Physiology Team 431

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- Blue for explanation
- Green (from male slides)
- Red very important

Cardiac cycle 2

Why? Because the atria contract to pump the last 27-30%of blood to the ventricle

- **Volume changes:**

Phase	Ventricular volume
1. Atrial systole	↑ increase
2. Isometric contraction phase	No change
3. Rapid ejection phase	↓ Rapid decrease
4. Reduced ejection phase	↓ Slow decrease
5. Protodiastole	constant
6. Isometric relaxation phase	No change
7. Rapid filling phase	↑ Rapid increase
8. Reduced filling phase	↓ Slow increase

- **Pressure changes:**

We have different pressures at different locations either in.

Arteries Or Veins

- Aorta
- Arteries
- Pulmonary artery

- Jugular vein = the pressure in the atrium (a,c,x,v,y) waves

Systole Diastole

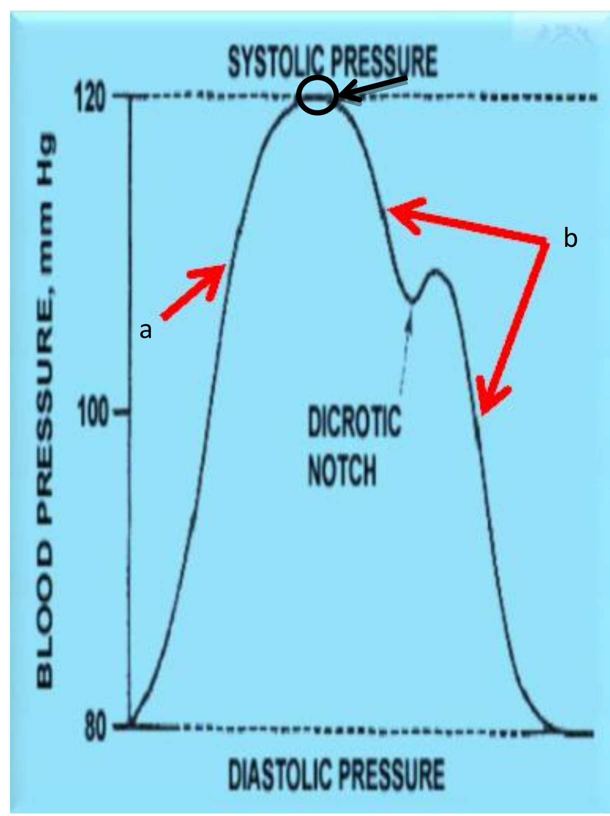
1- Pressure in the aorta: aortic pressure changes 120 /80

a. Ascending or anacrotic limb:

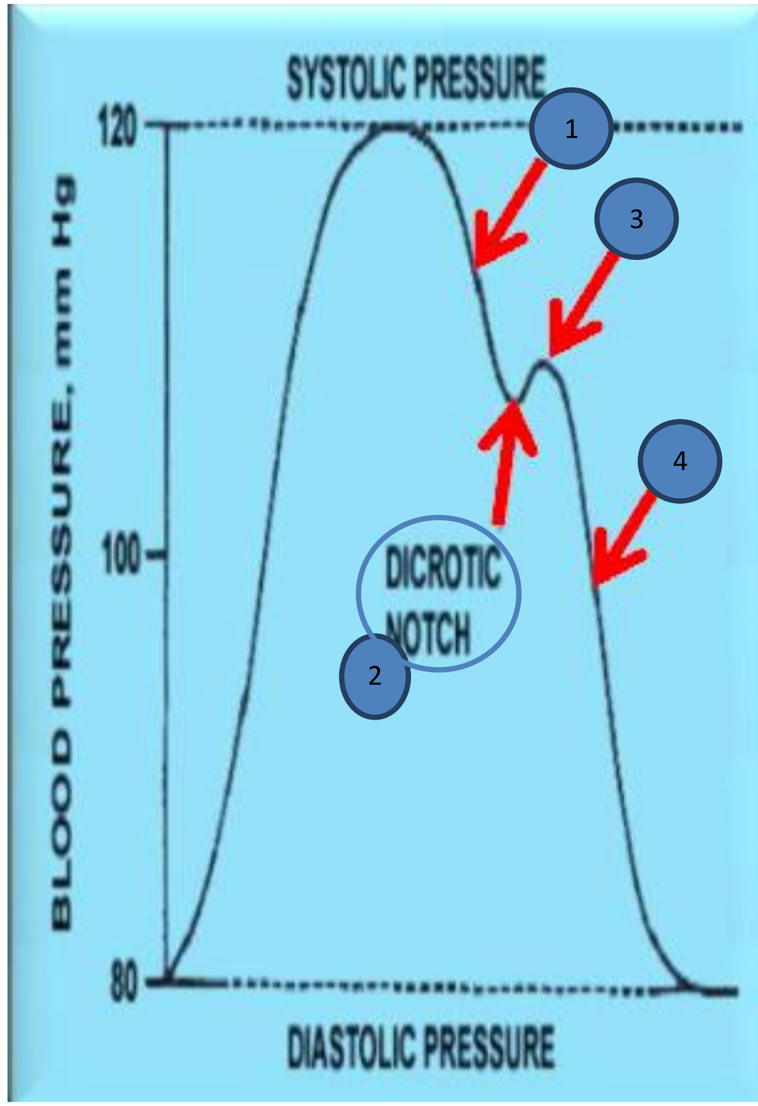
- It happens with rapid (max) ejection phase.
- The aortic pressure reaches up to 120 mmHg. (along with increase in ventricle pressure due to the communication between them in this phase)

