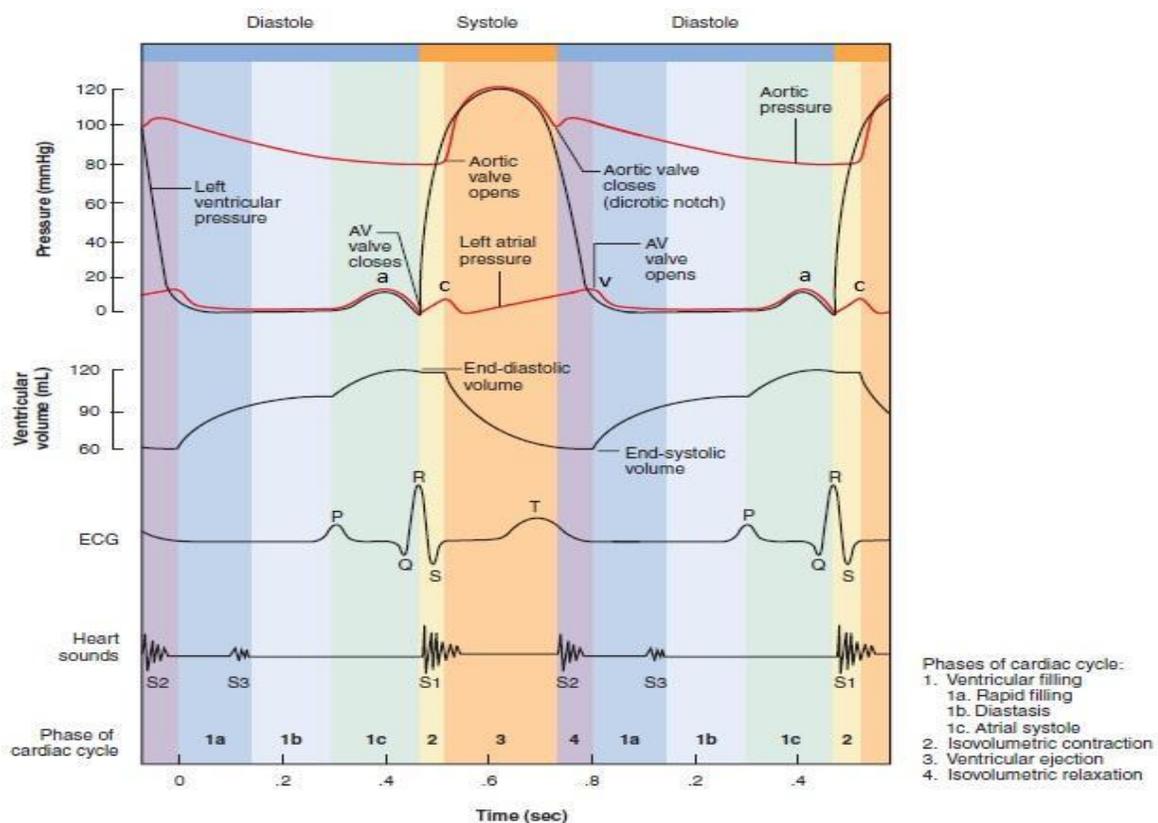
We don't have any phases during it all valves opened,

but there are 2 phases during it all valves are closed.

1- isometric contraction phase

2- isometric relaxation phase

There are 2 types of valves: 2 AV valve and 2 semi lunar



The cardiac cycle includes the following phases:

A-Atrial systole :

1. Atrial contraction phase (late diastole):

- Duration : 0.1 Sec.

-  Events : the atria contract and pump 30% of the

ventricular filling (to the ventricles).

***If we ignore a problem in the atrium it's not dangerous**

The atrial pressure: rise from 4 mmHg to 8 mmHg and return to 4 mmHg at the end of this phase due to the atria evacuation.

If the size decrease the pressure increase

Atrial pressure return to 4mmHg as a result of opening of valve released blood and decrease pressure as a result.

Ventricular pressure : rise from 4 mmHg to 8 mmHg and return to 4 mmHg at the end of this phase as the ventricles dilate to accommodate the blood passing to it .

