Relevance of work on bats to our understanding of the role of active venous vasomotion in the circulatory system

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A seemingly appropriate way to introduce a discussion of our knowledge of venous vasomotion in bat wing vessels is to quote a paper written in 1851 by T. Wharton Jones. This paper is probably the first report of venous vasomotion seen in bat wing vessels through a microscope. Jones used magnifications of ×370–550 and noticed a peculiarity about flow of blood in veins which was produced by a rhythmical contraction and dilation. He states that 'the act of contraction of the vein is manifested by progressive contraction of its caliber and increasing thickness of its wall; the relaxation of the vessel, by a return to the former width of caliber and thickness of wall'. Jones noticed that there was a variation in rate as well as in the degree of constriction in different experiments, and he believed that the heart's action maintained flow during the relaxation phase and the venous contraction caused acceleration of the blood as an aid to the heart. After noting no contractility in veins in the ears of long-eared bats, he concluded that the activity occurred in the wings to promote blood flow because the wing was large and its vessels were probably beyond the influence of the heart to some extent.

The view that rhythmical venous contractions assisted the work of the heart was not held by Carrier who, 70 years later in association with August Krogh, studied bat wing vessels and ascribed no importance to venous vasomotion as an aid to venous return.

The asynchronous contractions of consecutive segments of veins which also interrupted in flow from tributaries did not appear to her to promote flow of blood from distal to more proximal areas.

The next reports in the literature of rhythmical contractile activity of veins, but now called venous vasomotion, appeared in the investigative studies of Nicoll and Webb in 1946 and in more detail in 1955. These authors proposed that venous vasomotion was an inherent property of smooth muscle cells and was independent of control through the central nervous system, having demonstrated that the contractions persisted after denervation. Venous vasomotion was described as a sharp contraction and one that sweeps along the vein as a peristaltic wave in a central direction, an action that would aid in venous return to the heart. Nicoll and Webb suggested that venous vasomotion was more wide spread than recognized, realizing that anesthesia reduced the activity as did sluggish flow, both conditions which were likely to appear in experimental animal preparations. They expressed the belief that pressure within the veins could well be the principal stimulus for vasomotion.

In 1949, Folkow published a paper in which he reviewed the Bayliss concept of 1902 that intravascular pressure was important as a factor in regulating the tone in small vessels. This idea of a myogenic activity was later to be incorporated in one of the theories of autoregulation of blood flow through tissues. Experimental work on venous vasomotion in bat wing veins was cited by Folkow as supportive evidence for the influence of intraluminal pressure change on vascular smooth muscle. Experiments by Wiedeman in 1957, carried out in bat wing vessels, showed that when venous outflow from the wing was diverted into a single vein by ligating other venous pathways, a significant increase in cycles of venous vasomotion occurred. An increase in total volume of fluid in the vascular system achieved by infusion of dextran produced the same results. It should also be noted that spontaneous changes in pressure of small veins in the hind limb of dog were recorded, and simultaneous measurements of arterial pressure and respiration showed the vasomotion cycles to be independent of both. It was concluded that these small vein pressure fluctuations seen in the dog leg were a result of venous vasomotion. Spontaneous changes in small vein pressures have also been recorded in rabbit ear vessels and in arm veins of man.

In summary then, the observation that bat wing vessels, both arterial and venous, contract spontaneously and rhythmically has led to the development of concepts regarding management of the circulation of blood. The idea that small blood vessels autoregulate blood flow into tissues in spite of variations in perfusion pressure is a direct outgrowth of the knowledge that vascular smooth muscle is stimulated to contract in response to an increase in intra-luminal pressure. This myogenic activity is considered to be an inherent property of smooth muscle cells. While the arterial side is involved in autoregulation of blood flow into capillary networks, the veins respond to intraluminal pressure to maintain tone on the venous side of the vascular tree and therefore contribute to the delivery of blood back to the heart and to sustaining systemic blood pressure. Where ever venous vasomotion occurs, venous return is enhanced.