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The role of the arteriolo-venular anastomoses in the regulation of blood flow in the system of the visceral branches of the abdominal aorta

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ABSTRACT

Arterio-venous anastomoses (AVAs) are direct connections between small arteries and small veins. In humans they are numerous in the glabrous skin of the hands and feet. The AVAs are short vessel segments with a large inner diameter and a very thick muscular wall. They are densely innervated by adrenergic axons. When they are open, they provide a low-resistance connection between arteries and veins, shunting blood directly into the venous plexuses of the limbs. The AVAs play an important role in temperature regulation in humans in their thermoneutral zone, which for a naked resting human is about 26°C to 36°C, but lower when active and clothed. From the temperature control center in the hypothalamus, bursts of nerve impulses are sent simultaneously to all AVAs. The AVAs are all closed near the lower end and all open near the upper end of the thermoneutral zone. The small veins in the skin of the arms and legs are also contracted near the lower end of the thermoneutral zone and relax to a wider cross section as the ambient temperature rises. At the cold end of the thermoneutral range, the blood returns to the heart through the deep veins and cools the arterial blood through a countercurrent mechanism. As the ambient temperature rises, more blood is returned through the superficial venous plexuses and veins and heats the skin surface of the full length of the 4 limbs. This skin surface is responsible for a large part of the loss of heat from the body toward the upper end of the thermoneutral zone.

1. Introduction

Arterio-venous anastomoses (AVAs) are direct connections between small arteries and small veins, with no capillary section between them. Since they contain no capillary segment, they cannot transport dissolved substances to or from the tissues. The only transport function they could possibly have is the transport of heat from the body core to surface areas containing AVAs.

2. Discussion

AVAs are found in many organs and tissues in vertebrate bodies, but usually in low numbers [1]. The

exceptions are certain areas of the skin and mucous membranes in mammals and birds, where they may be numerous. Results of thorough light microscopic investigations were first published by [2] and later by [3]. Later anatomical investigations have mainly confirmed their findings [1], [4], [5]. The AVAs are typically short vessel segments with a very thick muscular wall. The walls are usually much thicker than those of the small arteries which feed into them. The AVAs are densely innervated by adrenergic axons [6]. The inner diameter is described as being from 10 to 150 mm and the thickness of the wall from 40 to 60 μm. The length is typically from 200 to 500 μm. The wall is composed of circular smooth muscle cells as is the case for arterioles, but in addition there is usually an inner layer of longitudinal smooth muscle cells. This suggested to the early anatomists that the AVAs could act as sphincters, in other words that they could close down the vessels completely.

3. References

[1] Clara M. Die arterio-ven€osen Anastomosen. Wien: Springer, 1956.

[2] Hoyer H. Ueber unmittelbare Einmundung kleinster € Arterien in Gef€ass€aste ven€osen Charakters Archiv fur € mikroskopische Anatomie 1877; 13:603-46; http://dx.doi. org/10.1007/BF02933950

[3] Grosser O. Ueber arterio-ven€ose Anastomosen an den Extremit€atsenden beim Menschen und den krallentragenden S€augethieren. Arch Mikro Anat Entw 1902; 60:191-216; http://dx.doi.org/10.1007/BF02978384

[4] Popoff NW. The digital vascular system - With reference to the state Glomus in inflammation Arteriosclerotic gangrene, diabetic gangrene thrombo-angiitis obliterans and supernumerary digits in man. Arch Pathol 1934; 18:295- 330

[5] Boyd JD. Arterio-venous anastomoses. London Hospital Gazette 1939; 42:2-8

[6] Donadio V, Nolano M, Provitera V, Stancanelli A, Lullo F, Liguori R, Santoro L. Skin sympathetic adrenergic innervation: An immunofluorescence confocal study. Ann Neurol 2006; 59:376-81; PMID:16437571; http://dx. doi.org/10.1002/ana.20769

[7] Lossius K, Eriksen M. Connection between skin arteriovenous shunt flow fluctuations and heart rate variability in infants. Early human development 1994; 39:69-82; PMID:7843046; http://dx.doi.org/10.1016/0378-3782(94) 90071-X

[8] Clara M. Die arterio-ven€osen Anastomosen der V€ogel und S€augetiere. Ergebnisse der Anatomie 1927:246-301

[9] Grant RT. Observations on direct communications between arteries and veins in the rabbit's ear. Heart-J Stud Circ 1930; 15:281-303

[10] Clark ER, Clark EL. Observations on living arteriovenous anastomoses as seen in transparent chambers introduced into the rabbit's ear. Am J Anat 1934; 54:229- 86; http://dx.doi.org/10.1002/aja.1000540204

[11] Grant RT, Pearson RSB. The blood circulation in the human limb; Observations on the differences between the proximal and distal parts and remarks on the regulation of body temperature. Clin Sci 1938;

ISSN: 0005-2523
Volume 61, Issue 03, June, 2021

3:119-39

[12] Clark ER. Arterio-venous anastomoses. Physiol Rev 1938; 18:229-47

[13] Burton AC. The range and variability of the blood flow in the human fingers and the vasomotor regulation of body temperature. Am J Physiol 1939; 127:437-53

[14] Thoresen M, Walloe L. Skin blood flow in humans as a function of environmental temperature measured by ultrasound. Acta physiologica Scandinavica 1980; 109:333-41; PMID:7446176; http://dx.doi.org/10.1111/ j.1748-1716. 1980.tb06604.x

[15] Johnson JM, Taylor WF, Shepherd AP, Park MK. LaserDoppler measurement of skin blood flow: comparison with plethysmography. J Appl Physiol Respir Environ Exerc Physiol 1984; 56:798-803; PMID:6706783; http:// dx.doi.org/10.1063/1.334009

[16] Eriksen ML, K. Inadequacy of laser Doppler flowmetry in skin areas of the human hand. Med Biol Eng Comput 1993; 31:311-8; PMID:8412386; http://dx.doi.org/ 10.1007/BF02458052

[17] Scholander PF, Hock R, Walters V, Johnson F, Irving L. Heat regulation in some arctic and tropical mammals and birds. Biol Bull 1950; 99:237-58; PMID:14791422; http://dx.doi.org/10.2307/1538741

[18] Bergersen TK. A search for arteriovenous anastomoses in human skin using ultrasound Doppler. Acta physiologica Scandinavica 1993; 147:195-201; PMID:8475746; http:// dx.doi.org/10.1111/j.1748-1716. 1993.tb09489.x