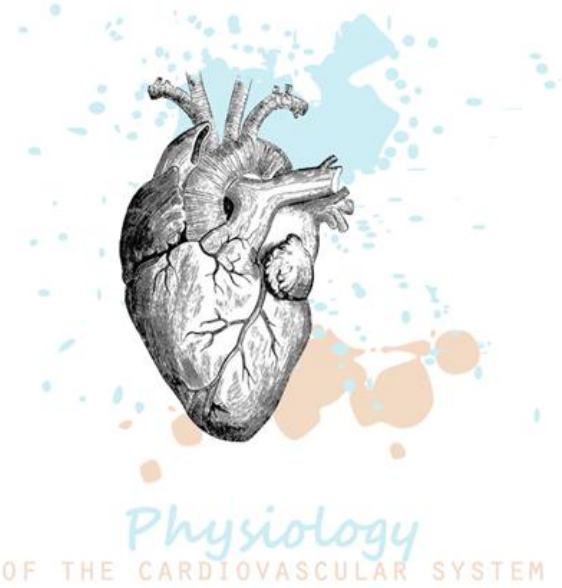
PHYSIOLOGY TEAM 435

جامعة الملك سعود
King Saud University



These notes are based on Dr.najeeb's videos only

" لا يُستغنى بها عن المحاضرة الأصلية "

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Dr. Najeeb Notes

- When we talk about cardiac cycle, we are discussing the events that occur in :

1) **Atrium**
2) **Ventricle**
3) **Aorta**

Notice here: the events occur in the left side of the heart = the events occur in the right side; the only difference is that the pressure in the right side is less than the left side.
[1 Cardiac cycle = 1 systole "contraction" + diastole "relaxation"]

Let's discuss each phase:

80% of ventricular filling is passive (does not require atrial effort); that means if someone has a mechanical problem in his atrium, he will still have the 80% so will not suffer significantly. In other words, before atrial contraction, about 80% of ventricular filling is already done, which means that when atrial contraction occurs it just adds 20% of ventricular filling. *Atrial 20% filling becomes significant during exercise.*

1. Arterial contraction phase

- When left atrium contracts → pressure in atrium increases. Increased pressure within the left atrium produces [a wave] due to atrial contraction.
- **Mitral** valve must be **open** *(Aortic valve will be closed)* which means that during **atrial contraction** there is a **communication** between the **left atrium** & **left ventricle** BUT there is **NO** communication between the left ventricle & aorta.
- The pressure in the aorta is **more** than the pressure in the ventricle. Blood moves into ventricle and **pressure is transferred** to left ventricle. Before atrium contracted, the pressure was zero in **relaxed ventricle**. When atrium contracted and blood came in to the **ventricle**, its pressure starts **increasing** in a mild way. Just after the atrium completes its contraction, **action potential** enters ventricle through **A-V node**. Now it is the turn of *ventricle to contract (atrium relaxes) (next phase)*.
- We hear **S4** (pathological sound)

2. Isovolumetric contraction phase

- Ventricular contraction starts > pressure increases and become more than atrial pressure, so blood will turn back to atrium BUT the mitral valve will be closed!
- **[at 5 mmHg = closure of mitral valve]** this closure produces a sound which called as : **"First heart sound [S1]".**
- [C-wave] occurs in the atrium as a result of bulging of mitral valve. Blood from lungs will accumulate in the atrium > atrium will work as a tank and it will keep blood accumulating from the lungs > slightly increased pressure.
- Ventricle will continue to contract as a closed chamber (because both aortic and mitral valve are closed), the pressure goes up to **80** mmHg *" it cannot open the aortic valve yet"*
- We called this phase **[Isovolumetric contraction]** which is the early phase of ventricular systole "the reason behind this name is that there is no blood entering or leaving the ventricle so the amount of blood is the SAME + the size of ventricle remains the SAME".
- During this phase, what is happening to Aorta?
  Due to its elastic property, it is squeezing whatever blood it has to push it forward to peripheral parts.
- As soon as the pressure in the ventricle becomes MORE than the pressure of aorta *(more than 80 mmHg)*, the aortic valve **opens** > **Termination of Isovolumetric contraction** *(next phase begins)*
- We hear **S1** (at closure of mitral valve & tricuspid valve)

