Spinal Origin of Nasal Vasoconstrictor Innervation in the Dog.* (29693)

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The exact spinal origin of the sympathetic nerve fibers constricting the blood vessels of the nasal mucosa has never been investigated quantitatively, as far as we are aware. Langley(1) studied the vasomotor innervation to the head of dog, cat and rabbit and the spinal origin of the vasomotor fibers to mouth, lips and conjunctiva of the dog. He found that a vasoconstrictor effect (pallor) was produced by stimulating the spinal nerves from the first to the fourth thoracic, with the second thoracic being particularly effective, and he mentions the possibility that the fifth thoracic may supply a sparse vasomotor innervation. Slome(2) writes that the sympathetic preganglionic cells supplying the nasal vascular bed are presumed to be located in the lateral horn of gray matter in the first and second thoracic segments of the spinal cord, but there is no experimental evidence substantiating this localization.

Methods. Jackson's method of nasal plethysmography(3) was used on the anesthetized dog (pentobarbital sodium, 35 mg/kg i.p.). The nasal cavity is considered to be surrounded by unyielding bony walls and can be blocked off posteriorly and anteriorly except for a connection with the recording device. When the blood content of the nose falls, intranasal air pressure also falls. In early experiments(4) we used a method based on the principle of variable volume and constant pressure. The nasal cannula was connected with a water manometer and a 10 cc syringe, partly filled with air and operated manually. Any change in intranasal pressure could be compensated for by forcing air into the nose or aspirating air out of it, thus keeping the water in the manometer at approximately the zero level. The volume displacement of the syringe on nerve stimulation, attributed to changes in blood content, was transmitted to a lever writing on a smoked drum. The kymograph record was calibrated. The anterior roots of the upper thoracic spinal nerves were exposed on one side extradurally by laminectomy. The roots were cut and their peripheral ends were stimulated electrically with a square wave stimulator, usually for 20 seconds (9 volts, frequency 22.2/sec, shock duration 2.5 millisec).

In a subsequent series of experiments (10 dogs) the method employed was based on the principle of constant volume and variable pressure. The cannula, introduced in the anterior nares, was connected to a straight plastic tubing (8 mm bore), thence to a sensitive Grass pressure transducer, with a period of 0.2 second. The transducer was connected to a galvanometer for optical recording on photographic paper. In this way small rapid changes in pressure such as those produced by the pulse could be registered. Around the straight plastic tubing but connected to it by a small opening was a large plastic reservoir immersed in a water bath at constant temperature. This reservoir acted as a volume expander. It was thus possible to prevent the large fluctuations in intranasal pressure which would otherwise have occurred on nerve stimulation. Large fluctuations in pressure might alter the nasal circulation and promote leaks. This arrangement made it possible to record simultaneously the small rapid pulses due to the heart beat and respiration together with the relatively larger and slower pressure changes due to stimulation of vasoconstrictor nerve fibers. The deflections on the record were calibrated by withdrawing or injecting known volumes of air from a syringe into the recording system. The anterior roots, exposed by laminectomy, always included the upper thoracic and ranged from C_8 to T_8. Stimulation might be obtained with the Harvard inductorium, with 2 dry cells (1.5 volts each) and the secondary coil set at 6, 8 or 10 cm. With the square wave stimulator, the most frequent charac-

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TABLE I. Mean Maximal Decrease in Nasal Blood Volume (cc) from Stimulation of the Various Anterior Roots (All Experiments).

Method	C_8	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Mechanical method		.93	1.02	.55	.49	.44			
Electronic method	.27	.92	1.04	1.00	.53	.07	0	0	0

teristics of the current employed were 3 volts, 22.2/sec, 15 millisec shock duration. The period of stimulation was usually about 5 seconds. In 5 experiments a section of the spinal cord was removed in the region of the anterior root stimulation.

Results. Using the mechanical method of recording, 25 anterior root stimulations (T_1 to T_5) in 4 dogs were performed. Nasal vasoconstriction was obtained from each segmental level, with T_2 averaging the largest effect (Table I).

Electronic method. Fig. 1 shows a record of the nasal vasoconstrictor effect on stimulation of the anterior root of T_3. The response had a latent period of about 1 second and recovery took place in about 3½ minutes. The constriction (about 1.56 cc) was considered active since no fall in arterial blood pressure accompanied it. In this series of experiments 211 anterior root stimulations (C_8 to T_8) were performed in 10 dogs. T_2 was stimulated most frequently (58 times), and T_8 the least (5 times). T_2 consistently gave the greatest vasoconstrictor response, T_1 and T_3 gave relatively good effects, T_4 and T_5 gave progressively decreasing effects, T_6 doubtful or no constriction and T_7 and T_8 no constriction (Table I). Stimulation of C_8 (18 times in 4 dogs) caused a mild (avg. 0.27 cc) but definite constriction in at least 2 instances. Often active dilatation occurred during the stimulation of C_8, followed by a constriction which could have been passive.

