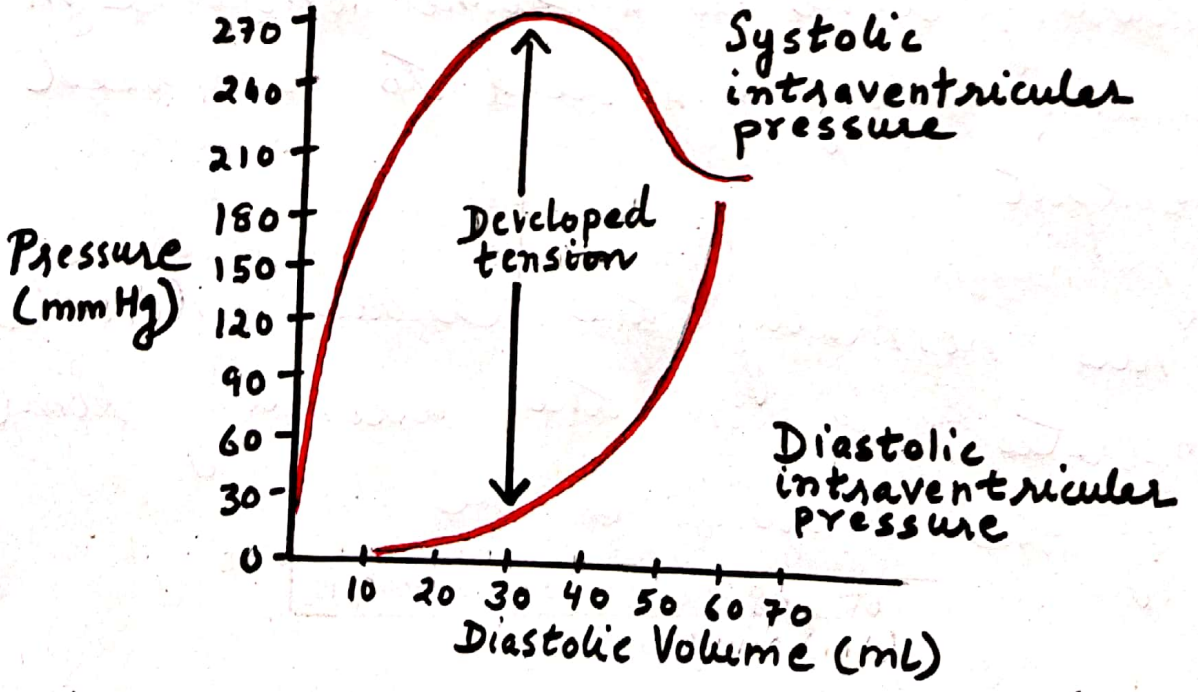
Frank-Starling Law of the Heart

→ In the cardiac muscle fibre the relation between the initial fiber length and total tension is such that there is a resting length at which the tension developed upon stimulation is maximal.

→ The initial length of the cardiac muscle fibre is determined by the degree of diastolic filling of the heart, and the pressure developed in the ventricle is propotionate to the total tension developed (Starling's law of the heart)



LENGTH-TENSION RELATION OF CARDIAC MUSCLE

→ The tension increases as the diastolic volume increases untill it reaches maximum (ascending limb of Starling Curve) and tends to decrease (descending limb of Starling curve)

→ The descending limb of the curve is due to the beginning of the disruption of the myocardial fibers.

→ Normal hearts most probably never dilate to the point that they are on the "descending limb" of the Frank-Starling Curve as a further increase in cardiac filling will lead to decreased output.

→ Thus normally the cardiac muscle operates only on the ascending limb of the Systolic Curve.

→ The heart automatically adjusts its output to match the end diastolic volume (EDV) according to the "Starling's Law of the heart."

