CHOLINERGIC FACTORS

IN THE MAINTENANCE OF VASCULAR TONE

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SUMMARY

1. The aim of the study was to examine cholinergic factors which might contribute to the control of blood flow in a peripheral cutaneous artery, the central artery of the rabbit ear.

2. The study comprised morphological investigations, including histochemistry at both the light-microscope and electron-microscope levels, an enzyme assay, and functional (perfusion) studies using the isolated whole rabbit ear, and also the isolated central rabbit ear artery.

3. With light-microscope histochemical techniques, the enzymes cholinesterase (pseudocholinesterase) and acetylcholinesterase were demonstrated in transverse sections of rabbit ear artery, near the medial-adventitial border. The number of areas stained for the enzymes was greatly reduced after sympathetic nerve degeneration. Comparison with the results of fluorescence microscopy for the demonstration of catecholamines in adjacent tissue sections, and within single sections, indicated an extremely close morphological relation between the enzymes and adrenergic fibres in the artery.

4. The general ultrastructural morphology of the rabbit ear artery was studied with the electron microscope, with particular attention to the neural elements in the artery wall. On the
basis of the morphology of the neuronal vesicles, and their ability to take up 5-hydroxydopamine, all axons in the artery wall were classified as adrenergic. In sections of artery treated to demonstrate the enzymes the adrenergic axons exhibited weak acetylcholinesterase activity in association with the axon membrane, and more intense cholinesterase activity was associated with the Schwann cells.

5. No choline acetylase activity could be demonstrated in the rabbit ear artery, using either an enzyme assay technique or a histochemical method.

6. In perfusion studies using the isolated whole rabbit ear, exogenous acetylcholine (ACh) was shown to have a potent dilator action when the perfusion pressure was raised with the synthetic octapressin analogue P0R8. The dilator effect of ACh was prevented by atropine.

7. In the isolated perfused central artery of the rabbit ear, exogenous ACh had a potent dilator action when the perfusion pressure was raised by periarterial electrical stimulation. The action of ACh was prevented by antimuscarinic agents, and enhanced by cholinesterase inhibitors. No evidence was seen for a facilitatory role of exogenous ACh, and there was no indication of an action of endogenous ACh in the artery's constrictor response.
8. The dilator action of ACh was further studied by examining the
effects of the ester on other constrictor stimuli, namely -

(i) noradrenaline
(ii) noradrenaline in the presence of cocaine
(iii) noradrenaline in sympathetically denervated arteries
(iv) histamine

The results indicated that the artery had cholinergic inhibitory receptors related to the sympathetic nerve terminals, and also inhibitory receptors related to the arterial smooth muscle. It appeared likely that the neuronal action of ACh was responsible, in the majority of arteries, for the depression of responses to periarterial electrical stimulation.

9. The study demonstrated pharmacological actions of ACh on the
rabbit ear artery which may be of importance in other vascular systems. Although cholinergic elements were demonstrated histochemically within the artery wall, the suggestion of functional, endogenous cholinergic mechanisms in the artery was not confirmed.