b. descending or catacrotic limb:

- It happens with reduced ejection phase.
- It decreases in 4 stages.



Stages of the descending or catacrotic limb:



1. decrease in aortic pressure:
   - it decreases until 110mmhg
   - it decreases because the amount of blood that leaves the ventricle (entering the aorta) is reduced, and the blood in aorta is leaving into the blood circulation.
2. Dicrotic notch(incisura):

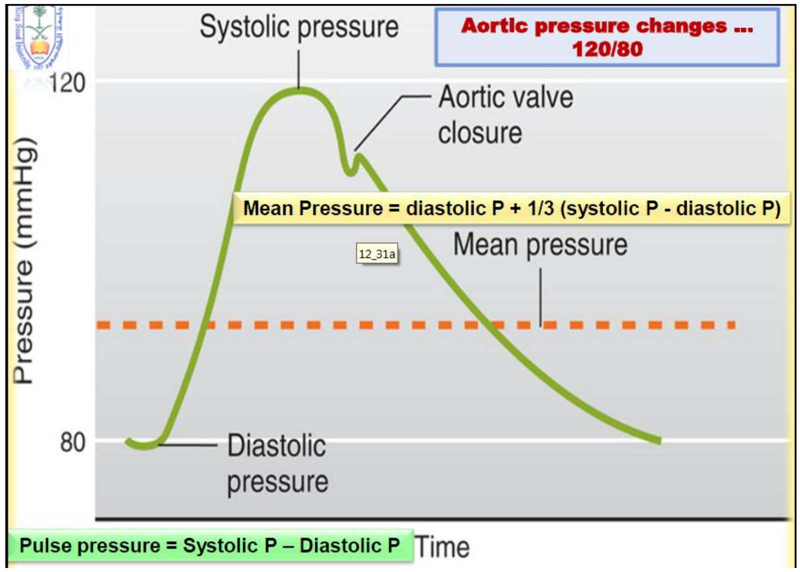
   = sudden drop in aortic pressure.

   - Due to sudden closure of aortic valve.
   - At the end of protodiastole phase.
   - (is presented by the closure of the valve in 100mmhg)
3. Dicrotic wave:

= slight increase in aortic pressure.

- Due to elastic recoil of aorta.(it happens at the time where the valve are closing when the blood of aorta return back and hit the valve producing slight increase in pressure).

4. Slow decrease in aortic pressure: Up to 80 mmhg
   - Due to continued flow of blood from aorta → systemic circulation.



