ABSTRACT FORM FOR 1981 MICROCIRCULATORY MEETING

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OPTIMAL MICROVASCULAR DESIGN: IN VIVO EVIDENCE. H. N. Mayrovitz and J. Roy* Miami Heart Institute, Miami Beach, Florida 33140

By simultaneously minimizing the energy equivalent cost of blood flow (q) and volume, Cecil Murray in 1926 calculated that an optimal enonomy of circulation results if q is everywhere proportional to the cube of vessel radius (r) in which it flows ($q=kr^3$). Though this theoretical prediction has far reaching implications and has been used in a variety of ways no systematic test of its in vivo applicability has been reported. In the present study simultaneous measurements of q and r in each of five arterial branching orders in the skeletal muscle microvasculature of the cremaster have been made in 8 normotensive (WKY) and 8 hypertensive (SHR) rats under control and maximally dilated conditions. A total of 160 paired values of q and r were thus obtained. Regression analysis was done to determine the values of k and m in the equation $q=kr^m$ using logarithmically transformed data. Results show that when all paired values are analyzed independent of animal type (WKY or SHR) or vascular state (control or dilated) m lies between 2.95 and 3.25 with a 99.9% probability. Other analyses which consider animal type and vascular state as separate classes still yield values for m which lie close to this range. In all cases the correlation coefficient between q and r^m was greater than 0.98. Values of k across classes were insignificantly different and ranged from 3271 to 10,062 with a mean for all data of 6702 with r in um and q in nL/sec. Based on this analysis and the fact that the value of m was independent of animal type or vascular bed state, we conclude that the third power dependence of flow on vessel radius is in fact an average property of the vascular bed.
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