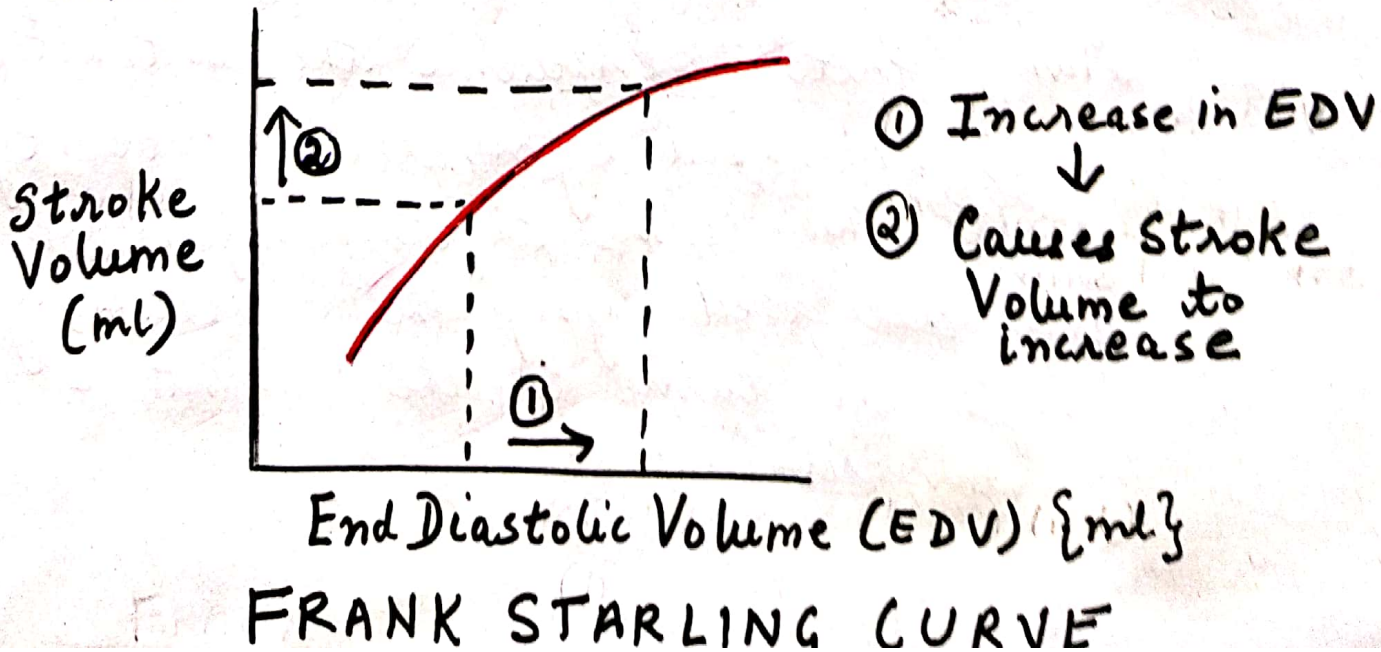
→ As the EDV increases, the force of ventricular contraction increases

→ The stretching of the cardiac muscle fibers leads to an increase in the force of the contraction via two mechanisms

(i) As length of fiber increases it comes closer to its optimal length of contraction

(ii) Stretching of fiber increases affinity of troponin for calcium.

