Author(s): Louis D’Alecy, 2009

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Venous Tone and Venous Return

M1 – Cardiovascular/Respiratory Sequence
Louis D’Aleyc, Ph.D.
Friday 11/07/08, 9:00

Venous Tone & Venous Return

25 slides, 50 minutes

1. Venous Return vs. cardiac output
2. Family of Venous Return Curves
3. Family of Cardiac Function Curves
4. Review
   • Flow Mediated Dilation (FMD)
   • Coronary Flow Reserve
Reflex Influences

Local Influences

sympathetic constrictor nerves

NE $\alpha$

basal tone

vasodilator metabolites

arterioles

sympathetic constrictor nerves

NE $\alpha$

passive distention

eexternal compression

veins
Slight increases in venous pressure produces large increases in venous volume.
M&H Fig 8.1 “Simplified” CVS

No right heart and no lungs -- in case you missed it!

70% of volume
Circuit Properties

\( V_0 = \text{Vol @zero P}, \ C = \text{Compliance}, \ R = \text{Resistance} \)

<table>
<thead>
<tr>
<th>Compartment</th>
<th>( V_0 ) mL</th>
<th>( C ) mL/mmHg</th>
<th>( R ) mmHg/(L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricle in diastole</td>
<td>30</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Arteries</td>
<td>600</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Arterioles</td>
<td>100</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Capillaries</td>
<td>250</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Peripheral venous compartment</td>
<td>2500</td>
<td>70%</td>
<td>110</td>
</tr>
<tr>
<td>Central venous compartment</td>
<td>80</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Entire circuit</td>
<td>3560</td>
<td>140</td>
<td>20</td>
</tr>
</tbody>
</table>

Values are for a normal, young, resting 70-kg adult. \( V_0 \), anatomical volume of compartment at zero pressure; \( C \), compliance of compartment; \( R \), resistance to flow through compartment.
Peripheral Venous Pressure: $P_{pv} = 7 \text{ mmHg}$

Central Venous Pressure: $P_{cv} = 0 \text{ mmHg}$

Source: McGraw-Hill
VR fills the central venous pool and CO empties the central venous pool.

Central Venous Pool

Great Veins in Thorax and Right Atrium
Venous Return $= CO$
VR

7 mmHg
Posture?
Muscle move?

0 to 2 mmHg
Ventilation??
Volume

To increase VR you need to Decrease CVP.

Typical 5 L/min
2 mmHg

8.3 MH

CVP, mmHg
8.3 MH

Ventricular function curve

Stroke volume (ml)

Ventricular end-diastolic volume (ml)

Normal resting value
**limited**

Diagram: Relationship between cardiac output and preload.

- **Cardiac Output**
- **Preload**

- **↑ Afterload**
- **↓ Contractility**
- **↓ Heart Rate**

- **↑ Afterload**
- **↓ Contractility**
- **↑ Heart Rate**
Typical 5 L/min
2 mmHg

CVP, mmHg

Cardiac output curve

Venous return curve

8.5 MH

Review??

Flow Mediated Dilation (FMD) & Coronary Stenosis
ADMA (NOS Inhibitor)

Sheer or flow mediated Vasodilation FMD

FMD Setup of Arm, ultrasound, & cuff on fore arm

Measure here

Compress here
FMD = flow mediated dilation
NMD = nitroglycerine (Max) mediated dilation
NO mediated vasodilation

Compromised by endothelial dysfunction (?ADMA?)
lated that in normal individuals, the relaxation effect of EDRF-NO outweighs the direct α-adrenergic constrictor effect of catecholamines on arterial smooth muscle, such that vasodilatation results. However, in patients with dysfunctional endothelium (e.g., atherosclerosis), an impaired release of endothelial vasodilators leaves the direct catecholamine effect unopposed, such that relative vasoconstriction occurs instead. The resultant decrease in coronary blood flow and myocardial oxygen supply contributes to ischemia. Of note, in patients with risk factors
Ischemia

- blood flow to a tissue or organ that is inadequate to maintain function.

- i.e. myocardial ischemia (MI)
With the same perfusion pressure, the same measured flow means the overall (series) resistance is the same regardless of a focal lesion! BUT *** You have used up vasodilator reserve !!!!!!
Series Resistance Network

Compensatory Vasodilation here so series resistance stays the same.

Lesion here

\[ R_s = R_1 + R_2 + R_3 \]

\[ \Delta P = P_i - P_0 \]

\[ \dot{Q} = \Delta P / R_s \]
