VALSALVA MANEUVER

HEMODYNAMICS OF THE VALSALVA MANEUVER

Introduction

- Antonio Maria Valsalva 300 year ago
- Initially to test patency of Eustachian tube
- Cardiovascular effects were described in 1850 by Ernst Heinrich Weber

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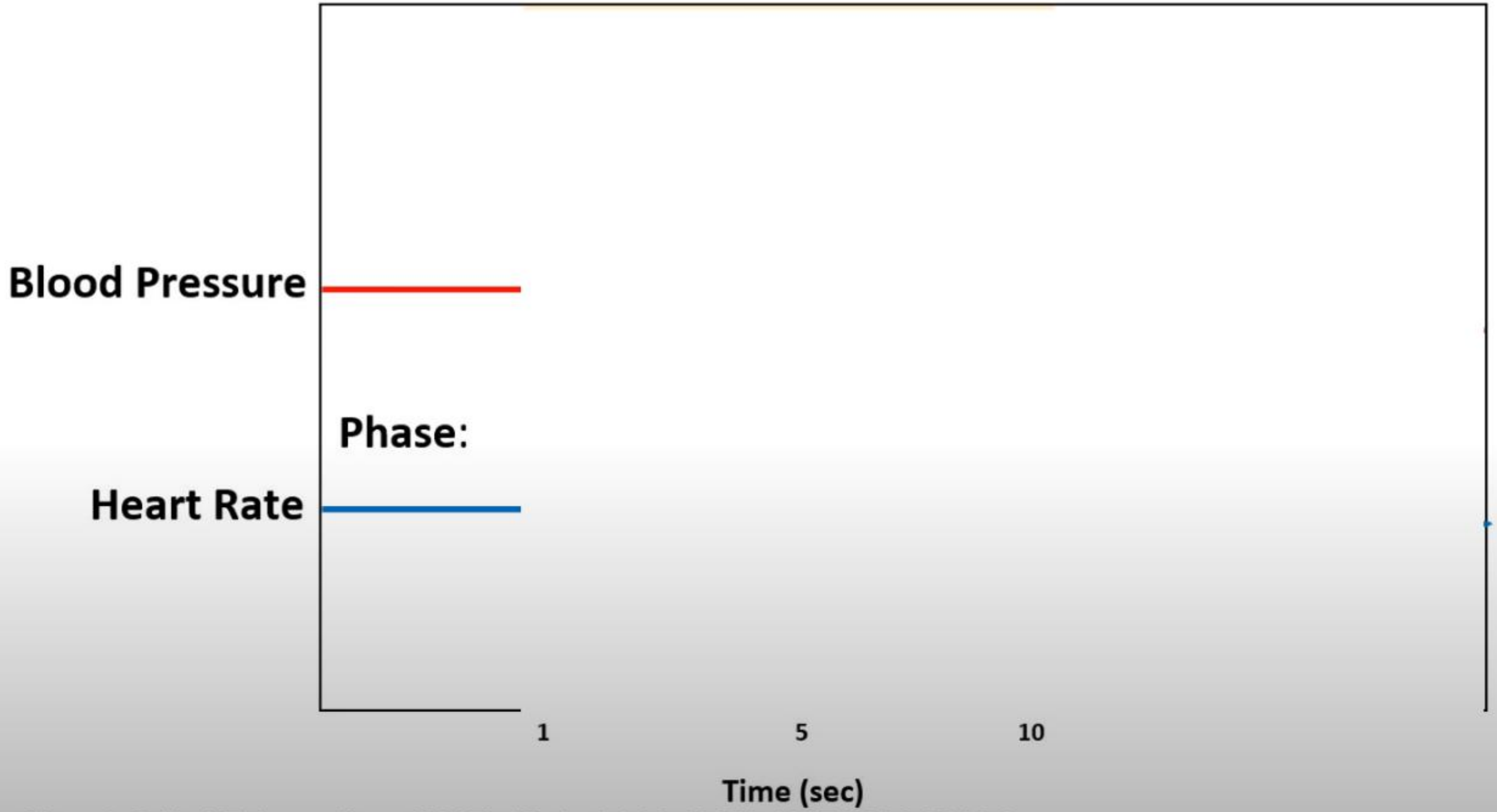
Definition

- Forceful expiration against closed nose and mouth

The Valsalva maneuver is typically performed by blowing through a mouthpiece connected to a mercury manometer for 15 or 20 seconds. The mercury column of the manometer is maintained at 40 mm.



