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Dilatation of the Spleen. Stimulation of Nerves; Effect of Autonomic Drugs.

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Schafer and Moore,[1] using dogs as experimental animals and measuring splenic volume by use of the plethysmograph, obtained in only 2 isolated cases dilatation of the spleen as a result of stimulation; the first by slow and weak stimulation of the splanchnic nerve, the second by stimulation of the splenic nerve of an excised, perfused spleen 3 hours after removal from the body. Cleland and Tait,[2] also using dogs and measuring the length of the exteriorized spleen, obtained dilatation of the spleen only as a result of constriction of the splenic vein when they stimulated the vein directly, or the phrenic nerve by which this vein is innervated.

In the majority of our experiments we used decapitate cats, but in several cases we employed amytalized dogs and cats. Since plethysmographic methods for registering volume of the spleen, particularly increases in volume, were found to be unsatisfactory, changes in the area of the exteriorized spleen, registered by the method of Cook and Rose,[3] were taken as a measure of volume changes.

We found that, independent of blood-pressure changes, stimulation of the splanchnics on either side, or of branches of the splenic nerve craniad or caudad to the splenic artery, by means of a tetanizing current of weak intensity, produced dilation of the spleen in both the cat and dog, an increase of about 12% of its resting value. Slow break shocks of different intensities all proved to be ineffect-

[1] Schafer, E. A., and Moore, B., *J. Physiol.*, 1896, **20**, 1.

[2] Cleland, J. G. P., and Tait, J., *Quar. J. Exp. Physiol.*, 1927, **17**, 179.

[3] Cook, S. F., and Rose, M. I., *Am. J. Physiol.*, 1930, **92**, 240.

ive. Any form of stimulation of the abdominal vagus was without effect, nor were we able to obtain dilatation of the spleen by stimulation of the splenic vein with a weak tetanizing current. These experiments indicate the presence of dilator fibers for the spleen running in the splanchnic nerves.

Effect of Autonomic Drugs. Classification of the autonomic nervous system into sympathetic and parasympathetic divisions has been based in part upon the responses of various tissues to certain drugs. A study of the responses of the spleen to the intravenous injection of the so-called autonomic drugs and to stimulation following such injection have given evidence for the nature of the innervation of the dilator mechanism.

Decapitate cats, or excised perfused spleens in a few cases, were used and the drugs were chosen in accordance with their generally accepted relations to the autonomic system as follows: adrenalin, motor to the sympathetic; ergotoxin and ergotamin, inhibitory to the motor sympathetic; pilocarpin, physostygmin, and acetyl cholin, motor to parasympathetic; and atropin, inhibitory to parasympathetic (including or excepting the dilator fibers). The dosages used were those recommended by Sollman,[4] for vascular and systemic effects. It is recognized that, with the possible exception of adrenalin, none of these drugs is strictly confined to either sympatho-mimetic or parasympatho-mimetic action, and that interpretation of results obtained must be made with caution.

Dilatation of the spleen was produced by, (a) the injection of pilocarpin, following atropin or ergotoxin when the adrenals had been ligated, (b) the injection of a small dose of acetyl cholin into the decapitate animal or into the perfusing fluid of the excised spleen, and (c) the stimulation of the splanchnic or the splenic nerves with a weak tetanizing current after the injection of atropin, ergotoxin or ergotamin.

There was no effect upon the spleen, when (a) adrenalin was injected following ergotoxin, or (b) pilocarpin or physostygmin was injected into the perfusing fluid of the excised spleen.

As evidence for the sympathetic and against the parasympathetic innervation of the dilator mechanism may be offered: (a) the dilatation produced by weak stimulation after atropin injection, (b) the dilatation following pilocarpin injection after atropin in the decapitate cat, and (c) the failure to produce dilatation where pilocarpin or physostygmin was added to the perfusate. This inter-

[4] Sollman, T., A Laboratory Guide in Pharmacology, Philadelphia, W. B. Saunders Co., 1917.

pretation, in the first two cases, is based upon acceptance of the theory that atropin paralyzes all parasympathetics and that pilocarpin may act upon the sympathetic.

As evidence for the parasympathetic control may be offered; (a) the dilatation following addition of small doses of acetyl cholin to the perfusing fluid of the excised spleen, (b) the dilatation produced by acetyl cholin or pilocarpin after ergotoxin into the decapitate cat, and (c) the dilatation produced by weak stimulation of the splanchnics or injection of pilocarpin after atropin, this interpretation being based upon the assumption that parasympathetic dilators are not paralyzed by atropin.

Evidence against the sympathetic control is offered by the fact that adrenalin did not produce dilatation of the spleen, after ergotoxin, even though reversal of the usual systemic effects of adrenalin was obtained. Since the action of adrenalin parallels so closely the action of the sympathetic system, the hypothesis that the dilators of the spleen are of parasympathetic origin is strongly supported by the failure of adrenalin to produce dilatation under these circumstances.

Probable course of dilator fibers through the ventral spinal roots. Kuré and his associates,[5] have concluded from histological and physiological evidence that vasodilator fibers to certain viscera are carried in the splanchnic nerves, that they come from the cord *via* the dorsal roots, are truly efferent fibers and are all of parasympathetic origin.

We were unable to obtain dilatation of the spleen in either the cat or the dog by weak stimulation of the dorsal roots of the 11th, 12th, or 13th post-cervical nerves, or of the cord, when the ventral roots had been sectioned. Weak stimulation of the ventral roots of these same spinal nerves or of the cord, when the dorsal roots had been sectioned, produced dilatation of the spleen in several preparations.

[5] Kuré, K., *et al.*, *Quar. J. Exp. Physiol.*, 1928, **18**, 333; 1930, **20**, 51; 1931, **21**, 1, 103, 119.