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Connecting The Vascular Community

Factors Impacting Venous Return

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Nothing To Disclose

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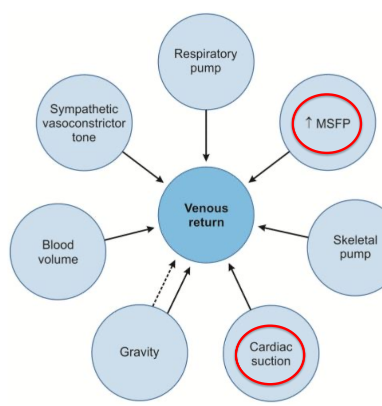
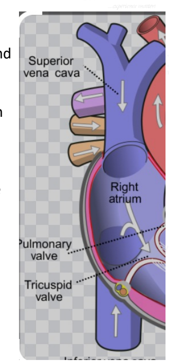


MSFP

The right heart is filled by the large compliant venules and small veins - **mean systemic filling pressure (MSFP)**

At low transmural pressures, the veins can be elliptical in shape- only the volume beyond this resting length produces tension in elastic walls of vascular structures.

When the pressure inside the great veins is less than the pressure outside their walls because the floppy walls of veins collapse and produce what is called a vascular waterfall or a flow limitation.



The volume that stretches the walls is called stressed volume and the rest is called unstressed volume.... only the stressed component determines flow.

It creates an elastic recoil pressure that is an important factor in the generation of blood flow.

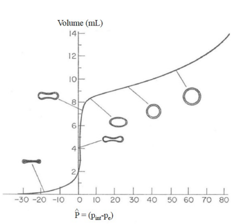
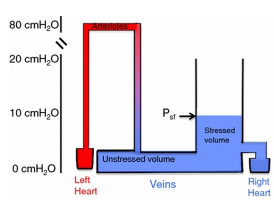


Figure 1.1.—The static pressure volume relationship (Katz, 1969).



MSFP- mean systemic filling pressure

When venous return is limited:

1. cardiac output can only be increased by increasing MSFP by a volume infusion
2. by recruiting unstressed into stressed volume without a change in total volume
3. or by decreasing the resistance to venous return

Stressed volume is relatively constant under steady state conditions. It is usually about 30 % of total volume.

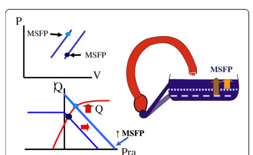


Fig. 6 Change in cardiac output and venous return with an increase in capacitance. An increase in capacitance is the same as lowering the opening on the side of a tub for it allows more volume to flow out, which is the equivalent of more volume being stressed. Graphically it results in a leftward shift of the volume–pressure relationship of the vasculature (*upper left*). This shifts the venous return curve to the right and increases cardiac output through the Starling mechanism (*lower left*). This effect is identical to giving volume to expand stressed volume. *Pra* right atrial pressure

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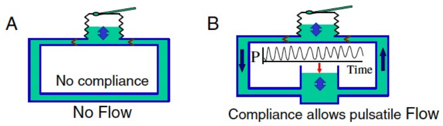
Compliance requirement



Non-compliant closed system-
flow is not possible because pressing on the bellows instantly raises the pressure everywhere and there is no pressure gradient for flow.

The compliance of the vessel is not considered in Poiseuille's equation because it assumes a rigid tube.

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Boundary Conditions

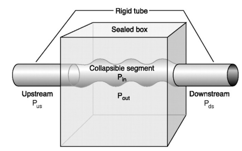

Figure 5. Schematic of collapsibility of a vessel under certain loading conditions.

When the transmural pressure is negative (i.e., the vein collapses), the pressure gradient ($P_i - P_o$, inlet and outlet pressures, respectively) no longer dictates the flow as given by Poiseuille's equation; rather, the flow is dictated by transmural pressure where vessel collapse can occur (zero flow).

G Kassab, PhD

Volume recovers before pressure (legs)

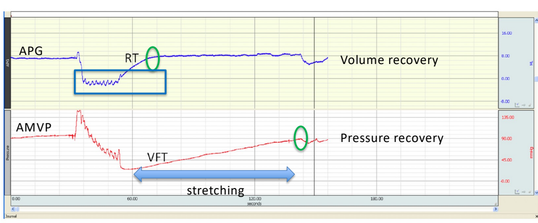

Fig 2. Simultaneous calf volume (air plethysmography [APG], *blue*) and pressure (ambulatory venous pressure [AMVP], *red*) recordings with calf exercise. The calf volume recovers rapidly in a fraction of the time (recovery time [*RT*]) compared with the time for pressure recovery (venous filling time [*VFT*]). The difference is due to stretching of the venous wall required to recover the high resting pressures. The ratio between RT and VFT could be used as an index of calf pump elastance in the stretching mode. Note that calf volume recovery is complete when the ambulatory pressure gradient is the highest. Significant reflux is not possible after calf volume recovery is complete.

Raju, JVSVL 2015

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THANK YOU!