PHYSIOLOGY

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CONTROL OF THE HEART

1. (CNS) Control CNS: Central nervous system

I- (ANS) II- Reflex from cerebral cortex

2. Baroreceptor Control & Atrial Receptors

3. Auto Regulation Control

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1. (CNS) Control:-

I- (ANS) : ANS: Autonomics nervous system

The (CNS) control of the heart involves mainly the (ANS) control of the heart

A... **The Parasympathetic Innervation:** It is through the branches of the vagus N, the right vagus passes to the right atrium & concentrated mainly in the (SA) node, while the left vagus concentrated mainly in the (AV) node.

Accordingly, the predominate effect of stimulation of right vagus is on the heart rate, while that of left vagus is on the atrio- ventricular conduction. The action of parasympathetic N. fiber mediates in the heart by chemical substance called (Acetyl Choline)

B... **The Sympathetic Innervation:** It is distributed nearly to all parts of the heart. The cardiac accelerator sympathetic N. comes from the upper thoracic segments of spinal cord (T_1 _T_5) & makes synaptic connection (relay) in the (3) cervical ganglia & the upper (5) thoracic ganglia of sympathetic trunks (SCG, MCG & ICG) especially (stellate ganglia).

The sympathetic influence on the heart also can be exerted by catechol amine released from the adrenal medulla into the blood. The action of sympathetic N. fiber mediates in the heart by chemical substance

In the medulla & pons, there are two cardiac centers present within the (VMC) These cardiac centers are the "Cardio-Inhibitory Center "& the "Cardio-Acceleratory Center "These centers control the activity of the heart by the way of the above mentioned sympathetic N fiber & parasympathetic N. fiber (vagus N.). The effect of these centers on the heart are on the following:

a.. Heart rate (chronotropic action)

b.. Contractile force or force of contraction inotropic action

c.. Velocity of atrio-ventricular conduction (dromotropic action)

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a.. Chronotropy (change in heart rate):-

The increase of vagal activity as stimulation of right vagus or direct application of acetyl choline to the (SA) node causes a decrease in the heart rate (HR) {negative Chronotropy} stimulation or direct application of nor adrenaline on the heart wall causes an increase in the heart rate (HR) {positive Chronotropy} The increase of sympathetic activity as sympathetic When the vagus & the sympathetic Ns. Are stimulated at the same time, the vagus action usually predominate.

b.. Inotropy (change in strength of myocardial contraction) :-

Vagal stimulation decreases the strength of contraction of atrial myocardium then followed by a decrease in ventricular myo- cardium, this is called { negative inotropic action }

SCG: superior Cervical ganglia

MCG: Middle Cervical ganglia

ICG: Inferior Cervical ganglia

The increase of sympathetic activity will increase the strength of contraction in both atrial & ventricular myocardium, this s called {positive inotropic action}

c.. Dromotrophy (influence of atrio-ventricular conduction):-

The effect of autonomic N. on the conduction of cardiac impulse on the walls of excitation mostly on (AV node conduction, & thus shortening the interval between atrial & ventricular conduction contraction, this is called {positive dromotropic action}

The vagal stimulation, especially on the left side, decreases (AV) conduction & in the extreme case can produce transient complete (AV) block, this is called {negative dromotropic action}

II- Reflex from cerebral cortex- Mention later as High center control.

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2. **<u>Baroreceptor Control & Atrial Receptors:-</u>**

1- Baroreceptor control:-

Baroreceptor control in aortic arch & carotid sinus. The baro-receptor (or.. baroceptor.. or.. pressure receptor..or.. mechanoreceptor) are present in the adventitia of aortic arch & the carotid sinuses which are located in the internal carotid A.

Impulses are transmitted from the arch of aorta by depressor N. called " aortic N. "which is a branch of vagus N to the medullary center. From the carotid sinus, the impulse pass in sinus N " hering N. " which is a branch of glossopharyngeal N. which passes to the medullary centers.

◇Mechanism of Baroreceptors (Marey's reflex):-

Normally, baroreceptor send inhibitory impulses to the (VMC) in medulla in order to keep normal (HR) & normal (BP).

When (BP)increased, its receptors is mechanically stimulated by a stretching of the wall of the blood vessel (BV) that contains these receptors, resulting in an increase in the activity of the baroreceptor (i.e.) increase the inhibitory impulses to the medullary center (VMC), resulting in a decrease in (HR) & (BP) by the following effects:

1\ stimulation of (CIC) 2\ inhibition of (CAC)

Therefore; (HR) & the force of contraction of the heart will decrease, so (Co) & (BP) also will be decreased.

