On the adrenergic innervation of the rat parotid gland[1]

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Summary. In parotid glands of rats, some adrenergic nerves persisted after avulsion of the superior cervical ganglion, while in submaxillary glands, the adrenergic nerves disappeared completely.

Salivary glands are often used as model organs in studies on the autonomic nervous system and on the secretory processes. Of primary importance in such investigations is knowledge about the innervation of the glands. In recent studies dealing with the parasympathetic nerve supply of the parotid glands of some species, attention was drawn to the fact that severance of the 'classical' secretory nerve, the auriculo-temporal, leaves some cholinergic nerves intact within the glands[2-4]. In such a study on the rat parotid gland, it was also found that a few adrenergic nerves remained after avulsion of the superior cervical ganglion[5].

In the present study, using the fluorescent technique, the effect on the presence of adrenergic nerves in the parotid gland and, for comparison, in the submaxillary gland was investigated, not only after avulsion of the ganglion or removal of the whole sympathetic cervical trunk but also when such an operation was combined with tearing away the central stump of either the auriculo-temporal or the facial nerve, or with nerve dissection along the external carotid artery.

Materials and methods. 14 male rats, 5–7 months old, of a Sprague-Dawley strain bred at the Institute of Physiology, were used. In ether anaesthesia, the following

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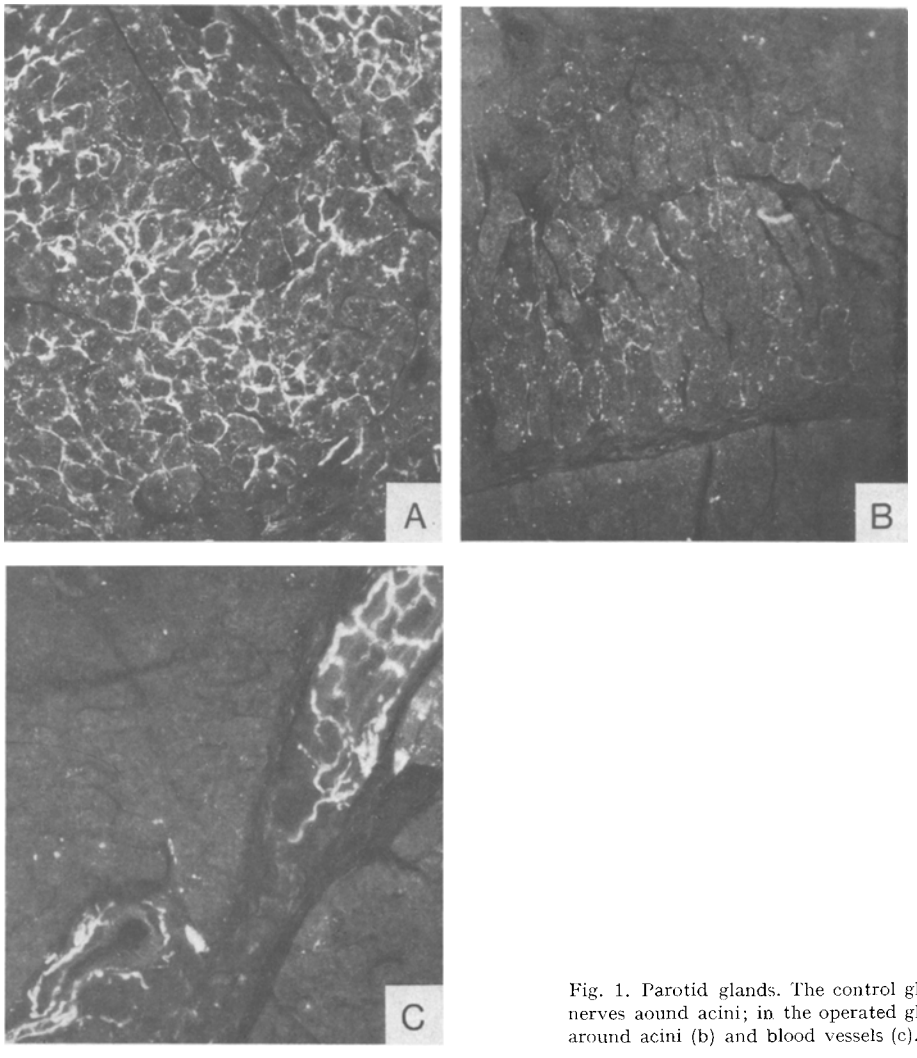

Fig. 1. Parotid glands. The control gland (a) shows numerous adrenergic nerves aound acini; in the operated glands some adrenergic nerves persist around acini (b) and blood vessels (c). × 175.

