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Other Reflexes and Reflex Actions

M1 – Cardiovascular/Respiratory Sequence
Louis D’Aley, Ph.D.
Wednesday 11/05/08, 10:00
Other Reflexes & Reflex Actions
   22 slides, 50 minutes
1. Valsalva maneuver
2. Idiopathic Orthostatic Hypotension
   • (autonomic nervous system defect)
3. Baroreceptor reset in hypertension
4. Gravity (standing)
5. Low pressure -volume (Bainbridge Reflex)
6. Cardioinhibitory (Bezold-Jarisch Reflex)
7. Cerebral ischemic (Cushing Reflex)
Valsalva Maneuver: forced expiration against a closed glottis

Intrathoracic Pressure or Esophageal pressure (cm H₂O)

Arterial pressure (mm Hg)
Valsalva Maneuver:

1. Increased MAP due to increased intrathorasic pressure (ITP)
2. MAP & PP decrease due to decreased VR
3. Baro-R increase in HR & VC (little effect)
4. Decrease ITP, Increase VR & PP, Baro-R, decrease HR

STOP FORCED EXPIRATION
Image of arterial baroreceptor removed

Please see: http://mor.phe.us/jtw/Gateway/Projects/Vertebrates/images/EvolutionOfTheHeart/ArterialBaroreceptors.gif
Hypertension resets baroreceptors to Regulate pressure at a higher set point.
Idiopathic Orthostatic Hypotension (autonomic defect)
Deep anesthesia and over inflation of lungs
Restricts VR and decreases preload.
M&H Fig. 10.2
Pattern of pressures in recumbent individual

![Diagram showing pressure distribution in a recumbent individual](image)

- **Heart**: Pressure is **0 mm Hg**.
- **Arteries**: Pressure is **100 mm Hg**.
- **Arterioles** and **Capillaries**: Pressure decreases to **95 mm Hg**.
- **Veins and Valves**: Pressure is **25 mm Hg**.
- **Foot**: Pressure decreases further to **5 mm Hg**.
- **Foot**: Pressure is **90 mm Hg**.

Pattern of pressures upon standing

No Baro-R YET!

Hydrostatic column

Pooling in veins

5 + 90 = 95

95 + 90 = 185

VC = vasoconstriction or venoconstriction
One-way valves
Contraction of skeletal leg muscles breaks the Hydrostatic Column

Leg muscles relaxed: Pressure due to gravity = 80 mmHg

Image of man’s body with leg muscles contracted removed

Leg muscles contracted: Pressure due to gravity = 14 mmHg
Bainbridge Reflex: Increase stretch of low pressure receptors causes a reflex increase in heart rate and cardiac output.

In a normally hydrated individual the “excess” volume is sensed by venous side low pressure receptors and reflexly increases HR and CO (Bainbridge reflex) favoring removal of excess fluid on the arterial side by renal mechanisms.
Arterial baroreceptor reflex: A increase stretch (pressure) causes a reflex decrease in heart rate (negative chronotropic effect).

In a dehydrated (patient) individual the volume replacement increases CO and produces increased MAP and a reflex bradycardia.

Used as test of “How dry?”
Volume status determines the heart rate response to “volume expansion”.

![Graph showing the effect of volume depletion and loading on heart rate (HR), cardiac output (CO), and stroke volume (SV). The graph demonstrates a normal response to volume status changes.]
Other Cardiovascular Reflexes
(Resetting of Set Point ? Pathophysiology ? )

Bezold-Jarisch Reflex
- respond to chemostimulation in myocardium
  by veratrum alkaloids
- may be “pharmacological curiosity”

BUT
- ***bradycardia with hypotension***
- over rides arterial baroreceptor reflex !!
- vagal afferents
- atropine blockable
- may have role in posterior-inferior infarcts

Anesthesiology 2003; 98:1250-1260
Other Cardiovascular Reflexes  
(Resetting of Set Point ? )

**Cushing (Cerebral Ischemic Reflex)**
- response to compressive ischemia in CNS
- marked increase in arterial blood pressure
- over rides arterial baroreceptor reflex !!
- may involve central chemoreceptors
- presumed to be “protective” of ischemic CNS
When intracranial pressure approaches arterial pressure the **Cushing reflex** produces a sustained increase in arterial blood pressure.
If time permits
And not to be tested
Cardiovascular Response to Exercise
Control of cardiovascular system

Begin

Brain “exercise centers”

Arterial baroreceptors
  Reset upward

Medullary cardiovascular center

Exercise skeletal muscles
  Contractions
  Stimulate mechanoreceptors in the muscles
  Local chemical changes
  Stimulate chemoreceptors in the muscles
  Dilate arterioles in the muscle

↓ Parasympathetic output to heart
↑ Sympathetic output to heart, veins, and arterioles in abdominal organs and kidneys

↑ Cardiac output
↑ Vasconstriction in abdominal organs and kidneys
Strenuous Exercise

Skeletal Muscle

RELATIVE FLOW THROUGH SPECIFIC ORGANS

<table>
<thead>
<tr>
<th></th>
<th>REST</th>
<th>Strenuous Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>cardiac output</td>
<td>6 liters/min</td>
<td>18 liters/min</td>
</tr>
<tr>
<td>heart rate</td>
<td>70 beats per minute</td>
<td>160 beats per minute</td>
</tr>
<tr>
<td>ejection fraction</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>arterial pressure</td>
<td>120/80 mmHg</td>
<td>150/80 mmHg</td>
</tr>
<tr>
<td>central venous pressure</td>
<td>2 mmHg</td>
<td>2 mmHg</td>
</tr>
</tbody>
</table>

Change in cardiac output/heart rate/stroke volume

- Cardiac output (L/min)
  - Trained
  - Untrained

- Work rate
  - Untrained
  - Trained

- Stroke volume (ml)
  - Trained
  - Untrained

- $O_2$ consumption