The perirenal venous arch of the rat: Its functional significance

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Summary. A functional and morphological study of the perirenal venous arch of the rat has been carried out. The various drainage possibilities of this arch through its multiple collaterals are demonstrated. Venous renal blood can reach the adrenal gland via the perirenal arch. The endocrine interactions between these organs are discussed.

The perirenal venous arch, first described in man by von Haller, was later studied in animals[1-3] and in man[4-11]. It has always been considered as a vicariant venous drainage in the event of occlusion of the more important routes. Nevertheless, the fact that this venous arch relates the kidney with the adrenal gland suggests that it might also be a possible route for endocrinal interaction between these 2 organs.

Material and methods. 39 rats of both sexes were used: 25 for the morphological study of the venous arch, and the remainder for the study of its functional significance.

A. Morphological study. The 25 rats were divided into 3 groups. The first group, which consisted of 10 rats, was used to study the disposition of the perirenal venous arch by injection of a solution of gelatin-india-ink, via either the renal vein or the adrenal vein. In the second group of 10 rats, venostasis was utilized for the recognition of the perirenal venous arch and its collaterals: post-mortem stasis in 7, and active stasis (by clamping the inferior vena cava for 10 min) in the remaining 3. Finally, in the third group of 5 animals, the connection between the perirenal venous arch and the veins of the posterior abdominal wall were studied by dissection under stereoscopic microscope.

1–Left renal vein
2–Left adrenal vein
3–Left spermathic vein
4–Perirenal venous arch

Schematic view of the perirenal venous arch, seen obliquely from the lateral border of the left kidney.

In the necropsy, a block made up by the 2 kidneys, the adrenal glands, and the surrounding fatty tissue was removed and fixed in 10% formalin. After fixation, the block was dehydrated and then diaphanized with toluene.

B. Functional study. 2 kinds of experiment were carried out: a) The 1st was done on 4 rats in which the left adrenal vein was clamped for 5 min. In 1 case, the clamping was proximal, and in 3, distal, to the outlet of the inferior diaphragmatic vein into the adrenal vein. In the necropsy, both adrenals were removed with the surrounding fat, embedded in paraffin and sectioned (6 µm), and stained with hematoxylin-eosin.

b) 10 rats were used in the 2nd experiment. 9 of these were injected with methylene blue via the left renal artery, using the Krause's intravital staining method. Simultaneously to the injection, the inferior vena cava in 2 of the rats was compressed. In another case, the periadrenal fat was removed, leaving only that of the lower surface which conserved its vascular connections. Finally, in the remaining rat, the injection was carried out i.v. to observe whether the stain could reach the adrenal via the systemic circulation, thus ruling out the possibility of part of the stain in the previous experiment reaching the adrenal by this route. Both adrenal glands were removed in the necropsy to be studied macroscopically and, later on, to be sectioned in frozen microtom (50 µm) and mounted without further staining, other than that resulting from the previously injected methylene blue.

Results. A. Morphological study. The presence, bilaterally and in both sexes, of the perirenal venous arch is constant. In the male, it originates from the central part of the lateral renal edge in the form of small capsular venules joining to form a common trunk which, in turn, bordering on the upper pole of the kidney, penetrates the lower surface of the adrenal capsule near the exit of the adrenal vein, ending eventually in the gland where it divides into multiple branches (figure). There may, frequently, be a small anastomotic vessel between the trunk of the perirenal arch and the adrenal vein, or the venous arch may simply terminate directly in the adrenal vein. In the female, the venous arch continues beyond the lateral renal border until it unites with the uterine and ovaric plexi. This venous arch is also related, by means of the venules of the perirenal fat, to the ovaric or spermatic and periureteric veins. Moreover, there is also anasto-

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mosis with the veins which penetrate the psoas and cuadratus lumborum muscles and, further above, with the branches of the lower diaphragmatic vein.