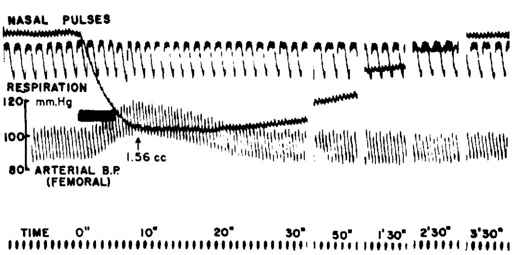

FIG. 1. Example of stimulation of anterior spinal root T_3. Black rectangle shows period of stimulation. Downward swing of nasal pulse indicates vasoconstriction. Portions of the record, during recovery, were deleted.

The results show fairly good agreement between the two methods. Stimulation of the right and left anterior roots of the same spinal segment may give constrictions of almost identical magnitude or one may be considerably greater than the other. Mechanical stimulation of the anterior roots by ligating or cutting produces constriction without the possibility of spread of current but this effect is usually less than that produced by electrical stimulation.

Discussion. Our results show that the vasoconstrictor fibers have a wide origin from the upper thoracic spinal cord, but that the segments having the most marked influence are T_1, T_2 and T_3. It may seem surprising that C_8 was included as having a sympathetic influence; however, several years ago Dr. Albert Kuntz in a personal communication suggested such a possibility based on neuroanatomical considerations, and Bridges and Yahr(5) report that stimulation of the anterior root of the eighth cervical nerve produced digital vasoconstriction.

The fall in pressure in the nose on stimulation of the anterior thoracic roots is believed to be due chiefly to a decrease in blood content because of its rapid onset (about one second) and its reversibility in a few minutes. Pallor of the nasal mucosa occurs on sympathetic stimulation indicating decreased blood content. There is a possibility that stimulation of the sympathetic efferent nerve fibers might arouse reflex responses from some other organ, which might in turn affect other nasal vasoconstrictor fibers in the upper thoracic cord or produce a secretion of epinephrine, for example by way of the carotid sinus or the hypothalamus which receives cervical sympathetic fibers. It is believed that removal of a section of the upper thoracic spinal cord would greatly decrease such a possibility. Our results were similar whether the spinal cord was intact or not.

Others do not express their results with the nasal plethysmograph in cc of blood displaced, probably because of the danger of leaks, influence of temperature changes, secretion of mucus and changes in tissue fluid content. There are advantages in quantitation and the likelihood of the other factors being important seems small in short runs of a few minutes. Studies of this nature, whereby changes in blood content of the nasal mucosa are followed under different experimental conditions, can be of great interest to the clinician who often encounters stuffiness of the nose as a prevalent symptom.

Summary. The origin of the vasoconstrictor fibers to the nasal mucosa of the dog was investigated by nasal plethysmography and anterior root stimulation. T_2 stimulation, more often gave the greatest vasoconstrictor effect, T_1 and T_3 gave good vasoconstriction, T_4 and T_5 progressively less, T_6 doubtful, and T_7 and T_8 no constriction. In exceptional instances C_8 might give some constriction.

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Effect of Scurvy on Serum Proteins of Rhesus Monkeys.* (29694)

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Banerjee and Rohatgi(1) reported changes in the electrophoretic patterns of serum proteins in scorbutic guinea pigs. In studies with monkeys, Greenberg *et al*(2) did not observe any significant change in the different fractions of serum proteins during the early stages of scurvy. Salmon and May(3), however, reported diminished total serum proteins and an increase in plasma fibrogen in scorbutic monkeys. An increase in plasma fibrogen has also been reported in scorbutic guinea pigs(1,4). A detailed study of the various fractions of serum proteins in scorbutic monkeys has not been reported The present report deals with studies on the serum total proteins and different fractions of serum proteins in normal and scorbutic rhesus monkeys and also in monkeys recovered from scurvy after supplementation with ascorbic acid.

Materials and methods. Fifteen rhesus monkeys weighing on the average 4 kg were maintained in the laboratory on a scorbutogenic diet(5). In addition 50 mg of ascorbic acid per animal per day and 2 drops of a concentrate of vit. A and D twice a week were given to the animals. The animals were housed in individual cages.

After the animals were on the above dietary regimen for one month, they were fasted overnight and fasting blood samples were collected in centrifuge tubes from the femoral vein. Serum was analyzed for the different fractions of protein.

After the initial studies were completed, ascorbic acid was withdrawn from 10 of the monkeys. The remaining 5 monkeys which continued to receive ascorbic acid supplement were designated as "pair-fed controls." The amount of food consumed daily by each of the 5 monkeys from whom ascorbic acid supplement was withdrawn was noted and the same amount of food was given to the corresponding pair of the monkey in the "pair-fed control" group on the next day. Food consumption of the monkeys not re-

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