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Quantitation of Changes of Vasomotor Tone.* Change of Vasomotor Tone as Cause of Traube Hering Waves.

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This paper presents a technic for expressing quantitatively changes in vasomotor tone which has been applied successfully in a number of experiments. The description will, however, be limited to a single typical experiment in which the vasomotor tone was oscillating spontaneously (Traube Hering waves).

Method. The hind limb of an anesthetized dog was isolated at mid-thigh by two tight wire ligatures which compressed all structures except the femoral artery and vein and the sciatic and saphenous nerves. The dog was heparinized† and blood flow from a constant pressure reservoir into the femoral artery measured with a photographically recording orifice meter[1] at each of a series of perfusion pressures from 10 to 105 mm Hg. The femoral arterial (perfusion), femoral venous and aortic pressures were recorded simultaneously.

Results. The aortic pressure oscillated rhythmically between 100/80 and 120/100 at the rate of one cycle per 17 seconds; the venous pressure was 10 mm Hg. At perfusion pressures of 10 and 30 mm Hg, no flow occurred; at a pressure of 48 mm Hg the flow oscillated rhythmically from 0 to 0.7 cc/min., each increase and decrease of flow preceding slightly the associated decline and rise of aortic pressure. At higher perfusion pressures the flow was continuous but oscillated between maximum and minimum rates. The simultaneous measurements of flow (abscissal scale—blood flow cc/min.) and the difference of pressure between the femoral artery (perfusion pressure) and vein (ordinate scale AP-VP mm Hg) at moments of maximum (a, b, c, etc.) and of minimum (a^1, b^1, c^1, etc.) flow at each perfusion pressure are plotted in Fig. 1.

Discussion. Since the curves $P,F_{unconstricted}$, and $P,F_{constricted}$ drawn through the points of maximum and minimum flow respectively yield smooth divergent lines it is felt that the vessels assumed the same degree of constriction and dilation at the minimum and maximum points throughout the series of flow measurements. Therefore such pairs of curves express most satisfactorily the change of vasomotor tone. However, it is desirable in many experiments to find some numerical expression for the change of tone which can be plotted with respect to time or which can be used in comparing the results of one experiment with those obtained in another.

Alterations of vasomotor tone are often thought to parallel changes of peripheral resistance—defined as the ratio of pressure to flow. However, as may be seen from the curve $P,F_{unconstricted}$, the peripheral resistance changed from 27 mm Hg/cc/min. at a difference of pressure of 54 mm Hg to 8.6 mm Hg/cc/min. at a difference of pressure of 86 mm Hg in the absence of any active change of vasomotor tone. Furthermore, the peripheral resistances at point *c* in the unconstricted, and at point *g'* in the constricted state are approximately the same—50 and 54 mm Hg/cc/min. respectively—although the vasomotor tone is obviously much greater at *g'*.

Change of vasomotor tone has often been computed in terms of the ratio of flow in an unconstricted state to the flow in the constricted state when the vascular net is perfused at a constant head of pressure. In order for this procedure to have quantitative significance, this ratio should be the same regardless of the perfusion pressure used. However, as shown in Fig. 1 by the plot of

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† Liquaemin (Courtesy Roche Organon, Inc.)—0.3 ml/kg initially plus 0.1 ml/kg/half hour.