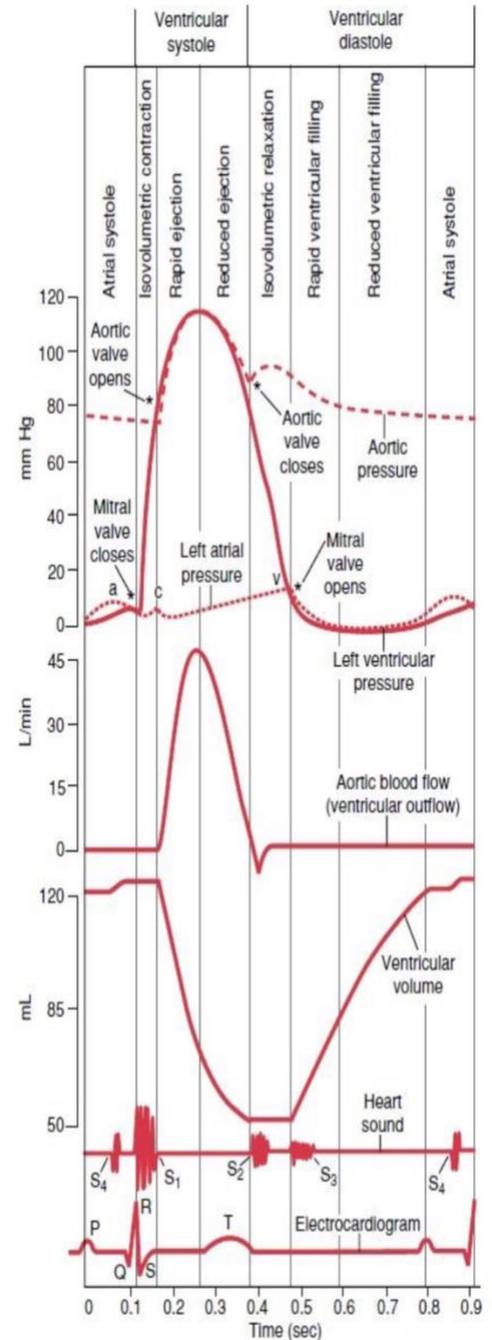
- Ventricular volume : Increased by (20 ml) to reach the end diastolic volume.  (E.D.V. = 140 ml).

If the volume increase the pressure decrease

- Heart sounds : The 4th heart sound which is weak and inaudible due to vibration of atrial muscle during the contraction and rushing of blood into the ventricles.

Atrial contraction make the 4th sound.

- Valves : - The semilunar valves are closed.



- The A.V. valves are opened .

*Opening of valve doesn't give sounds

B. Ventricular systole :

2. Isometric (iso-volumetric) contraction phase:

- Duration : 0.05 sec

- Events : It begins by closure of A.V. valve and the ventricles begin to contract isometrically (without change in muscle fiber length). Thus the ventricles are closed chambers filled with blood.

*Closure of A.V valve produce a sound

- Atrial pressure : rise due to bulging of the A.V. valves into the atria and also due to regurgitation of some blood into the atria before closure of the A.V. valves.

AV valve ring :is a fibrous tissue that contains AV valve
When the ventricle filled with blood the ring is pushed upward and decrease the volume, thus the pressure increases.

- Ventricular pressure : rise from 4 mmHg to 80 mmHg in the left ventricle.

- Ventricular volume : is constant (isometric) this is

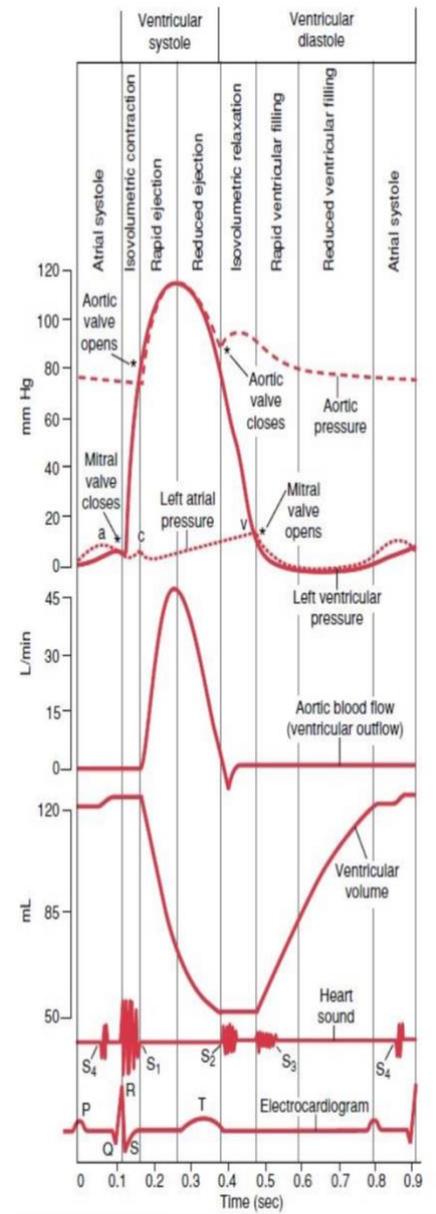
because the blood is not compressible. **Its constant on EDV =140 ml**

- Heart sounds; the first components of the 1st heart sound due to closure of the A.V. valves.