B. Functional study. a) Clamping of the adrenal vein for 5 min. In this experiment, it is to be noted that, in spite of the total occlusion of the adrenal vein, no important lesions appeared in the adrenal parenchyme. There was a certain amount of congestion in the medullar sinuses and in the plexus of the ZR and ZFI, as well as in veins of the periadrenal fat and some zones of the subcapsular plexus. Some focal hemorrhages were also present at the union of the ZR and ZF.

b) Injection of methylene blue via renal artery. By means of this method, stained zones on the surface of the gland could be observed macroscopically. These zones, in general, corresponded to the trajectory of the capsular venules. But when all the periadrenal fat, except that lining the lower surface of the adrenal, was removed, this surface only appeared stained. The staining was more profuse and uniform in the animal injected intravenously via the systemic circulation. When examined microscopically, staining was observed in 7 of the 9 animals and was localized in the adrenal capsule and ZF, and less intensely and with little uniformity in other adrenal areas. In the case of the i.v. injection, focal staining was not observed in the parenchyme, but rather in the endothelium of the medullary capillaries and arterioles.

Discussion. Since the perirenal venous arch has multiple collaterals, one of its important properties would seem to be the possible existence of various drainage routes. The effectiveness of these collaterals is evidenced by their ability to substitue the clamped adrenal vein, whilst the adrenals suffer no important lesions, although hemorrhages do appear easily in these glands[12-14]. The capacity of this venous arch to drain renal and adrenal blood has already been verified in man and other species[1,5,7]. This vicariant action further implies one other important function. Blood from the kidney with a high concentration of angiotensin which is undiluted in systemic circulation can reach the adrenal gland via the venous arch and exert a strong stimulus on the ZG for the secretion of aldosterone. Similarly, blood from the adrenal carrying adrenaline, corticosteroids and aldosterone can also reach the kidney via this route.

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A cholinergic modulator

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Summary. Soluble proteins obtained from presynaptic cholinergic vesicles have been tested regarding their effects to modify postsynaptic spike generation. The results suggest that these proteins (or derivatives, incl. glycopeptides) may act as modulators in increasing the effectiveness and duration of postsynaptic spike generation. They may partake in generation of homosynaptic (posttetanic) potentiation.

Homosynaptic (posttetanic) potentiation[1-7], the generation of a second postsynaptic spike of greater amplitude by 2 identical presynaptic shocks delivered within 1 sec, has been attributed to Ca^{2+}-transport related[8-10] presynaptic mechanisms[1,11-13]. In view of the recent discovery of protein-related specific neurotransmitter-modulators[14-17], it occurred to study whether presynaptic cholinergic vesicles contain cholinergic modulator(s). It seems that postsynaptic potentiation is, in part, inherent in the latency requirements of this modulator.

Methods. Soluble proteins were obtained from presynaptic cholinergic vesicles of adult rat brain and the electric

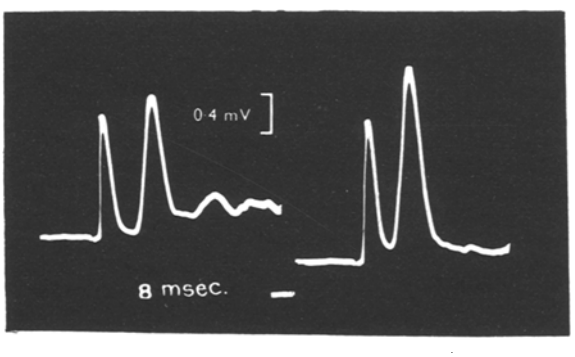

Fig. 1. Effects of protein extracts on homosynaptic potentiation. *X* 2 postsynaptic spikes generated by 2 supramaximal presynaptic pulses. The second spike had a larger amplitude than the first. *Z* Same presynaptic stimulation. Immediately after the first presynaptic pulse one of the vesicle extracts was added to the bathing fluid. The increased amplitude of the spike elicited by the second presynaptic pulse was significantly higher than that of the control. Horizontal mark: 8 msec; vertical mark: 0.4 mV.

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