II -Atrial Receptors:-

These receptors are present in the right atrium in the wall of the large veins that enter the right atrium (SVC & IVC). The pressure impulses pass to the medullary center by a branch of vagus N called " presser N."

◇Mechanism of Atrial Receptors (Bain Bridge reflex) :-

Whereas, an increase in the pressure at the arterial side of the heart, causes cardiac slowing (Marey's reflex),,, an increase in the pressure of the venous side of the heart causes the reflex cardiac acceleration (Bain Bridge reflex) i.e. the venous return to right atrium will increase. So, the pressure in the right atrium & in the big veins that open into it increases. This will stimulate

mechanical receptors present in their walls which send pressure impulses to the medullary centers through the vagus N. fibers. Then, pressure impulses inhibit the (CIC) & stimulate the (CAC), thus the (HR) & the force of contraction will be increased.

The importance of (Bain Bridge reflex) is that when venous e reflex will return to the heart increases - as in muscles exercise - so the reflex will increase in the (HR) to improve (CO) by preventing the occurrence of periods of " Diastasis".

3. **Auto Regulation Control**:-

The blood from all parts of the body comes to the right atrium via sup. & inf. vena cavae by what is called " Venous Return ", which is later pumped by the heart to the systemic circulation. Thus, the heart must adapt itself from moment to moment to widely varying input of the blood to the heart. Sometimes, it is falling to (2- 3 L/min.) & other times it is raising to (25 or more L/min.)

This intrinsic ability of the heart to adapt itself to such large changing loads of inflowing blood called Frank Starling Law of the heart.

◇Frank Starling Law of the Heart :-

It states that ((the greater the heart is filled during diastole the greater will be the quantity of blood pumped into the aorta)).

Or (the force of contraction of ventricles depend on the initial length of ventricular M. fiber)).

Or ((the strength of the cardiac contraction of ventricles depend on the Or the strength of the cardiac contraction is directly proportional to the initial length of its fiber "diastolic volume " since the fibers are not excessively stretched above their elastic limit i.e. the heart can pump either small or large

amount of blood that reach to it, so that the heart adapt itself for this function when the amount of blood within the physiological limit i.e. if the venous return increases, the ventricles will fill more during diastole, the subsequent systole becomes stronger & pumps the greater quantity of blood that has reached the heart. While if the venous return decreases, the diastolic volume will decrease & the contraction will become weaker so that no more expenditure of cardiac energy will be spent.))

◇Mechanisms of Frank Starling Law:-

When the cardiac M. becomes stretched by an extra amount of blood that enters the heart, the stretched M. contracts with greatly increased force & automatically pumping the extra blood in the arteries within physiological limit.

The ability of the heart to contract with increased force on its stretched chambers is sometime called " Heterometric Auto Regulation" of the heart. Other two less important causes in addition to the above cause are A .. stretch of right atrium wall will increase (HR) by (10 % - 30 %) which can increase the amount of the blood that pumped each minute. B.. changes in heart metabolism that occur when the heart is stretched cause an addition increase in contractile strength, this is called "Homeo-metric Auto Regulation "