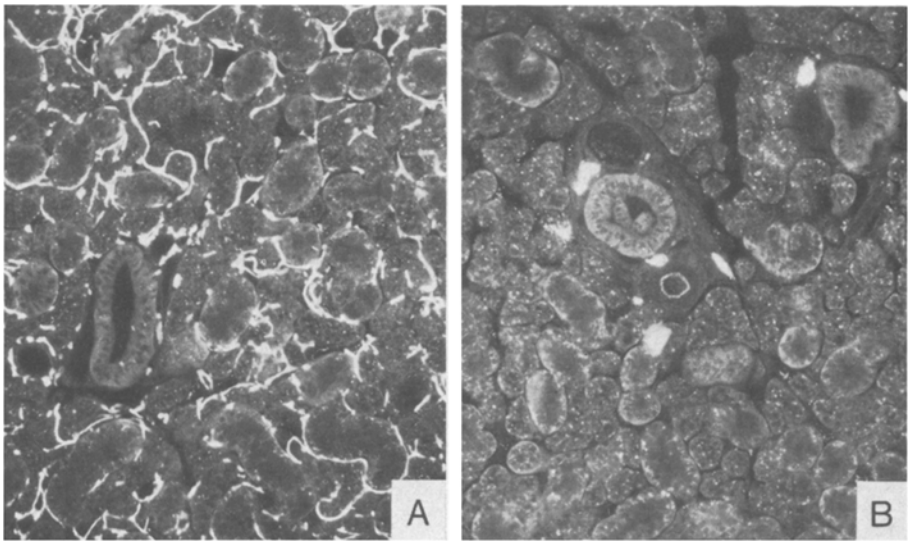

Fig. 2. Submaxillary glands. The control gland (a) shows an abundance of adrenergic nerves aound acini and granular tubules, while the operated gland (b) lacks adrenergic nerves; the dots of intense fluorescence are attributed to mast cells. × 175.

operations were performed on the right side under a dissecting microscope: avulsion of the superior cervical ganglion (4 rats); removal of the cervical sympathetic trunk (2 rats); avulsion of the ganglion and pulling away the central stump of the auriculo-temporal nerve (2 rats); avulsion of the ganglion and pulling away the central stump of the facial nerve (2 rats); and avulsion of the ganglion and dissection along the external carotid artery to about the level where the ascending pharyngeal artery branches off (4 rats). 7–10 days later, the rats were killed by inhalation of ether, and the parotid and the submaxillary glands on both sides were carefully dissected out, the left glands serving as controls, and processed for the fluorescent technique for the visualization of adrenergic nerves[6,7]; the pieces of tissue were sectioned serially. To the rats in the last experimental group, DL-dihydroxyphenylserine (DL-DOPS, Hässle, Sweden), a substance which is converted into noradrenaline, was given (40 mg/kg i.v.) 1 h before the animals were killed. This substance was used to increase the neuronal noradrenaline fluorescence in order to find remaining adrenergic nerve terminals after denervation.

Results and discussion. In agreement with earlier investigations[8,9], the secretory acini and blood vessels were, under normal conditions, well supplied with adrenergic nerves in both the parotid and the submaxillary gland which is shown in the figures 1a and 2a; also found by Fujiwara et al.[8], granular tubules of the submaxillaries were adrenergically innervated. No adrenergic ganglia were seen. After avulsion of the superior cervical ganglion, it is evident from the figures (1b,c) that nerves, although greatly reduced in number, still persisted in the parotid gland around blood vessels and some scattered acini. In contrast, the adrenergic nerves of the submaxillary gland disappeared completely (figure 2b), an observation in accordance with that of Fujiwara et al.[8]; in this connection it should be mentioned that also the operated submaxillary glands of the animals treated with DL-DOPS lacked adrenergic nerves.

The present results show that not all the synapses between the pre- and postganglionic sympathetic neurones of the parotid gland are located in the superior ganglion, as seems to be the case for the submaxillary glands. Neither does the relay seem to occur in any other part of the sympathetic cervical trunk proximal to the ganglion, since, when avulsion of the ganglion was combined with removal of the whole trunk, adrenergic nerves were still left in the parotid gland. One possibility is that some ganglion cells are located peripheral to the superior ganglion and thus escape the surgical procedure; the relay is, however, not on that part of the external carotid artery which is below the point where about the ascending pharyngeal artery takes off, since nerves were left in the gland after dissection along the carotid artery to that level. As to the course of the remaining adrenergic neurones, this is apparently not via the auriculo-temporal or the facial nerve, because when the central stump of either of these nerves was torn away together with the superior cervical ganglion, no further reduction in the number of adrenergic nerves seemed to occur.

It appears from the present results that when undertaking studies on the rat parotid gland after removal of the superior cervical ganglion attention should be paid to the fact that some adrenergic nerves persist in the gland. In the dog's parotid gland, a few adrenergic nerves were also found to remain after ganglionectomy[10], while in this gland of the rabbit all nerves disappeared[4,11].

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