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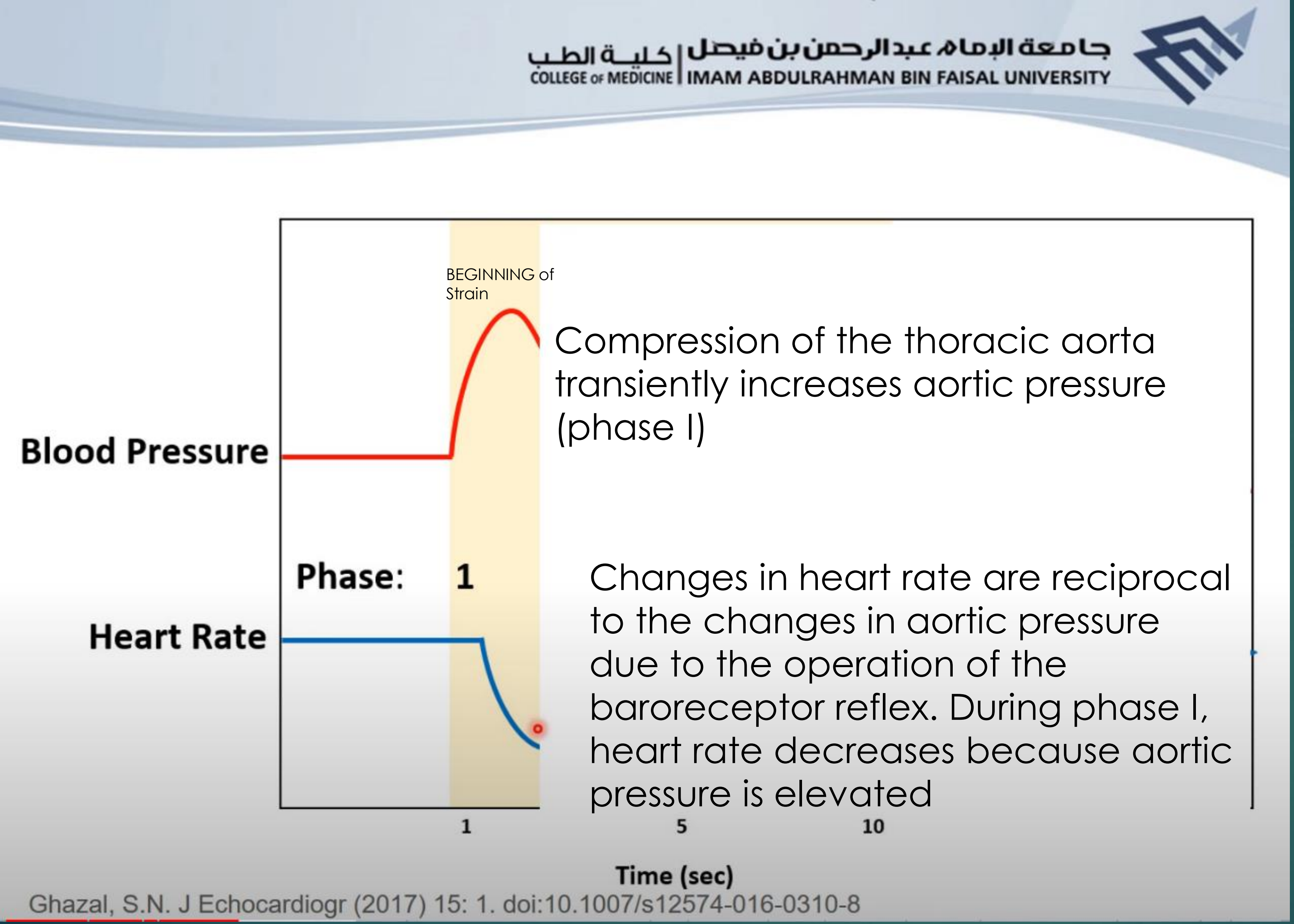
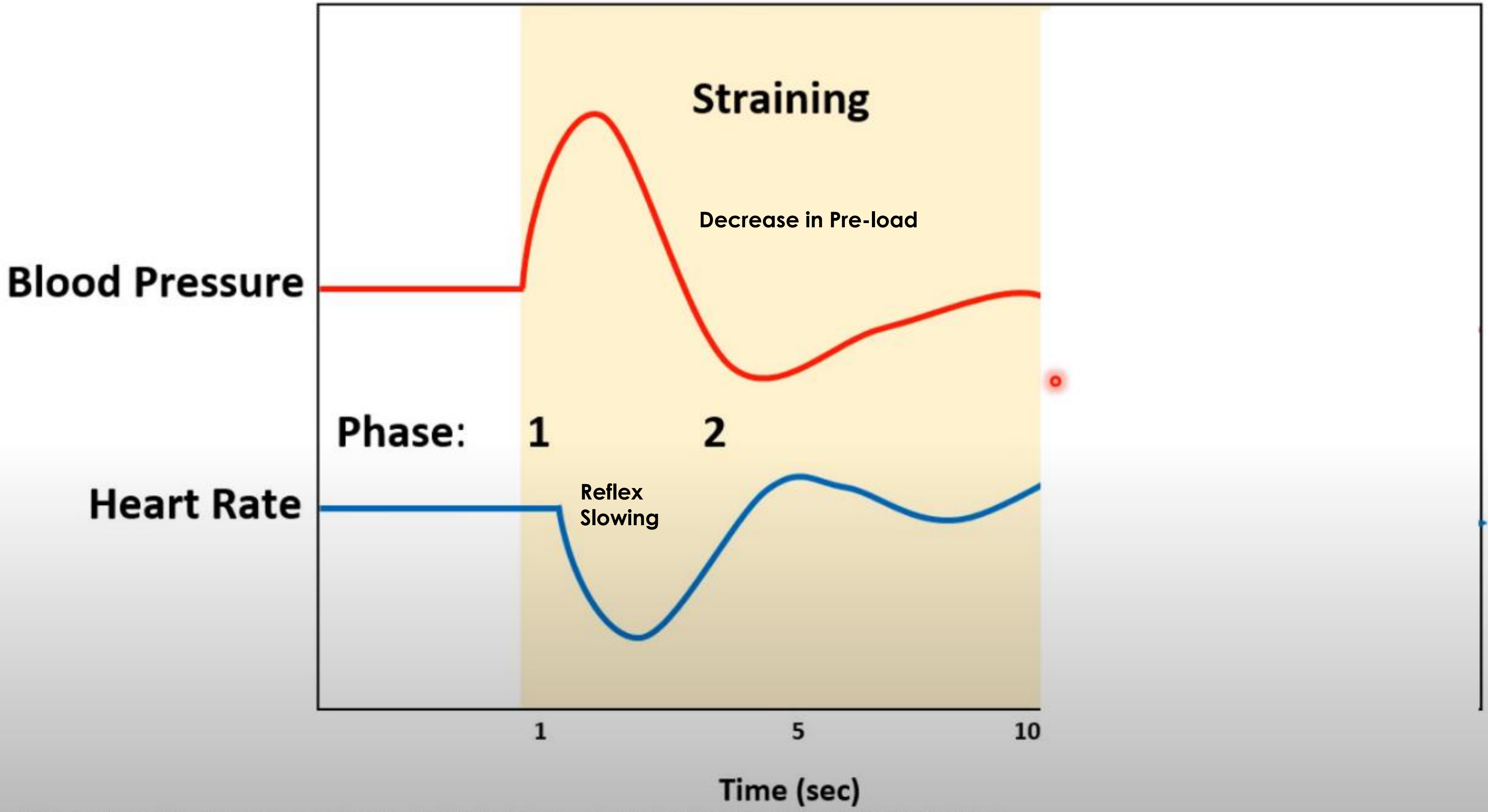


