Sympatho-Adrenergic Neural Control of the Sphincter of Oddi of the Cat and the Dog

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KYÖSOLA, K. Sympatho-Adrenergic Neural Control of the Sphincter of Oddi of the Cat and the Dog. Tohoku J. exp. Med., 1979, 127 (2), 113-117 — The presence of adrenergic axons within the sphincter of Oddi of the cat and dog was demonstrated using the glyoxylic acid-induced fluorescence histochemical method. After vagotomy (in cats), no reduction was observed in the number of the adrenergic axons or in the fluorescence intensity. It is concluded that the sphincter of Oddi receives direct adrenergic neural control derived from the sympathetic plexuses and ganglia, whereas the vagal contribution of adrenergic axons is negligible, if it exists at all. —— sympato-adrenergic innervation; sphincter of Oddi; cat; dog

There is a great deal of convincing physiological, pharmacological and experimental surgical evidence for the sympatho-adrenergic neural control of the sphincter of Oddi (see e.g. Bainbridge and Dale 1905; Westphal 1923; Johnson 1941; Johnson and Boyden 1943; Pallin and Skoglund 1961; Schein et al. 1969; Luoma 1971; Satler et al. 1972). However, surprisingly few neurohistochemical contributions have been published (Grapulin et al. 1968; Baumgarten and Lange 1969, 1970; Kyösa 1973; Kyösa and Rechardt 1973; Tansy et al. 1974). In these studies the formaldehyde-induced fluorescence histochemical (FIF) method (Eränkö 1961,* 1967; Falck and Torp 1961; Falck et al. 1962) has been used for the demonstration of adrenergic nerves. While this method is, in principle, extremely sensitive and specific for the demonstration of cellular monoamines in tissue sections, it is quite capricious with several critical steps (Eränkö 1967), which may partly explain the conflicting results obtained. Similarly, the vagal contribution of adrenergic axons (Muryobayashi et al. 1968; Liedberg et al. 1973) to the sphincter of Oddi has been a matter of dispute (see e.g. Alexander 1940; Boyden and Van Buskirk 1943, 1944; Inoue 1955; Grapulin and Ottolenghi 1968a, b; Grapulin et al. 1968). The present study is an investigation of the intrinsic adrenergic innervation of the sphincter of Oddi of the cat and the dog, based on the glyoxylic acid-induced fluorescence histochemical (GIF) method introduced recently (Lindvall and Björklund 1974; Lindvall et al. 1974), complemented by an examination of the effect of vagotomies on the fluorescing adrenergic axons within the sphincter of Oddi of the cat.

Received for publication, May 19, 1978.

* Personal communication, 1961. Acknowledged by Falck, Hillarp, Thieme and Torp.
Fig. 1. A rich distribution of single fluorescing varicose adrenergic axons and small nerve fascicles within the sphincter of Oddi of the dog. The nerves partly follow the course of blood vessels as typical perivascular fluorescing nerve plexuses, while the rest are obviously "free" nerves, i.e. not related to the blood vessels. × 250, reduced to 9/10.

Fig. 2. A nerve net consisting of fluorescing varicose adrenergic axons within the sphincter of Oddi of the cat. × 250, reduced to 9/10.

Fig. 3. A ganglion area in the region of the choledocho-pancreatico-duodenal junction (near the site of the confluence of the common bile duct and the main pancreatic duct of Wirsung) of the cat. Fluorescing varicose adrenergic axons surround "basket-like" non-fluorescing ganglion cells. Total abdominal infra-diaphragmatic vagotomy with associated Finney-type gastroduodenostomy was performed three months before sacrifice. The number of adrenergic axons and the intensity of fluorescence have remained unchanged. × 250, reduced to 9/10.
MATERIALS AND METHOD

Thirty cats and six dogs were used for the present study. Fourteen cats were subjected to vagotomies of different types: 1) total abdominal infra-diaphragmatic vagotomy with or without associated Finney-type gastroduodenostomy, 2) unilateral (left or right) or bilateral cervical vagotomy with or without tracheostomy, five days to three months before they were killed. Four cats were reserpinized before sacrifice: for two cats 2.5 mg/kg body weight reserpine (Serpasil®, Ciba, Switzerland) was given intraperitoneally 24 hr before sacrifice, and two cats received 3 × 3 mg/kg reserpine (30 hr, 8 hr and 4 hr) before sacrifice. Small tissue specimens from the region of the sphincter of Oddi were excised under general anesthesia and processed for fluorescence microscopy following the glyoxylic acid-induced fluorescence histochemical (GIF) method (Lindvall and Björklund 1974; Lindvall et al. 1974).

RESULTS

A rich distribution of single fluorescing varicose adrenergic axons and small nerve fascicles was observed within the sphincter of Oddi in both the dog and the cat. The nerves partly followed the course of blood vessels as typical perivascular fluorescing nerve plexuses, while the rest were obviously "free" nerves, i.e. not related to the blood vessels (Figs. 1 and 2). After vagotomy, no reduction was observed in the number of adrenergic axons or in the intensity of fluorescence (cf. Fig. 3). Reserpinization resulted in the complete disappearance of fluorescing axons.

DISCUSSION

In the present study, fluorescing varicose axons were demonstrated within the sphincter of Oddi of the cat and the dog using the glyoxylic acid-induced fluorescence histochemical method, suggesting direct adrenergic neural control of the sphincter. Reserpinization caused (in cats) the disappearance of fluorescing axons, confirming that they were reserpine-labile adrenergic axons. These observations agree with the results of Grapulin et al. (1968), Kyöösola (1973) and Kyöösola and Rechardt (1973), whereas they are to some degree dissentient with the conclusion of Baumgarten and Lange (1969, 1970) and completely contrary to the findings of Tansy et al. (1974) who failed to demonstrate histochemically an adrenergic nerve supply to the sphincteric region of the dog, and, consequently, were "reluctant to support hypotheses which presume an active control of the stability of the choledocho-duodenal junction by either intrinsic or extrinsic muscular action". Since vagotomies did not affect the fluorescing axons, the conclusion is that the vagal contribution of adrenergic axons to the sphincter of Oddi is, at least in the cat, negligible, if it exists at all, and that consequently the fluorescing varicose axons in the sphincter of Oddi are, mainly at least, derived from the sympathetic plexuses and ganglia.

References

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22) Muryobayashi, T., Mori, J., Fujiwara, M. & Shimamoto, K. (1968) Fluorescence histochemical demonstration of adrenergic nerve fibers in the vagus nerve of cats and
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