-Valves : are closed (A-V and semilunar valve) .

3. Rapid (maximum) ejection phase :

- Duration : 0.15 sec



- Events : it begins by opening of the aortic valve and rushing of blood into the aorta where 70% of stroke volume ejected in this phase.

Stroke volume : amount of blood ejected per beat in one contraction

Stroke volume = 70ml from 140 ml

The ventricle is never empty all of the blood inside it

Opening of aortic valve is due to (ventricular $p >$ aortic p).

- The atrial pressure : decreases due to down displacement of the A.V. valve during shortening of ventricular muscles.

The AV valve ring go down and the size of the atrium increase and decrease the pressure

- The ventricular and aortic pressures : rise from 80 to 120 mmHg. Because the amount of blood ejected through the aortic valve exceeds that which leaves the aorta.

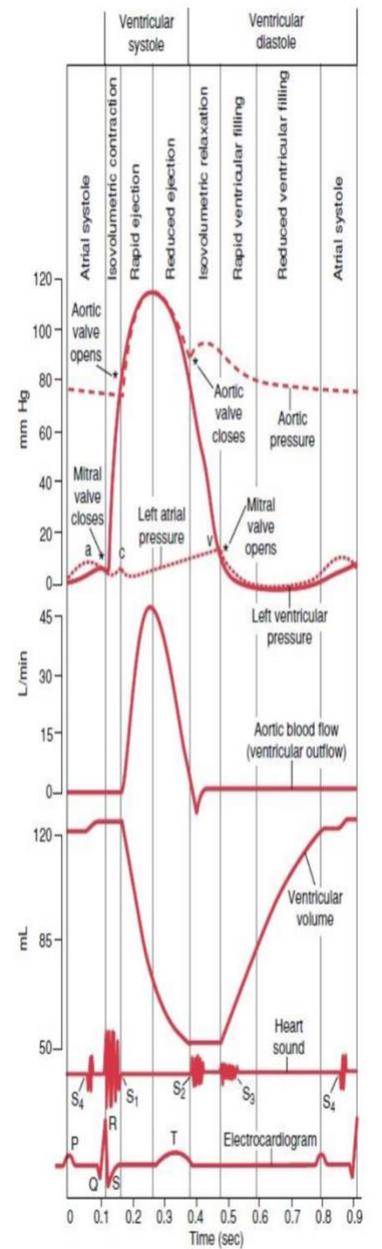
- Ventricular volume :decreases greatly due to change of the isometric contraction to isotonic contraction and ejection of the blood.

Ventricles are never empty, it's contents of blood between: 50% — 100%70 — 140ml

- Heart sounds : the second component of the 1st heart sound due to rushing of blood into the aorta and vibration of the aortic wall.

- Valves : - The semilunar valves are opened.

- The A.V. valve is closed . End Systolic volume = 70ml



4. Reduced (minimum) ejection phase :

- **Duration : 0.1 sec.**
- **Events :** the remaining 30% of stroke volume is ejected to the aorta.
- **The ventricular and aortic pressures :** reach their maximum and begin to decrease (due to escape of blood to peripheral circulation is more than the amount of blood ejected from the ventricle).

Atrial pressure : increased due to venous return.

Ventricular volume: decreases to reach the end systolic volume (ESV = 70ml).