Aortic pressure:

You have to know the difference between:

Blood pressure= 120\80

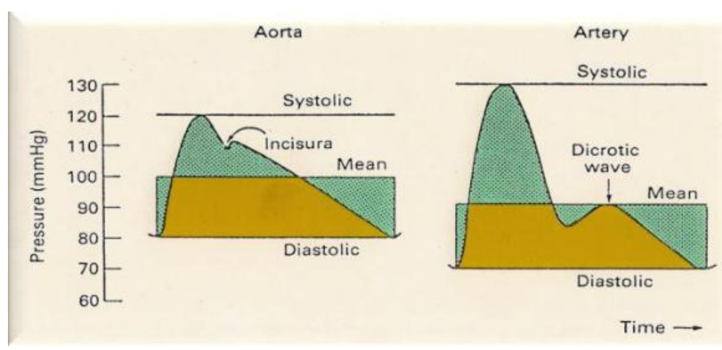
Pulse pressure= systolic p-diastolic p

Mean pressure=diastolic p+1/3(systolic p-diastolic p)

Why they are important? What is there clinical significant?

- Aortic stenosis (narrowing of aortic outflow) * when the heart is ejecting blood against resistance it will never reach 120 mmHg
- Shock or dehydration
- Aortic regurgitation (incompetent valve, the valves are not closed well)
- Hypertension
- Pregnancy

2- Pressure in arteries:



Arterial pressure range is 110-130/70-90

Similar to aortic pressure but differ in

*the magnitude.

*Arterial pressure is sharper.

Also, whenever we are closer to the heart the notch will be closer to the top.

3- Pressure in pulmonary artery:

It's Similar to aortic pressure changes but with difference in magnitude.

Pressures in the Heart Chambers

1. **Right atrial pressure (RA)= 0-4 mmHg, in some books is written (0-6), (-2-6)**

   Why it is so low?

   Because it is a venous pressure

2. **Left atrial pressure (LA)= 8-10 mmHg**
3. **Right ventricle pressure (RV)= 25(systolic)/4(diastolic) mmHg**
4. **Left ventricle pressure (LV)= 120(systolic)/10(diastolic) mmHg**
5. **Aortic pressure (A)= 120(systolic)/80 (diastolic) mmHg**
6. **Pulmonary artery pressure= 25(systolic)/ 10 (diastolic) mmHg**

pared to the systemic arterial system. The ranges in pressures in the right and left atria indicate the extent by which atrial pressure changes during the cardiac cycle.

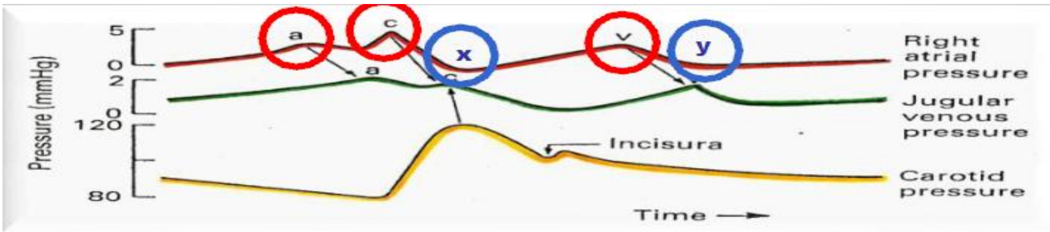
Ventricular Pressure-Volume Relationship

Although measurements of pressures and volumes over time can provide important insights into ventricular function, pressure-volume loops provide another powerful tool

- **The wall of left ventricle is 5 times thicker than right ventricle; as a result the pressure of LV is approximately 5 times higher than RV.**

pressure in atrium=pressure in jugular vein

*the only difference that the jugular pressure is delayed



Results in:

- 3 upward deflection (a,c,v)
- 2 downward deflection (x,y)

The 3 waves (a,v,c) are equal to one cardiac cycle=0.8

Causes of atrial pressure waves:

“A” wave: atrial systole

“C” wave: ventricle systole

- +ve: in isovolumetric phase
- -ve: rapid ejection phase

“V” wave: atrial diastole – increase in venous return

“X” wave: reduced ejection phase

“Y” wave: rapid filling phase

Pressure vs. volume Inside left ventricle

It demonstrate changes in intraventricular volume& pressure during cardiac cycle

- Both ventricle systole& diastole can be divided into early and late phases.