Phase 1 consists of a transient rise in arterial pressure and an associated decrease in heart rate.



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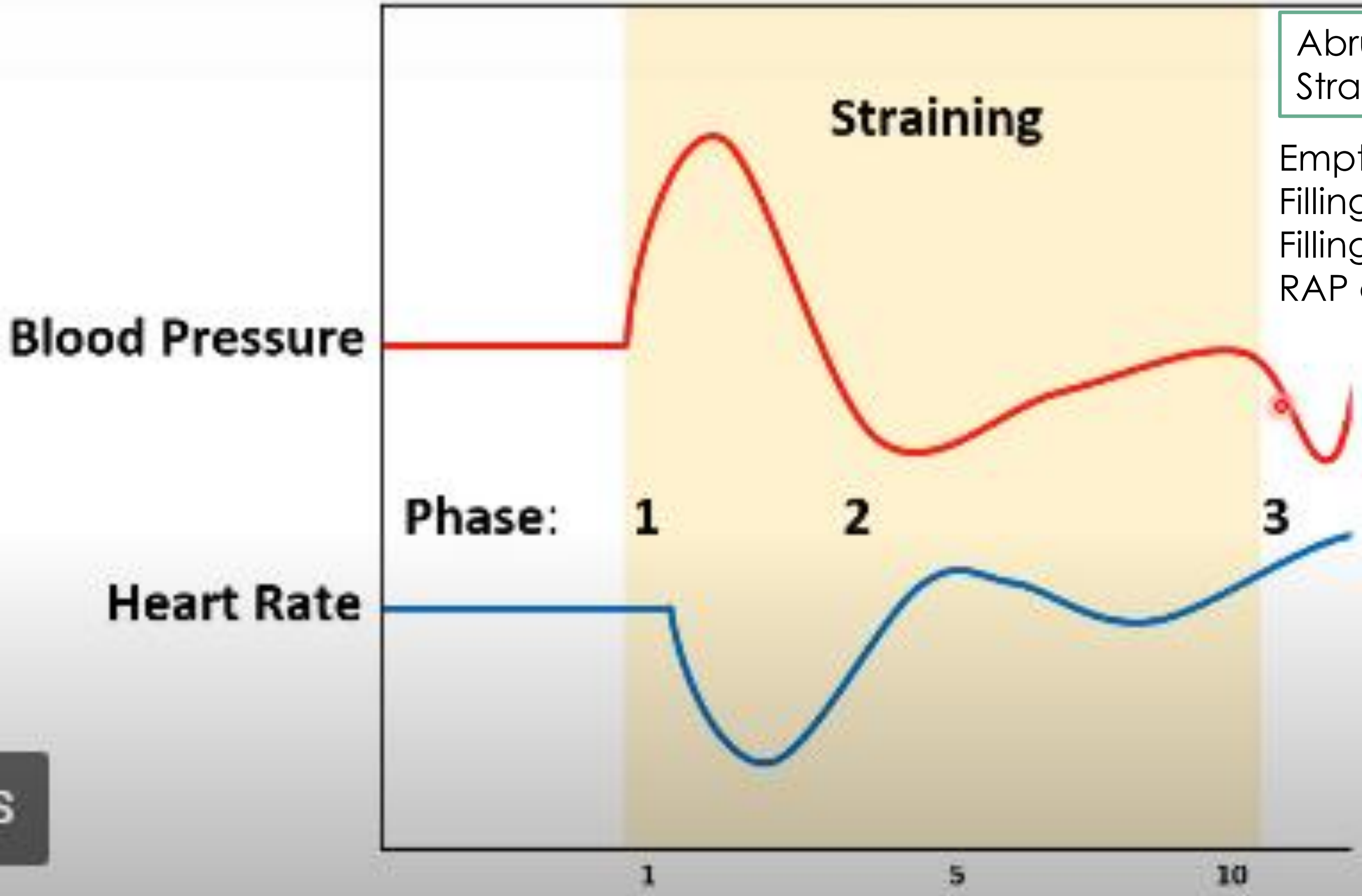
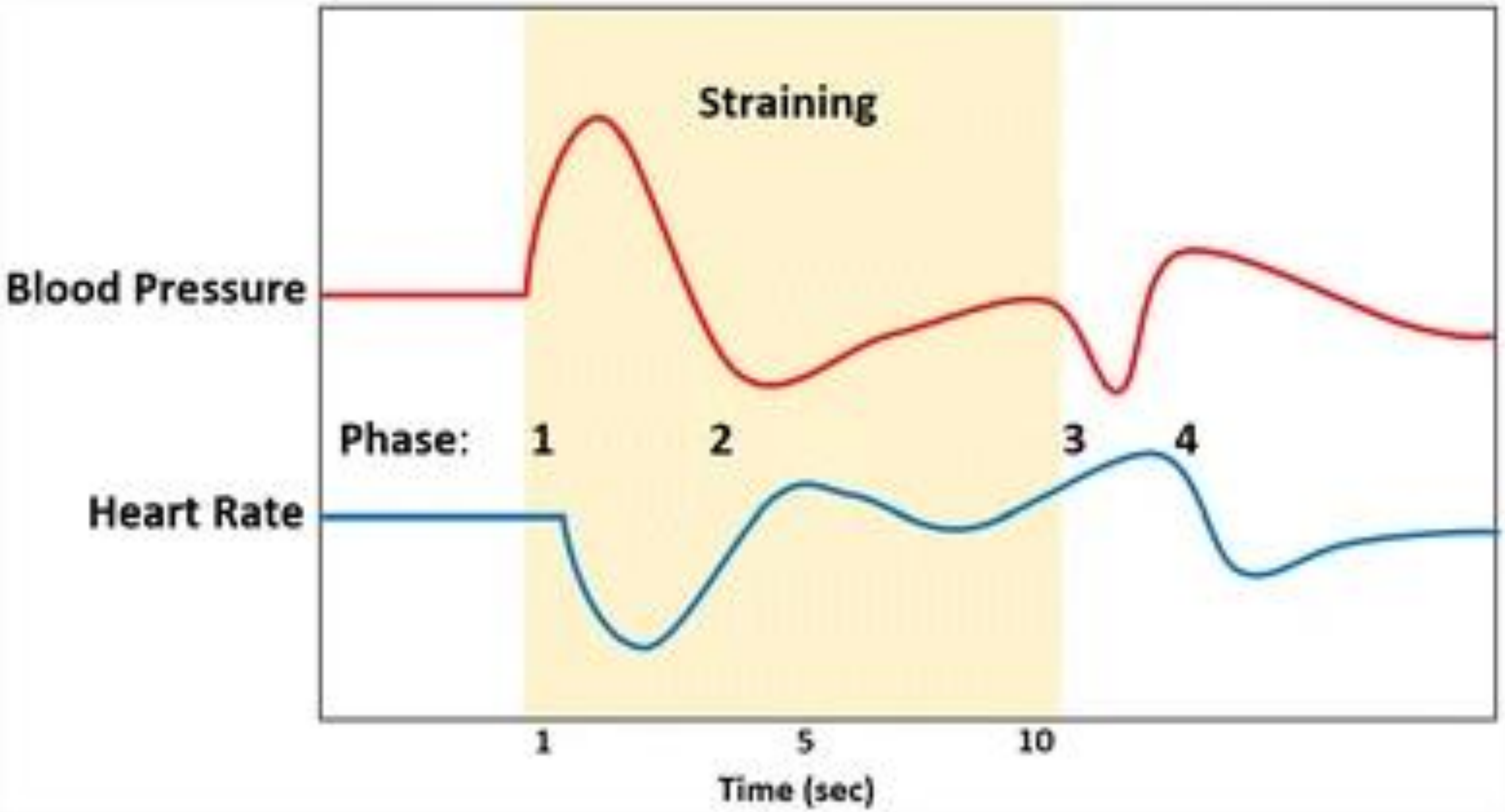
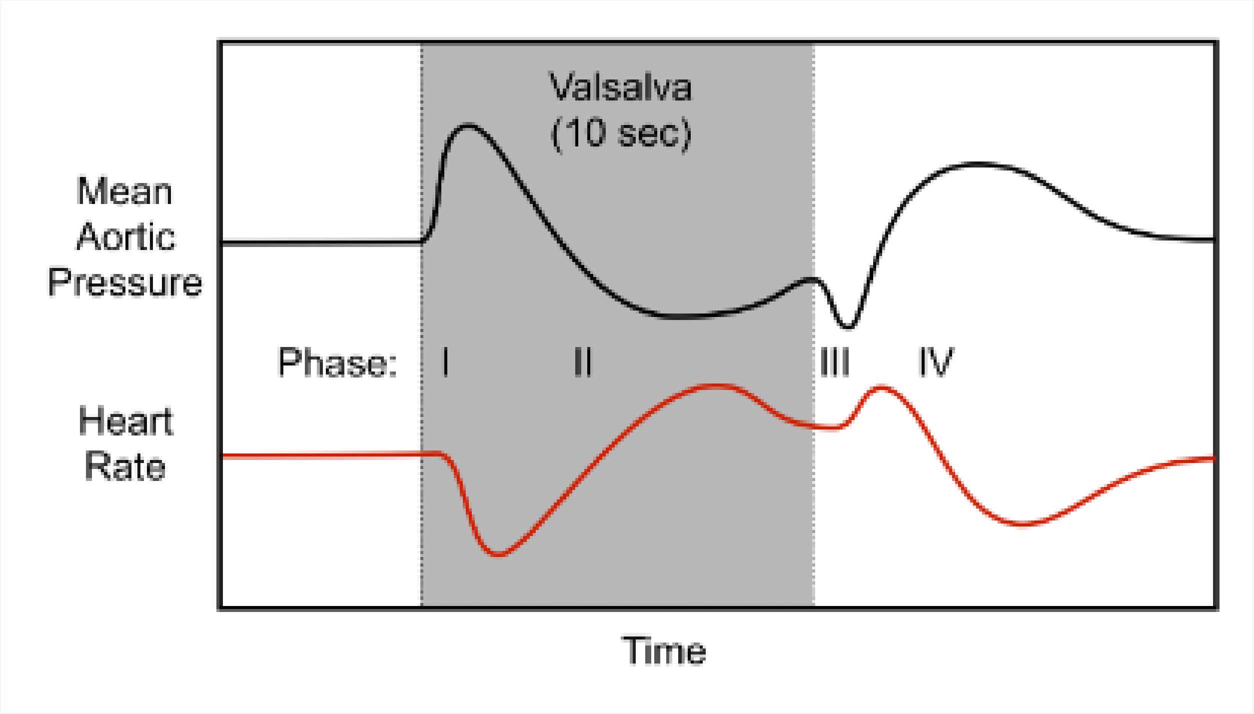