End diastolic volume = 140ml

Different between EDV-ESV =70 ml

EDV-ESV= 70 ... (stroke volume)SV

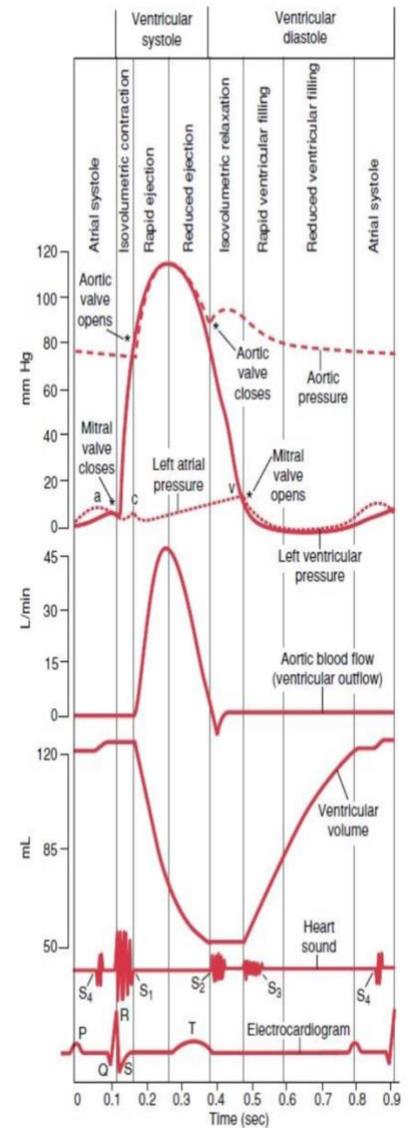
50% percentage of blood in one beat

C. Ventricular diastole :

5. Protodiastolic phase :

- **Duration : 0.04 sec**
- **Events :** the period between the end of ventricular systole and the closure of the aortic valve.
- **The ventricular and aortic pressures:** The ventricle begins to relax but still contracted and its pressure decreases about 20 mmHg and the aortic pressure decreases also (due to escape of blood to peripheral circulation). But still above the ventricular pressure. This causes the blood in the aorta to regurgitate to the ventricles leading to closure of the aortic valve at the end of this phase.
- **The closure of semilunar valves occurs as a result of fall of ventricular pressure below that of aortic and pulmonary arteries.**

Any blood flow is under effect of the pressure gradient even it was one ml



- The closure of the aortic valve and the change of potential energy to kinetic energy leads to sharp momentary fall in the aortic pressure called the dicrotic (incisura) notch.

- Ventricular volume : is constant.

- ECG : down slope of the (T) wave.

6. Isometric relaxation phase :

- Duration : 0.06 sec

- Events : it begins by closure of the aortic valve and the ventricles relax isometrically without change in the ventricular volume.

- Atrial pressure : increased above the ventricular pressure due to accumulation of venous return, this pressure can open the A.V. valve at the end of this phase.

- Ventricular pressure : falls rapidly from 90 to 0 mmHg.

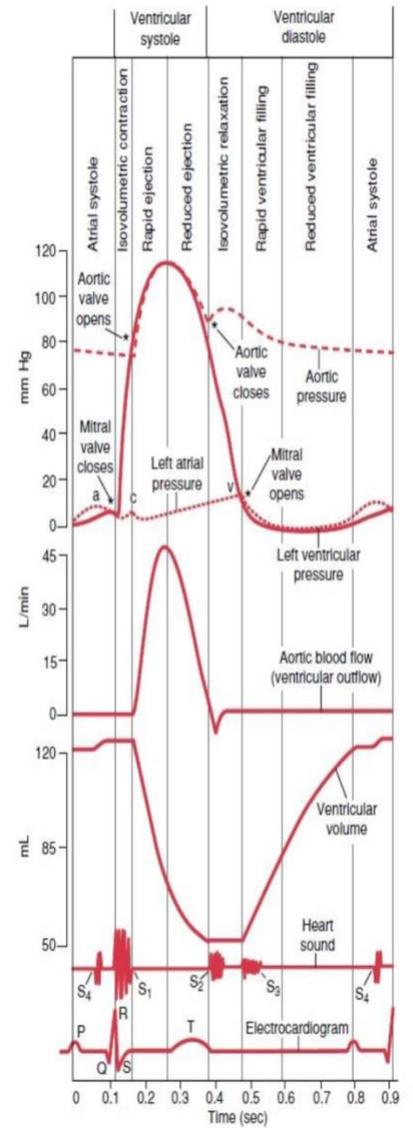
- Aortic pressure : due to elastic recoil of the aorta its pressure increased leading to upward (dicrotic) wave.

Minimum diastolic pressure of pulmonary artery and aorta is more than zero as a result of elastic fibers in its walls

- Heart sounds : the 2nd heart sound due to closure of the aortic valve and pulmonary valve (semilunar valves).

-The semilunar valves (aortic, pulmonary) close at the beginning of this phase

- The A.V. valves open at the end of this phase.



7. Maximal (rapid) filling phase :

- Duration : 0.1 sec.
- Events : It begins by opening of A.V. valve due to the increased atrial pressure above the ventricular pressure (60% of stroke volume is rushed to the ventricle).