Systole → early phase (isovolmutric contraction)
→ Late phase (isotonic contraction, Ejection phase)

Diastole → early phase (isovolmutric relaxation)
→ Late phase (isotonic relaxation, Filling phase) *STUDY THIS

Early phases	systole	diastole	Isovolmutric phase
Late phases	Systole	diastole	Isotonic phase(rapid ejection or filling) the work

CHART VERY WELL

B--->C--->D→SYSTLOE

Early late

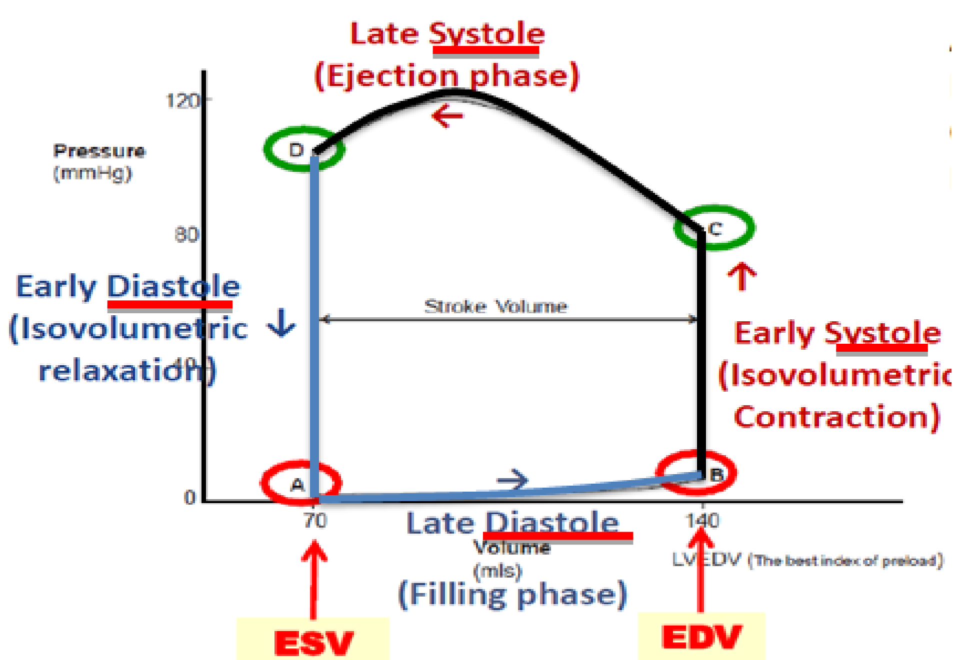
D--->A--->B→DIASTLOY

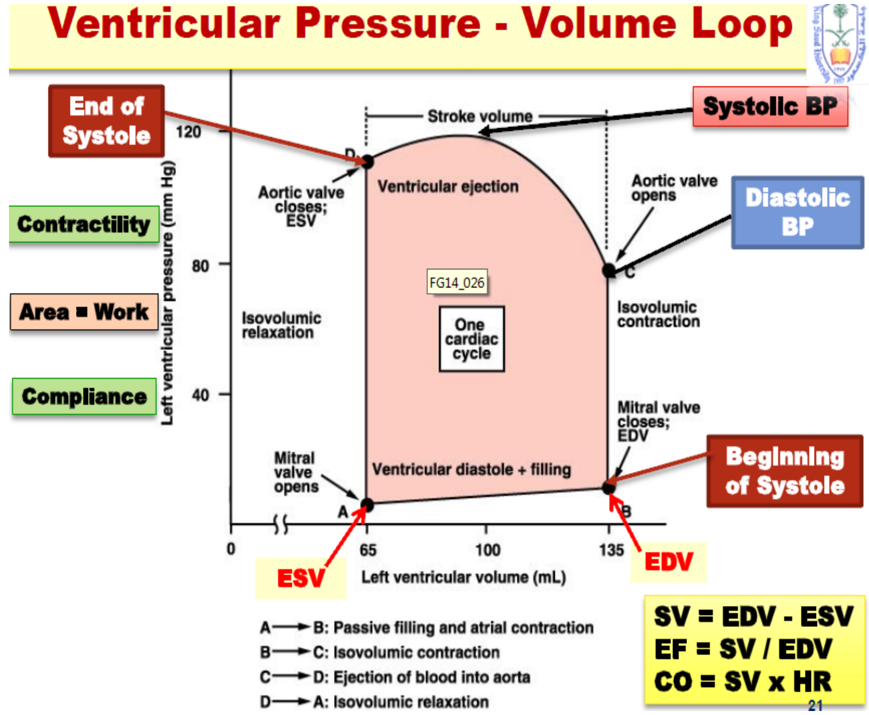
Early late

A – Mitral valve opens
B – Mitral valve closes
C – Aortic valve opens
D – Aortic valve closes

C→D→STROKE VOLUME

B→C→CLOSED CHAMPER so the blood inside is called EDV





The sharp straight lines on the sides indicate that there is no work in that phase.

