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## Effect of Venous Pressure on Volume Pulsation.

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In a previous study it was noted that, with ligation of the main venous outlet from the lower extremity of the dog, a marked reduction in peripheral pulse volume occurred.<sup>1</sup> The present observations were made to throw some light on the mechanism of these changes.

In 14 dogs the volume of pulsations in the hind foot was determined by adapting a specially constructed cellulose-acetate cup to the sensitive plethysmograph of Turner.<sup>2</sup> All observations were conducted under ether anesthesia and the operative procedure, consisting of isolation and ligation with silk of the femoral vein at the level of Poupart's ligament, was performed aseptically. Direct venous pressure determinations<sup>3</sup> were made in the saphenous vein at heart level before and after the ligation during the continuous determination of pulse volume. All observations were conducted under controlled atmospheric conditions, temperature 75°F and humidity 50%.

Observations were made on 2 groups of dogs: (1) 6 animals with intact sympathetic innervation, and (2) 8 animals on which resection of the ipsilateral lumbar sympathetic ganglia and intervening chain had been performed 24 hours previously.

*Results.* The results are graphically represented in Fig. 1. It may be observed that the rises in venous pressure in the femoral vein following ligation were 13.9 and 10.5 times the normal value in the non-sympathectomized and sympathectomized animals, respectively. The decreases in volume of pulsations following the ligations were 51.5% and 58.2%, respectively. The results obtained in each dog were essentially the same as the mean values, except in degree. It may also be observed that although the reactions in the sympathectomized and non-sympathectomized animals were essentially the same, the pulse volumes both before and after ligation were slightly lower in the sympathectomized than in the non-sympathectomized dogs,

<sup>1</sup> DeBakey, M., Burch, G., and Ochsner, A., *Proc. Soc. Exp. Biol. and Med.*, 1939, **41**, 585.

<sup>2</sup> Turner, R. H., *J. Clin. Invest.*, 1937, **16**, 777.

<sup>3</sup> Burch, G. E., and Sodeman, W. A., *J. Clin. Invest.*, 1939, **18**, 31.

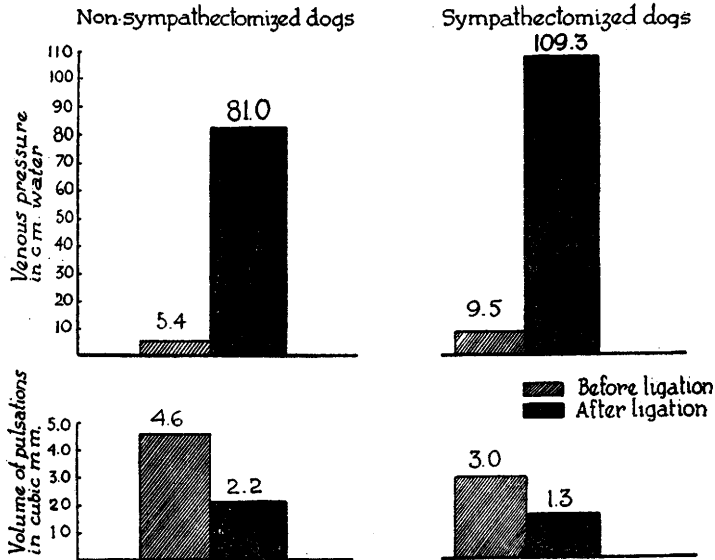


FIG. 1.

Graph of mean values of venous pressure and volume of pulsations in non-sympathectomized and sympathectomized dogs before and after ligation.

and that the corresponding venous pressures were slightly higher in the former.

There are at least 3 possible explanations for the reduction in volume of pulsations following venous ligation: (1) vasoconstrictor reflexes, (2) contraction of smooth muscle, for as demonstrated by Bayliss<sup>4</sup> smooth muscle of vessels, as elsewhere, reacts to a stretching force by contraction, and (3) the reduction in the elastic properties of the vessel produced by mechanical distension. The importance of the factor of vasoconstrictor reflexes transmitted by sympathetic pathways may be excluded by the data already given. Although vasoconstrictor reflexes by way of the sympathetics may have some slight influence, they cannot be considered the significant factor because the reactions in sympathectomized and non-sympathectomized dogs are qualitatively the same.

In an attempt to evaluate the remaining two factors the following experiment was performed. Sections of the dog's femoral artery 5.0 cm in length were removed from hind legs which had been refrigerated at approximately 0°C for 8 days. These were placed in a specially constructed plethysmographic cup and arranged as diagrammed in Fig. 2. The system was filled with normal saline, as indicated in Fig. 2, and a constant pressure of 108 cm of water maintained in the supply bottle. A mechanical interrupter was

<sup>4</sup> Bayliss, W. M., *J. Physiol.*, 1902, **28**, 220.

placed on the rubber tubing between the supply bottle and the vessel to produce a pulsatile flow at a rate of approximately 70/min. Both the collecting bottle and the supply bottle were simultaneously elevated from 0 to 70 cm in 10 cm increments. Thus, pulse pressure was maintained at a constant level throughout the entire procedure, but the initial and final tensions on the artery with each increment were increased. The results are shown in the curve of Fig. 3, which represents the mean values for the 6 arteries. The values for each vessel gave a curve similar to the composite curve for the 6 vessels. It may be observed from the curve that, as the tension within the vessel was increased (the pulse pressure remaining constant), the pulse volume decreased, the magnitude of the change diminishing with the higher tensions.