1 Gregg, D. E., and Green, H. D., *Am. J. Physiol.*, 1940, **130**, 114.

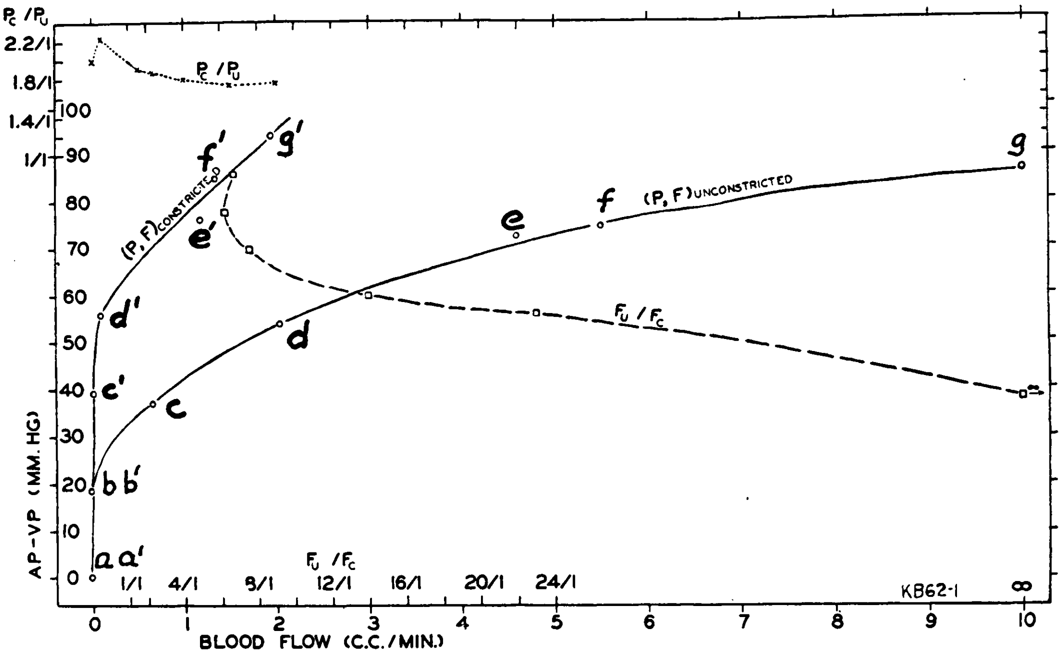

FIG. 1.

Plots of simultaneous measurements of the flow through the isolated vascular net of the femoral artery (blood flow cc/min) and of the difference of pressure between the femoral artery and vein (AP-VP.—mm Hg) of an anesthetized dog during the moments of maximum vasoconstriction $P,F_{constricted}$ and maximum vasodilation $P,F_{unconstricted}$, occurring during a continuous series of Traube Hering waves. a, a′; b, b′; c, c′; etc., are the corresponding maximum and minimum flows at each perfusion pressure.

Pc/Pu = plot of the ratio of the difference of pressure (AP-VP.—mm Hg) in the constricted state to the difference of pressure in the unconstricted state necessary to cause a given rate of flow (upper ordinate scale—Pc/Pu) vs. the rate of flow (abscissal scale—blood flow in cc/min).

Fu/Fc = plot of the ratio of the rate of flow in the unconstricted state to the rate of flow in the constricted state at each of several differences of pressure (abscissal scale — Fu/Fc) vs. the difference of pressure (ordinate scale — AP-Vp.-mm Hg).

Fu/Fc (abscissal scale) vs. the arteriovenous difference of pressure (ordinate scale), this ratio is approximately 6/1 at a difference of pressure of 86, but increases to 23/1 at a difference of pressure of 55 and to infinity at a difference of pressure of 40.

Comparison of the ratio of the difference of pressure in the constricted state to the difference of pressure in the unconstricted state necessary to cause the same flow indicates that this ratio varies only from 1.7/1 to 2.3/1 (see plot of Pc/Pu (ordinate scale) vs. flow (abscissal scale) in Fig. 1.) In view of the greater constancy of this ratio which has been confirmed in many other experiments, it is our belief that changes of vasomotor tone may best be expressed in terms of the ratio of the A-V difference of pressure in the constricted (or experimental) state to the A-V difference of pressure necessary to cause the same flow in the unconstricted (or control) state.

Computed by this method, it appears that the Traube Hering waves seen in this experiment were due to rhythmic changes in vasomotor tone which had a value of approximately 1.7/1 in the hind leg and recurred at the rate of one cycle/17 seconds.