HYPERPNOEA OF NEURAL STIMULATION AND CERVICAL SYMPATHETIC NERVES

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Summary: The study demonstrates the effect of bilateral cervical sympathectomy on the pattern of ventilatory response to electrical stimulation of somatic afferents in anaesthetized rats. Graded stimulation of central end of the cut sciatic nerve for one minute induced hyperpnoea which diminished on cessation of the stimulus. The ventilation exhibited a secondary rise in the second minute following stoppage of stimulation and did not return to the prestimulation level when observed at the end of three minutes. After bilateral sympathectomy, the magnitude of response was small, there was no secondary rise and the return to the prestimulation level was much faster.

Key words: respiration bilateral cervical sympathectomy somatic afferents

Stimulation of somatic nerves is known to result in significant hyperpnoea and this response is unaffected by decerebration (1,3,4,6). Stimulation of somatic afferents by passive hindlimb exercise in anaesthetised cats has been demonstrated to promptly increase the electrical discharge in the nerve fibres arising from the carotid body and the initial part of this response is dependent upon the integrity of the sympathetic nerve supply to the carotid body (2). This points to the possibility of participation of this pathway in the intial phase of hyperpnoea induced by stimulation of somatic afferent nerves. The investigation reported here was aimed at studying the respiratory response of the anesthetised cats to electrical stimulation of central end of the cut sciatic nerve in the first minute and to find out the influence of bilateral cervical sympathectomy on this response.

MATERIALS AND METHODS

Forty five observations were made on five cats under chloralose anaesthesia. Pulmonary ventilation was measured by collecting the expired air from the tracheostomy tube into a low resistance animal spirometer. The central end of the cut sciatic nerve was stimulated with electrical pulses obtained from a Grass stimulator. The stimulus was graded as multiples of threshold (T1) required to elicit a just visible twitch at the lateral head of the gastrocnemius muscle when stimulated through its motor nerve. Ventilation was recorded while the animal was lying undisturbed and then during stimulation of the sciatic nerve, while the stimulus was made to vary from T10 (ten times T1) to T30 (30 times T1). T1 was found to be a stimulus of 1 volt when applied for 0.03-0.05 msec. The frequency was kept at 50/sec. and the stimulation was continued for 60 sec. The basal VE and that during stimulation of sciatic nerve was recorded before and after performing bilateral cervical sympathectomy. Femoral arterial pressure was monitored to keep a continuous check on the general condition of the animal. Breathing was recorded for three minutes following cessation of the stimulus.

RESULTS

Table I details the effect of bilateral cervical sympathectomy of the increase in minute volume induced by the graded stimulation of the sciatic nerve. The data pertains only to the ventilatory increase occuring during the actual period of stimulation. It can be noted that the response is completely abolished when stimulation is at lower strength (T10) while at higher strength of stimulation (T20&T30) it does suffer an appreciable attenuation after bilateral sympathectomy. Tne complete data is plotted in Fig. 1.

TABLE I: Respiratory response expressed as % increase in minute volume as a result of graded stimuli (T10, T?0, T30) applied to the central end of the cut sciatic nerve. Each value is the mean of three observations obtained on the same animal in each step.

Animal No.	*% increase in minute volume*					
	Stimulus T10		*Stimulus T20*		*Stimulus T30*	
	Before sympathectomy	*After sympathectomy*	*Before sympathectomy*	*After sympathectomy*	*Before sympathectomy*	*After sympathectomy*
1.	23	No increase	32	13	36	25
2.	8	,,	14	3	50	24
3.	10	,,	19	12	19	12
4.	35	,,	70	5	70	45
5.	50	,,	50	0	80	0
MEAN	25.2	—	37.0	6.6	51.0	21.2
S.E.	7.9	—	10.5	2.4	11.3	7.6