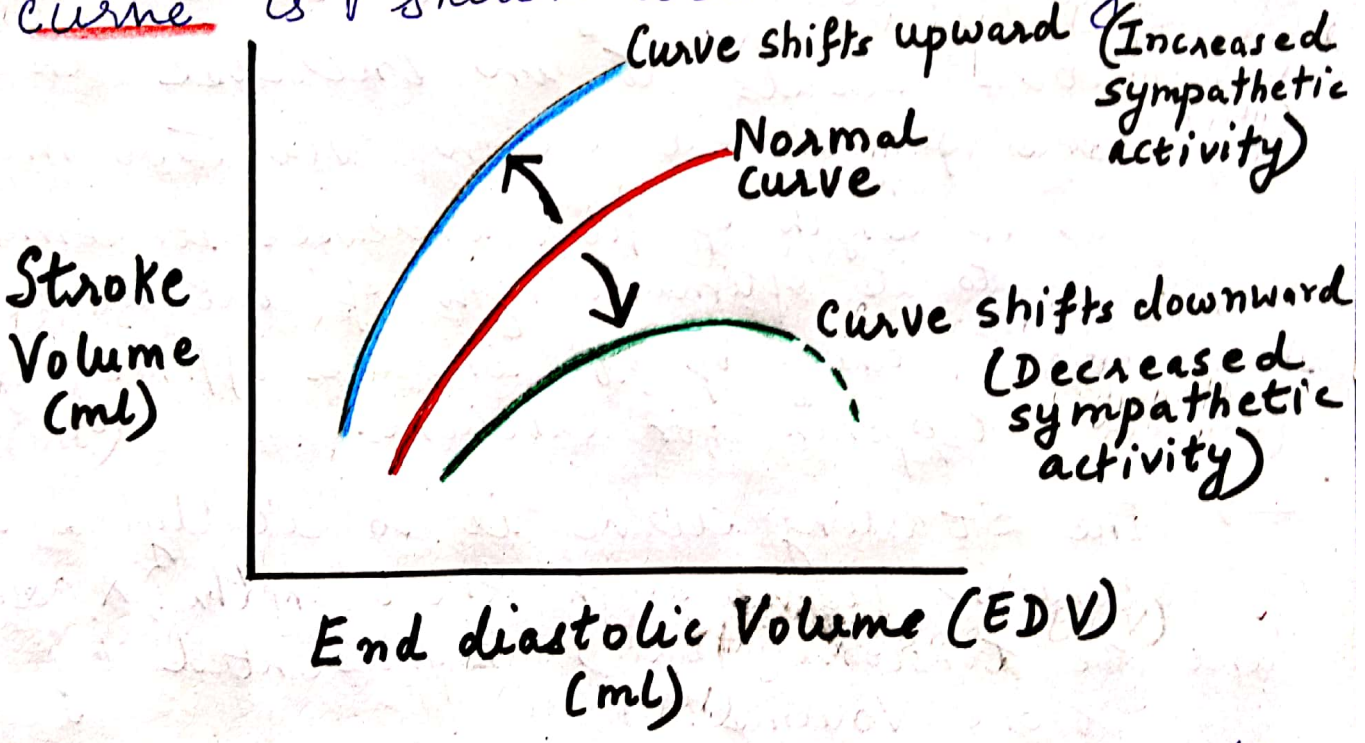
→ The Starling curve is basically a length-tension curve with the length (x axis) represented by EDV and the tension (Y axis) represented by the Stroke Volume.



FRANK STARLING CURVE

→ In a healthy heart the cardiac muscle is always at lengths less than the optimum and thus the slope of curve is always positive

→ Effects of changes in myocardial contractility on the Frank-Starling curve is shown below in the Figure.



Many factors influence the contractility for eg increased sympathetic activity shifts the curve to the left & upward and decreased sympathetic activity shifts the curve to the right & downward.

→ Clinical Significance of the Frank-Starling mechanism

(i) It plays a role in compensation of systolic heart failure by buffering the fall in cardiac output to help maintain the blood pressure sufficiently to perfuse vital organs.

(ii) It plays a role in patients with dilated cardiomyopathy.

(iii) Its physiological significance is appreciated as the relation between length and tension is very important for normal cardiac function. If there is an increased venous return then there is a corresponding increase in end diastolic volume (EDV) which results in greater stroke volume in next beat. Thus the ventricles can accomodate an increased venous return by means of a more vigourous contraction that ejects greater volume of blood from the heart

(iv) The functional importance of the Frank-Starling mechanism lies mainly in adapting left to right ventricular output. The dependence of individual stroke volume on end diastolic volume (EDV) can be described using Frank-Starling Curve.

(v) Thus, the Frank-Starling mechanism allows the cardiac output to be synchronized with venous return, arterial blood supply and humoral length without any dependence on external factors to make alterations.

References

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