The blood flow under affects of pressure gradient and little from gravity (helped by gravity).

- Atrial and ventricular pressure : around zero.
- Ventricular volume : increased.
- Aortic pressure: decreases due to escape of blood to peripheral vessels.
- Heart sounds: the 3rd heart sound due to rushing of blood into the ventricles and vibration of the ventricular wall.and the papillary muscle, chorda tendena

8-.Reduced filling phase :

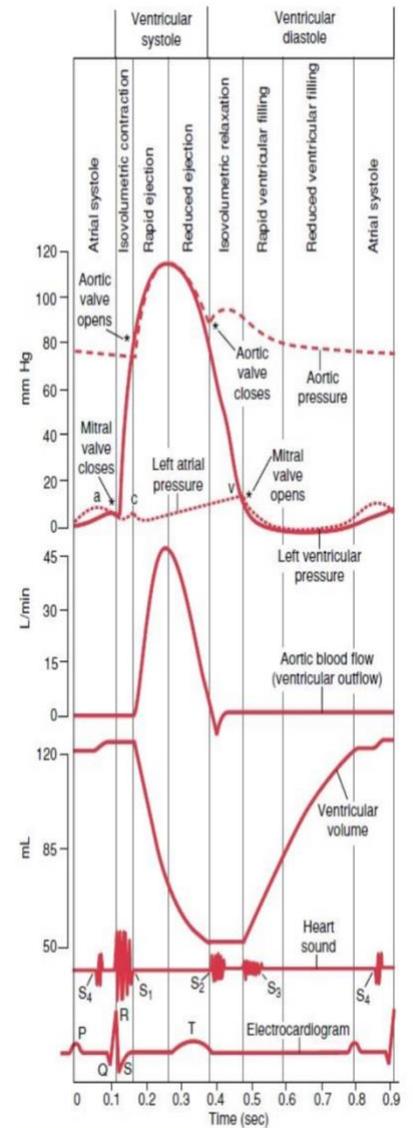
- Duration : 0.2 sec.
- Events : 10% of the stroke volume flow slowly to the ventricle.
- The ventricular volume increase gradually.
- The ventricular pressure rises to 4 mmHg.

Atherosclerosis means decrease in elastic fibers of the blood vessels

*Site of best hear of cardiac heart sound is ..5th left intercostal space

(Apex / this site for all sounds : 1st, 2nd, 3rd, 4th)

*1st and 2nd has special sites for hearing



Changes in pressures during the cardiac cycle:

* During the diastole :

1. The ventricular filling occurs in early diastole.

Ventricular wall has papillary muscle that make strong vibration.

2. The ventricles rest.

*One of the functions of resting ventricles ,, ,, , coronary flow

3. The coronary blood flow occurs.

Blood flow by one force only.... (pressure gradient)!

	Rt. Vent	L. Vent	Pul. art	Aorta
Systolic Pr	25	120	25	120
Diastolic Pr	0	0	8	80



The minimum in pul.art isn't zero due to elastic

-Summary of the heart sounds from Dr. Hamzeh Alshare

الجدول من الريكورد (مطلوب)

	1 st Sound	2 nd Sound	3 rd Sound	4 th Sound
Cause	- Sudden closure of <u>AV</u> valve - vibration of the aortic wall	- Sudden closure of <u>semilunar</u> valve	- Vibration of the <u>ventricular</u> wall & rushing of blood into the ventricles	- Vibration of <u>atrial</u> muscle and rushing of blood into the ventricles.
Character	Lubb Low Frequency & long duration	Dub High Freq. & Short duration	-	-
Timing (Phase)	- Isometric <u>contraction</u> (1 st component) - Maximum <u>ejection</u> (2 nd component)	- Isometric <u>Relaxation</u> phase	- Maximum <u>Filling</u> phase	- Atrial contraction phase
Beast heard	-	-	At the apex	At the apex

- 1st and 2nd heart sound are audible by stethoscope
- 3rd audible but need specific precautions and cardiologist
- 4th heart sound audible only with phonocardiograph so non-audible
- At the apex means 5th intercostal space

" اكمل أحلامك و لا تستسلم فالمشوار طويل و يحتاج الى اجتهادك ، و
اعمل كل يوم بأمل جديد ، و تذكر أن الله يبسر الأمور ، فلا داعي للقلق
... افعل ما بوسعك و توكل على الله ،،،، أيام السعد آتية ﴿﴾ "