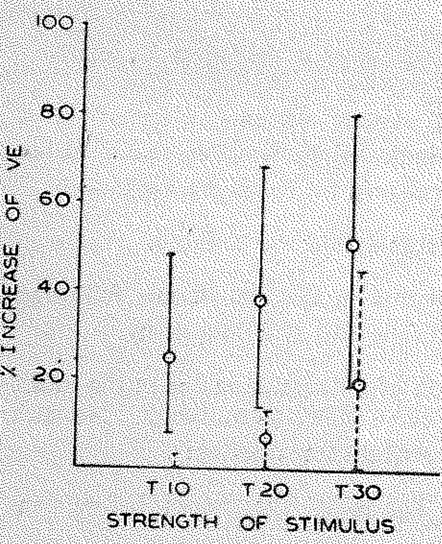

Fig. 1: Increase in minute volume during the first minute of stimulation of the central end of the cut sciatic nerve by graded stimuli before and after bilateral cervical sympathectomy in cats under chloralose anaesthesia.

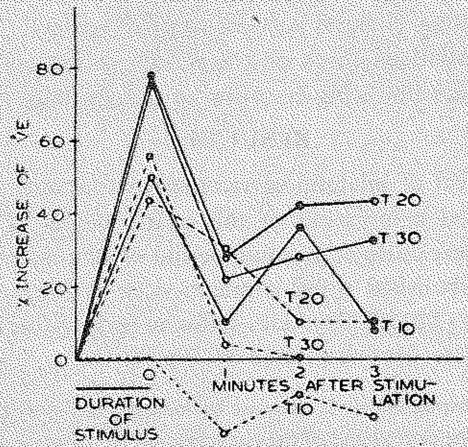

Fig. 2: Min volume of four successive minutes obtained with graded stimulation of (T 10, T 20 and T 30) the central end of the cut sciatic nerve in cats under chloralose anaesthesia. Note the increase in ventilation that occurs during stimulation and the secondary increase of ventilation that occurs during the second minute after stimulation. Bilateral cervical sympathectomy abolished completely the increased ventilation obtained during stimulation with weak stimuli settling the post-stimulatory ventilation at lower levels and decreased the ventilation response obtained by T 20 & T 30, during stimulation, while completely abolishing the secondary increase in ventilation obtained with these parameters of stimuli.

—o—o— Before sympathectomy ....o....o....After sympathectomy

Continuous recording of minute volume showed that it registered an appreciable increase in the second minute after the cessation of stimulation. This secondary increase in ventilation was completely depressed in all cases of the graded stimulation after bilateral cervical sympathectomy.

DISCUSSION

The respiratory response to graded stimulation of somatic afferents in anaesthetized animals with intact sympathetic nerves was on the lines indicated by Koizumi *et al.* (6) but the response obtained after cervical sympathectomy was peculiar in the following ways:—

1. The magnitude of response during the minute of stimulation was reduced.
2. The magnitude of immediate reduction in ventilation in the first minute following cessation of the stimulus was, however, significant following sympathectomy.
3. The readjustment of ventilation following cessation of a neural stimulus in the intact animal is brought about by a secondary rise in the curve showing ventilation. No such phenomenon was observed in the animals after cervical sumpathectomy.

The reasons for these differences could be many. The initial hyperonoea before sympathectomy seems to exhibit an overshoot which is not observed after sympathectomy. After cessation of stimulation the return to normal exhibits an overshoot which also is not observed after sympathectomy, the return to the basal ventilation being smooth and gradual. Thus, the cervical sympathetic nerve supply seems to be connected with the quick obersheets at the beginning of hyperpnoea brought about by stimulation of the somatic afferents and the return to basal levels of ventilation is slow and smooth. This observation fits in with the general function of the sympathetic system in that it promotes quick response to the change in millieu interiu. Regarding the mode of action of the cervical sympathetic nerves, it can well be through the carotid body and the carotid sinus nerve.

In an earlier study (5), we have demonstrated the relationship of stimulation of somatic afferents to the sympathetic outflow to the carotid body. Present study demonstrates the functional correlates of the electrical discharge that has been observed earlier. The study brings out that the increase in pulmonary ventilation accompanying electrical stimulation of somatic afferents is prompt and appreciable at the very outset, with intact cervical sympathetic nerves in cats under chloralose anaesthesia and is sluggish and of smaller magnitude when these nerves are cut. We suspect that this function of the cervical sympathetic nerves may be of importance at the beginning of hyperpnoea of exercise.

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