Abrupt Termination of Strain Initiates Phase 3

Emptying of Aorta
Filling of Left Atrium and Rapid Filling of the Rt. Atrium with RAP exceeding LAP


Straining
Blood Pressure
Phase: 1 2 3 4
Heart Rate
1
5
10
Time (sec)



Phase 1 consists of a transient rise in arterial pressure and an associated decrease in heart rate.

In phase 2, the expiratory phase of the maneuver, there is a gradual decrease in blood pressure followed by a recovery. An increase in heart rate accompanies this phase.

Phase 3 consists of a sudden brief decrease in blood pressure with an accompanying increase in heart rate that occurs with the cessation of straining.

In phase 4, there is an increase in blood pressure above the resting value (the "overshoot") that is accompanied by a bradycardia.

Phases 1 and 3 most likely reflect mechanical factors, Phases 2 and 4 are a consequence of sympathetic, vagal, and baroreflex interactions.

The Valsalva ratio (i.e., the ratio between the tachycardia occurring during the maneuver and the postmaneuver bradycardia) provides an index of cardiac vagal function.31

Indications

Indications of Valsalva in Echocardiography	Details	
Rule out right to left atrial shunt	- Rule out cardiac source of embolism - Unexplained right sided cardiac dilatation	Phase 3
Provocation of dynamic LVOT obstruction	- Evidence of flow acceleration in LVOT without significant gradient i.e. dagger shaped spectral Doppler in LVOT or LV mid-cavity - Evidence of HOCM without resting significant LVOT peak gradient (< 30mm Hg)	Phase 2
Estimation of LV filling pressure	- Evidence of impaired LV relaxation and E wave is taller than A wave in mitral inflow spectral Doppler	Phase 2

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Adequate Valsalva

- Clinical signs:
  - Distention of neck veins
  - Flushing of the face
  - Increase abdominal muscle tone

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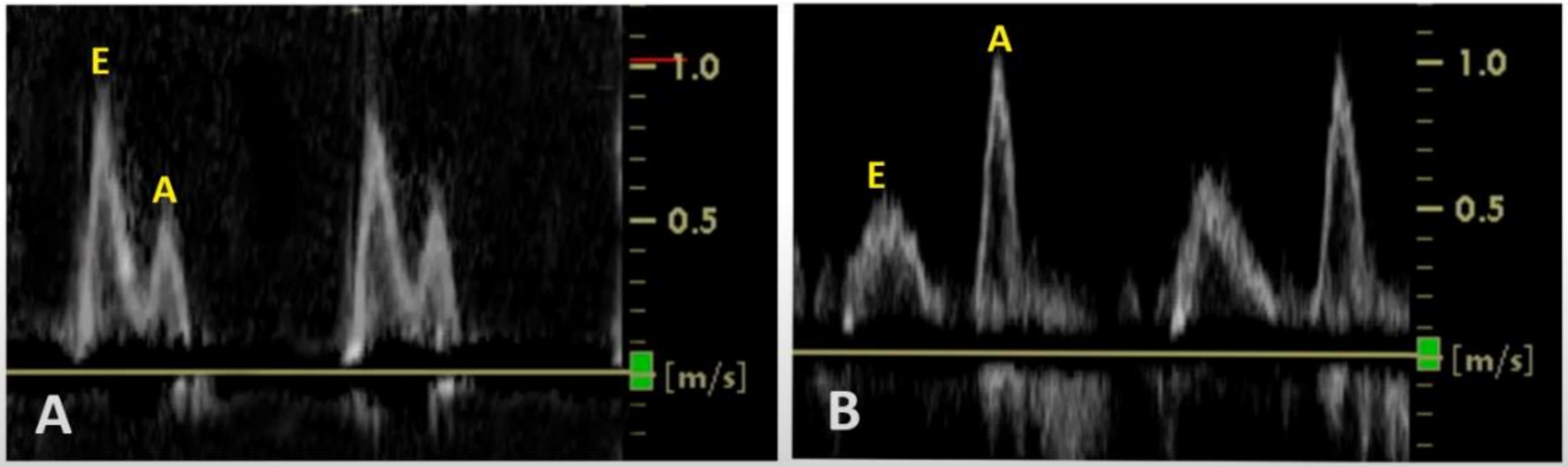
Adequate Valsalva Echocardiographically

Decrease mitral E velocity by 20 cm/s or more (phase 2) *



* Nagueh SF, Appleton CP, Gillebert TC, Marino PN, Oh JK, Smiseth OA, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography. J Am Soc Echocardiogr 2009;22:107-33.