<u>High Center Control:</u>

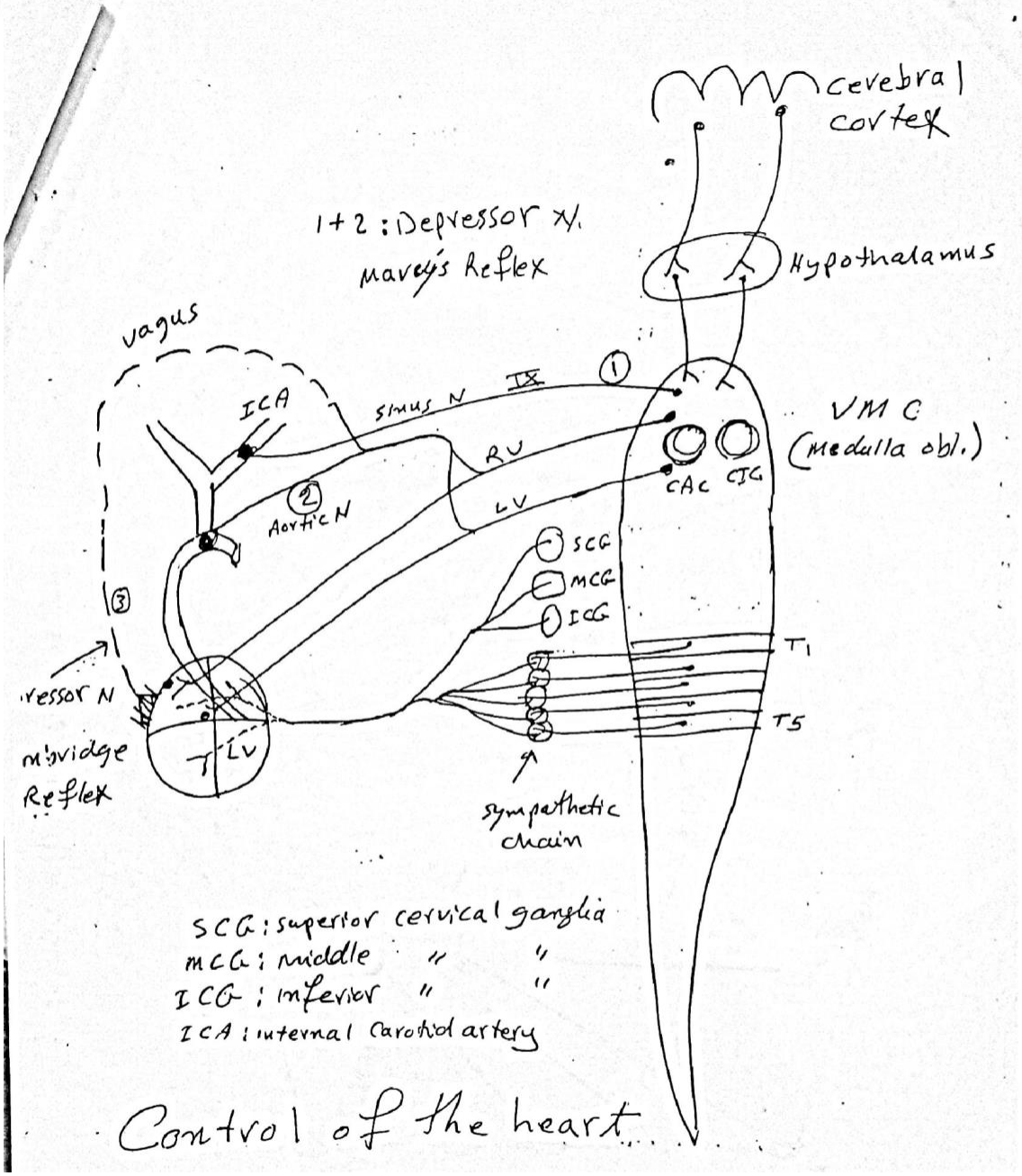
●Reflex from cerebral cortex & hypothalamus (control of the heart by the high center) is concerning with emotional stress & anxiety by affecting the psychic center in the cerebral cortex.

Impulses that pass to the hypothalamus & to the cardio-acceleratory center (CAG) cause an increase in (HR) &

occasionally some emotional reflex. They affect cardio-inhibitory center (CIC) & cause a decrease in (HR).

❖ NOTES :-

CIC = cardio-inhibitory center
CAC = cardio-acceleratory center
SVC = sup. vena cava
IVC = inf. vena cava
SCG = sup. cervical ganglia
MCG = middle cervical ganglia
ICG = inf. cervical ganglia
VMC = vasomotor center
HR = heart rate
BP = blood pressure
CO = cardiac output



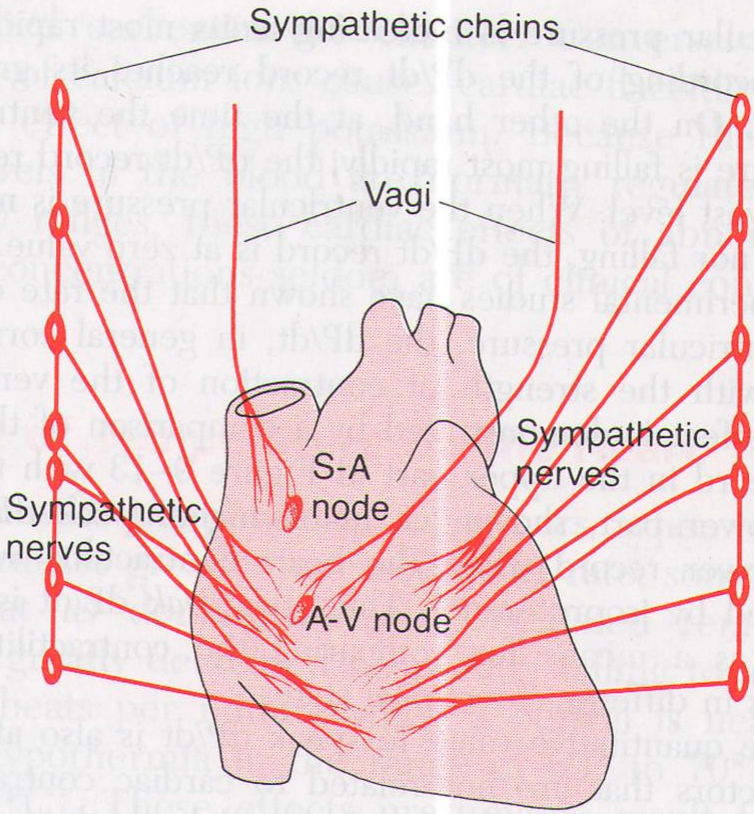


Figure 9–11. Cardiac nerves.