*you should study the chart very well

What do you have to know from this chart is:

- When the valves are open and when they are closed
- Beginning of systole (B) & **end** (D)
- Beginning of diastole (D)&**end** (B)
- Diastolic filling occurs between points A & B
- Ejection occurs between C & D
- B,C,D-> is systole and D,A,B->IS diastole
- Where is EDV,ESV,SV

What can affect systole and diastole?

Systole: is measured by* contractility

*Stroke volume is affected by→contractility; contractility is affected by → the function of the muscle, preload (initial volume) & after load (initial pressure)

Diastole: is measured by *compliance= elasticity

Compliance is affected by→ connective tissue, venous pressure & venous resistance

***Contractility**: is the change in volume per time caused by a change in pressure

$=(dV/dT)/dP$

***Compliance**: is the change in pressure caused by a change in absolute volume

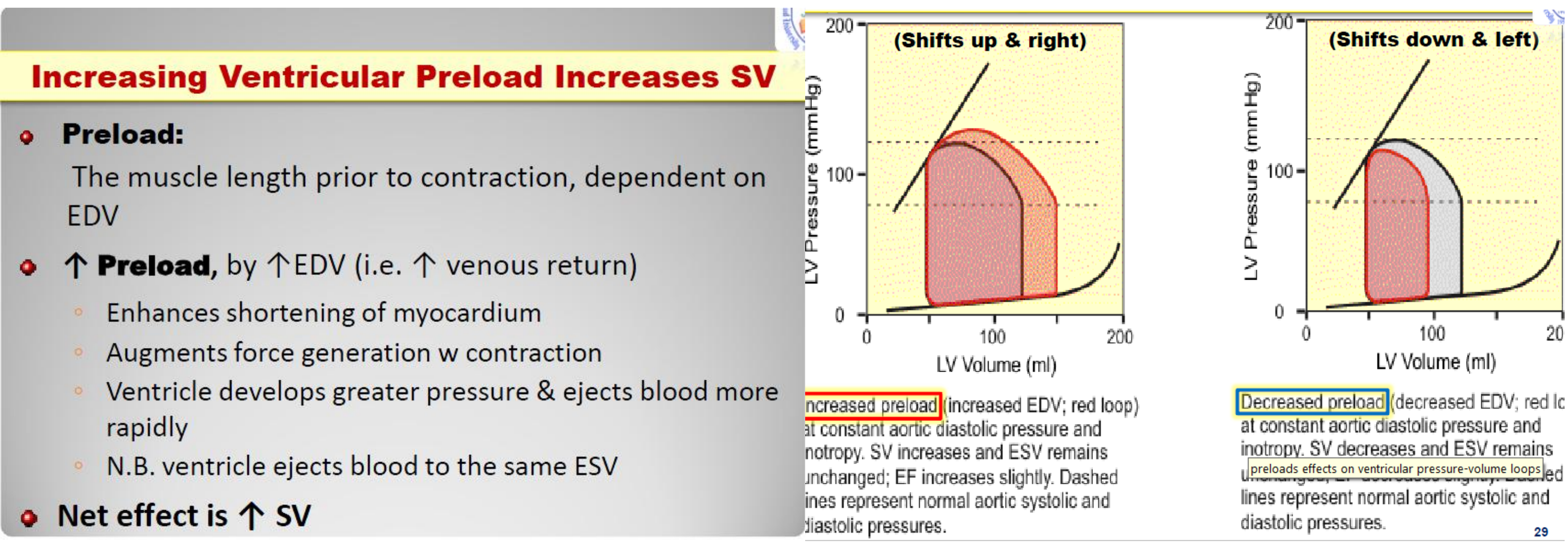
Compliance= $\Delta P/\Delta V$

Point compliance dP/dV

What is preload? It’s the amount of blood in ventricles before ejection= EDS

What is afterload? It’s the resistance that present in the structures surrounding the heart. For example in arteries constrictions, if I’m pumping against resistance I’ll pump harder causing a load to the heart that called afterload.