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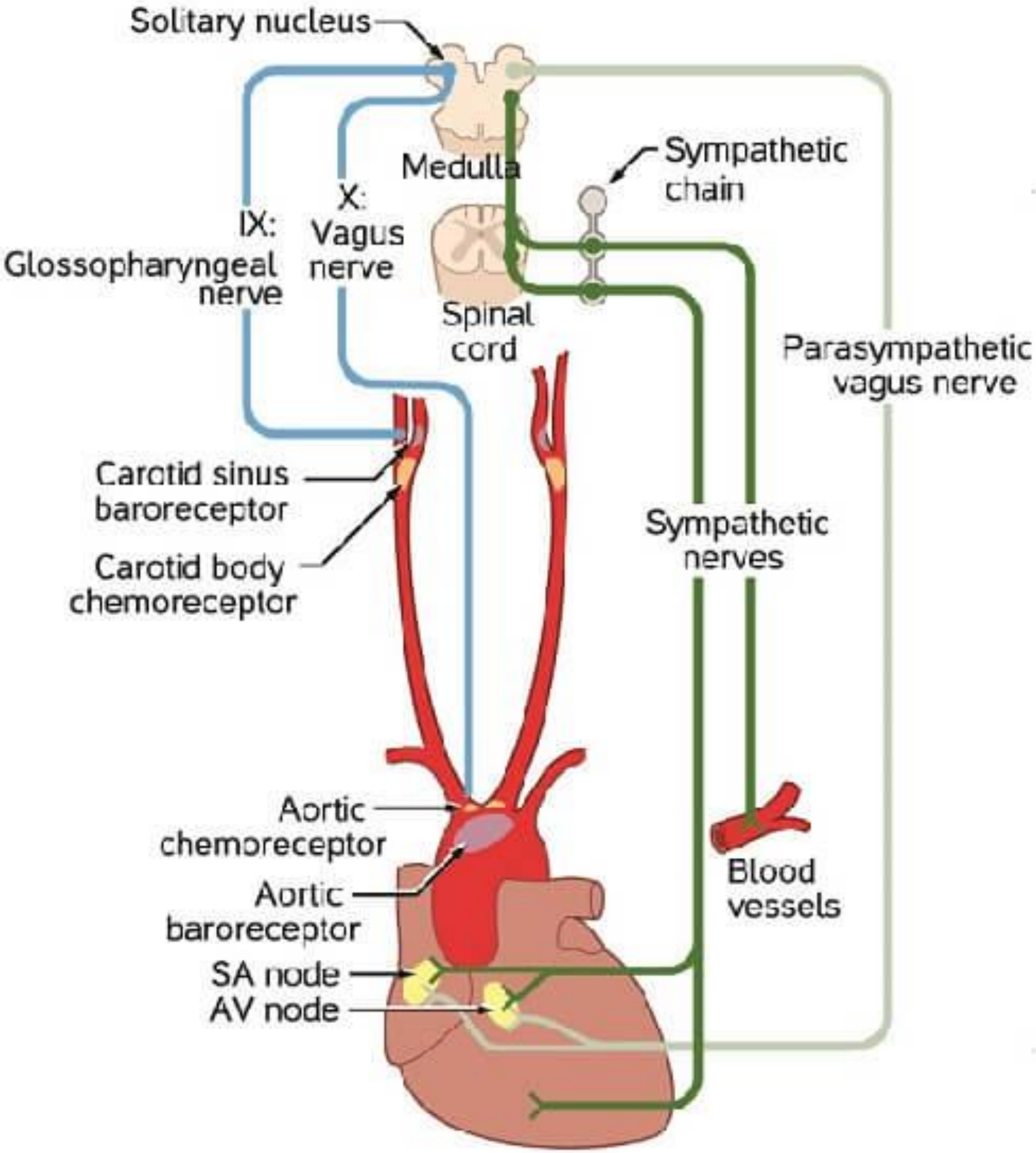
When a person forcefully expires against a closed glottis, changes occur in intrathoracic pressure that dramatically affect venous return, cardiac output, arterial pressure, and heart rate. This forced expiratory effort is called a Valsalva maneuver.