3. Rapid ventricular ejection phase

- Rapid ventricular ejection of blood starts: blood pumping from ventricle to aorta, aorta will stretch out "the advantage of stretching out: aorta can accommodate more volume when stretched out".
- At this phase, ventricle and aorta work as a single chamber; so pressure changes which are occurring in the left ventricle will be transferred to the aorta.
- **Pressure** in the ventricle increase up to 120 mmHg > **pressure** in the aorta becomes 120 mmHg.
- The atrium in this phase is still receiving blood from lungs > still accumulating blood > [V-wave] results.
- During this phase, blood is being ejected rapidly, but rapid ejection can't last forever, so it has to slow down. *(next phase)*
- **No** sound heard (no sound of opening of aortic valve)

4. Slow ventricular ejection phase

- Atrium still receiving blood from lungs.
- Ventricle still contracting but pressure start falling down.
- Aortic valve is still open
- Pressure in ventricle (after it gets to 120) will gradually become less, and when pressure starts falling naturally blood ejection becomes slow hence the name of the phase "slow ventricular ejection phase".
- In the same way pressure in aorta is falling, too.
- *Next step: ventricle starts relaxing*
- ***No** sound*

5. Isovolumetric relaxation phase

- The ventricle starts relaxing, (ventricular diastole)
- The pressure continue falling down in both ventricle and aorta; but the ventricle is having progressively **lower** pressure.
- After that, there will be closure of aortic valve > the ventricle and aorta now are disconnected.
- The aortic pressure back to its normal value (80 mmHg) but the ventricular pressure still falling down.
- Because both mitral & aortic valves are closed, the ventricle relaxes as a closed chamber [Isovolumetric Relaxation].
- The volume of blood present at the end of systole is called : [End systolic volume].
- We hear **S2** (aortic valve and pulmonary valve close)

"Onset of systole is isometric contraction→pressure is rapidly taken to aortic pressure."
"Onset of diastole is isometric relaxation→ pressure is rapidly dropped so ventricle pressure becomes less than atrial pressure eventually"

6. Rapid passive ventricular filling phase (R.P.V.F)

- Pressure in ventricle is less than pressure in atrium > Mitral valve will open > the blood that was accumulated in the atrium will drain into the ventricle **[** Rapid ventricular filling **]** "but without atrial contraction, so it is passive filling "
- Ventricular diastole will continue.
- We hear **S3** (sometimes, especially in young people after exercise)

7. Slow passive ventricular filling phase (S.P.V.F) (Diastasis)

- The blood flow from lungs directly to the ventricle because the mitral valve is open, so here the atrium is work as a passage *(atrium not contracting yet).*
- This phase is the longest phase of diastole.
- Next step : Firing of S.A. node > atrium will contract and the cycle repeats itself.

Sounds :

- Closure of mitral valve "left" and Tricuspid valve "right" : **S1**
- Open of aortic valve : HAS NO SOUND
- Closure of aortic valve and pulmonary valve : **S2**
  Between S1 & S2 there is ventricular systole
- At rapid ventricular filling phase (*sometimes, especially in young people after exercise*):**S3**
- **S4** is a pathological sound.

Notes :

- Atrial diastole is long , atrial systole is only 0.1 sec
- Total ventricular systole is about 0.3 sec (longer than atrial systole)
- Ventricular diastole = 0.5 sec
- We have to understand that the **electrical events** occur first, and then **mechanical events** follow.
- ECG waves:
  - **P wave:** Represents atrial depolarization just before the (a wave).
    P wave *on ECG is atrial depolarization and* ***a wave*** *is the pressure in the atria due to mechanical activity.*
  - **Q R S complex:** Represents depolarization of ventricles. When ventricle has been polarized, mechanical events in the ventricle will start and pressure in ventricle will go up.
  - **T wave:** When ventricle starts relaxing, just before relaxation ventricular repolarization should be there.
  - *You should understand that* ***p wave*** *should come before the next cycle (before next atrial contraction) and* ***Q R S complex*** *should come before the next ventricular contraction.*

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