Whereas in the live animal vasoconstrictor influence as a result of increased intravascular tension may be operative<sup>4, 5</sup> and may be a contributing factor in the response to increased venous pressure, it is not essential to the phenomenon, as demonstrated by the persistence of the reaction following refrigeration. By means of refrigeration for a period of 8 days the smooth muscle in these vessels may be considered no longer reactive.

The third possible explanation for the reduction in pulse volume, the reduction in the elastic properties of the vessel produced by mechanical distension, is strongly supported by the results represented in Fig. 3. The curve is, in essence, one of vessel elasticity in which nervous and myogenic influences have been excluded. The

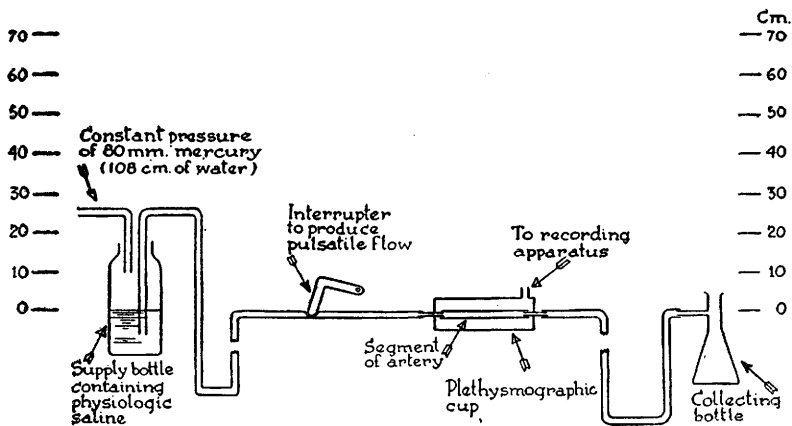


FIG. 2.

Diagram of experimental procedure used in study of isolated refrigerated vessels.

<sup>5</sup> Sodeman, W. A., Burch, G. E., and Turner, R. H., *PROC. SOC. EXP. BIOL. AND MED.*, 1937, **36**, 259.

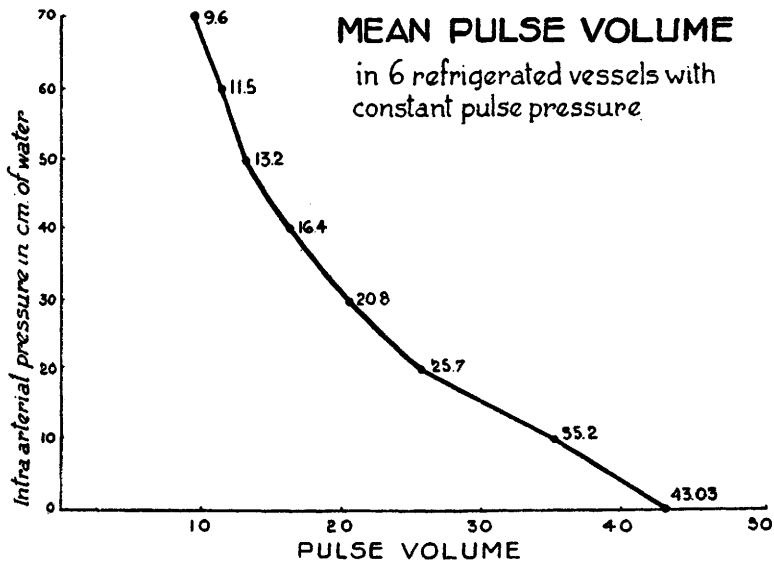


FIG. 3.  
Graph of mean pulse volume in 6 refrigerated vessels.

curve is similar to those obtained by Roy<sup>6</sup> on the elastic properties of the arterial wall by a somewhat different technic, and further confirms this explanation.

Although the results of the experiment on the refrigerated vessels cannot be used as direct proof for the possible explanation that the diminution in volume of pulsations, as obtained in the first experiment (Fig. 1) is due to a reduction in the elastic properties of the vessels produced by distension, the fact that such a reaction does occur in other portions of the vascular tree is significant. It suggests that a similar reaction may occur in the more peripheral vessels.

<sup>6</sup> Roy, C. S., *J. Physiol.*, 1880-82, **3**, 125.