hemodynamics of a Valsalva maneuver

Initially during a Valsalva, intrathoracic (intrapleural) pressure becomes very positive due to compression of the thoracic organs by the contracting rib cage. This increased external pressure on the heart and thoracic blood vessels compresses the vessels and cardiac chambers by decreasing the transmural pressure across their walls. Venous compression, and the accompanying large increase in right atrial pressure, impedes venous return into the thorax. This reduced venous return, and along with compression of the cardiac chambers, reduces cardiac filling and preload despite a large increase in intrachamber pressures. Reduced filling and preload leads to a fall in cardiac output by the Frank-Starling mechanism. At the same time, compression of the thoracic aorta transiently increases aortic pressure (phase I); however, aortic pressure begins to fall (phase II) after a few seconds because cardiac output falls. Changes in heart rate are reciprocal to the changes in aortic pressure due to the operation of the baroreceptor reflex. During phase I, heart rate decreases because aortic pressure is elevated; during phase II, heart rate increases as the aortic pressure falls.

When the person starts to breathe normally again, aortic pressure briefly decreases as the external compression on the aorta is removed, and heart rate briefly increases reflexively (phase III). This is followed by an increase in aortic pressure (and reflex decrease in heart rate) as the cardiac output suddenly increases in response to a rapid increase in cardiac filling (phase IV). Aortic pressure also rises above normal because of a baroreceptor, sympathetic-mediated increase in systemic vascular resistance that occurred during the Valsava.

Similar changes occur whenever a person conducts a force expiration against either a closed glottis or high pulmonary outflow resistance, or when the thoracic and abdominal muscles are strongly contracted. This can occur when a person strains while having a bowel movement. Similar changes can also occur when a person lifts a heavy weight while holding their breath


Solitary nucleus
Medulla
IX:
Glossopharyngeal nerve
X:
Vagus nerve
Sympathetic chain
Spinal cord
Parasympathetic vagus nerve
Carotid sinus baroreceptor
Carotid body chemoreceptor
Sympathetic nerves
Aortic chemoreceptor
Aortic baroreceptor
SA node
AV node
Blood vessels

The Valsalva maneuver is typically performed by blowing through a mouthpiece connected to a mercury manometer for 15 or 20 seconds. The mercury column of the manometer is maintained at 40 mm.

Importance of saline contrast transthoracic echocardiography for evaluating large right-to-left shunt in patent foramen ovale associated with cryptogenic stroke

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Discussion

The major findings of the present study were:

(1) saline contrast TTE showed large RL shunt more frequently than TEE

(2) (2) large RL shunt evaluated by TTE had greater sensitivity and accuracy for the association with CS compared to that evaluated by TEE, and large RL shunt evaluated by TEE had greater specificity compared to that evaluated by TTE. To the best of our knowledge, this is the first study to show the efficacy of TTE for evaluating large RL shunt associated with CS.

Saline Contrast TTE

TTE using a 2.5- to 3.5-MHz probe with harmonic imaging (iE33 with an S5-1 probe; Philips Medical Systems, Best, The Netherlands, and Artida with a PST-25BT probe; Canon Medical Systems, Otawara, Japan) was performed.

TTE images were obtained in an apical four-chamber view or a subcostal four-chamber view. Gain settings were individually adjusted to optimize visualization of the interatrial septum and agitated saline contrast.

Saline contrast was produced by 1 mL air, 1 mL blood, and 8 mL saline, and was agitated between two 10 mL syringes connected with a three-way stopcock. The Valsalva maneuver was performed when the patient inhaled.

TTE with the spontaneous Valsalva maneuver was performed at two times. Agitated saline contrast was injected from an antecubital vein immediately after applying the Valsalva maneuver, and the Valsalva maneuver was released at opacification of the right ventricle.

If the spontaneous Valsalva maneuver was inadequate, the epigastric compression was added during the Valsalva maneuver [14]. TTE images were digitally stored. The maximum number of microbubbles appearing in the left ventricle was counted in a single frame.

The severity of RL shunt was classified into three groups by independent cardiologists who were unaware of the status of the patient. Large RL shunt was defined as > 20 microbubbles, moderate RL shunt was defined as 10–20 microbubbles, and small RL shunt was defined as < 10 microbubbles.