Physiology of Venous Return

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Venous return (VR) is the flow of blood back to the heart

Under steady-state conditions, venous return must equal cardiac output (CO)

Although cardiac output and venous return are interdependent, each can be independently regulated

CO = VR

Factors regulating venous return

1. Respiratory activity. Inspiration decreases right atrial pressure
2. Vena cava compression. Decreases return
3. Decreased venous compliance. Sympathetic activation of veins (venous system can store 60-80% of blood volume)
4. Gravity. When a person initially stands and before the baroreceptor reflex is activated, right atrial pressure and ventricular preload falls, which decreases stroke volume and venous return
5. Foot, calf (and thigh) muscle contraction. Calf muscle pump
6. Venous valvular integrity
7. Venous conduit integrity

Respiratory activity
Thoraco-abdominal pump

Gravity

Supine
- RA pressure 0 mmHg
- Venous cap pr 15 mmHg
- Pressure gradient 15 mmHg

Standing
- RA pressure 0 mmHg
- Limb venous pr 15 + 80 mmHg
Pollack and Wood 1949

Gold standard measure of venous hemodynamics

Normally, ambulation “drains” the leg and reduces AVP

CVI results in elevated venous pressure due to:
- Outflow obstruction
- Valvular incompetence
- Muscle weakness
- AV malformations

Non-invasive estimates of lower extremity venous hemodynamics

Impedance Plethysmography measures changes in electrical resistance in tissues of the extremity in response to changes in volume

Photoplethysmography uses light absorbance by hemoglobin as a reflection of blood volume in the extremity

APG measures changes in leg size as an estimate of change in blood volume, by using an air-filled cuff applied to the extremity

Tiptoe maneuver