by:Hassan falah

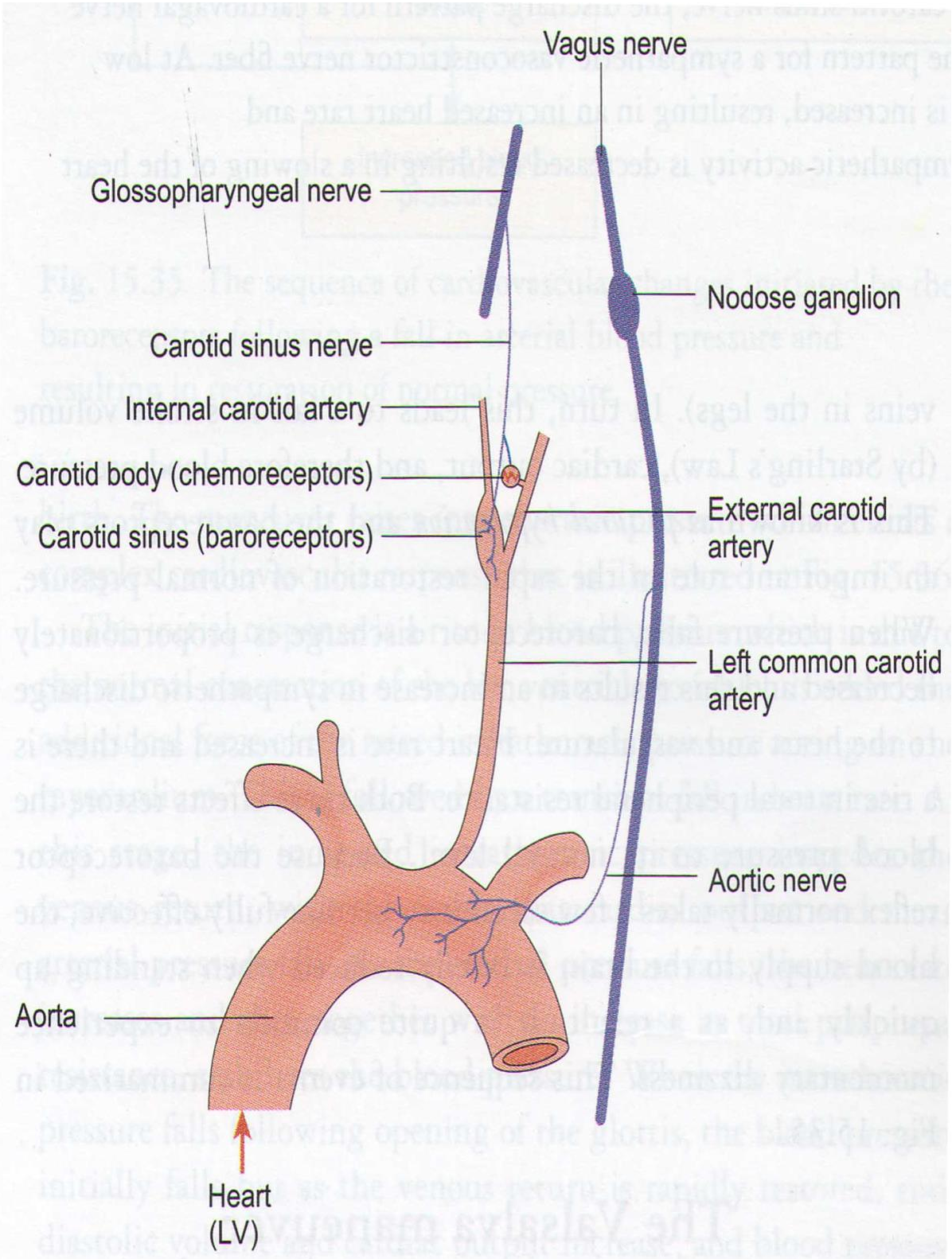


Fig. 15.33 A highly simplified diagram illustrating the position and nerve supply of the aortic and carotid baroreceptors.