- For the next 2 pages I’ve wrote what the doctor said about each chart in the blue box and she said that this is the conclusion. But, I did put the doctor’s slide also.



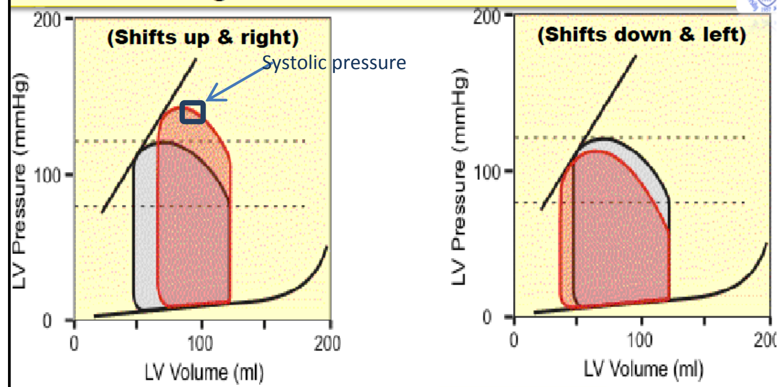
When the preload increases that means that EDV has increased cause I’m filling more blood. Hence the stroke volume will increase and then it will shift up and right. While if the preload decreases it will shift down and to the left.

- The ventricle pressure and work will increase to give us the same stroke volume (or larger) because we are pumping a large amount of blood

Increasing Ventricular Afterload Decreases SV

- **Afterload:**
  The tension against which the ventricle must contract
- ↑ **Afterload,** by ↑aortic diastolic pressure
  - Reduces the velocity of muscle fibre shortening
  - Reduces the velocity by which blood is ejected
- Net effect is to ↑ ESV & to ↓ SV

Increasing Ventricular Afterload Decreases SV



Increased afterload (increased aortic pressure; red loop) at constant preload (EDV) & inotropy. SV decreases and ESV increases; EF decreases. Dashed lines represent normal aortic systolic and diastolic pressures.

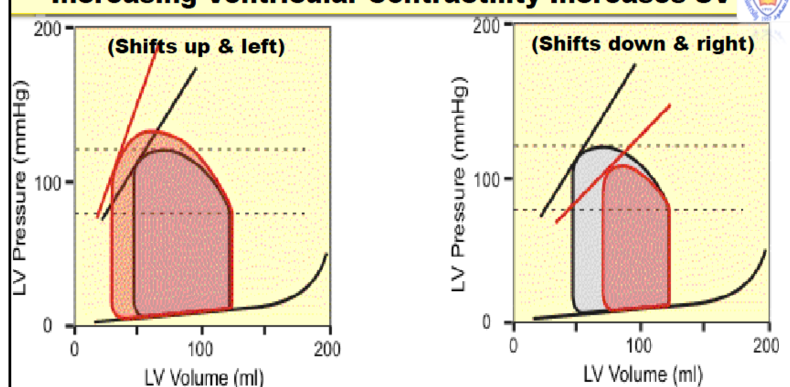
Decreased afterload (decreased aortic pressure; red loop) at constant preload (EDV) & inotropy. SV increases and ESV decreases; EF increases. Dashed lines represent normal aortic systolic and diastolic pressures. 31

If resistance is found the whole curve will shift up and to the right because the pressure will increase in(systolic pressure)above 120 mmHg and we will never be able to pump the whole amount blood because of the resistance so the Stroke volume will be deacresed

Increasing Ventricular Contractility Increases SV

- **Contractility:**
  The force of contraction for a given fibre length
- ↑ **Inotropy,**
  - Increases the velocity of muscle fibre shortening
  - Increases the velocity of ventricular pressure development & ejection
- Net effect is to ↓ ESV & to ↑ SV

Increasing Ventricular Contractility Increases SV



Increased inotropy (red loop) at constant preload (EDV) & aortic diastolic pressure. SV increases and ESV decreases; EF increases. Dashed lines represent normal aortic systolic and diastolic pressures.

Decreased inotropy (red loop) at constant preload (EDV) & aortic diastolic pressure. SV decreases and ESV increases; EF decreases. Dashed lines represent normal aortic systolic and diastolic pressures. 33

When the contractility of the muscle increases the stroke volume will increase also.