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THE EFFECT OF BRAINSTEM TRANSECTION ON BLOOD PRESSURE IN THE DOG*

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There are surprisingly few descriptions in the literature of the effect of brainstem transection on blood pressure. Owsjannikow (1) reported on the blood pressure effects of serial transections of the brainstem in unanesthetized rabbits, immobilized with curare. Although the results were highly variable in the 10 animals studied, this investigator stated that when brainstem transection was performed 1 mm or slightly more below the caudal border of the corpora quadrigemina a considerable and long-lasting fall in blood pressure occurred. According to Owsjannikow, transection above this level did not result in more than transient changes in pre-existing "normal" blood pressure. Dittmar (2) performed brainstem transections in 5 unanesthetized, curarized rabbits. On the basis of very limited evidence, Dittmar reported that the first level of brainstem transection which resulted in a fall in blood pressure was near the rostral border of the trapezoid body. Alexander (3) identified the pressor region of the medulla by exploratory stimulation with the aid of the Horsley-Clarke stereotaxic instrument. The pressor center, as identified in the chloralose anesthetized, open-chested cat, was said to occupy diffusely an extensive region of the lateral reticular formation in the rostral two-thirds of the medulla. To define further his localization of the pressor area, Alexander found that transection of the brainstem as far caudally as the lower third of the pons has no significant effect on blood pressure.

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Methods and Results

During the course of electroencephalographic studies in this laboratory, blood pressure is recorded to allow an assessment of the cardiovascular status of the animals, and to examine the possible relationship between EEG changes and fluctuations in blood pressure. Midpontine brainstem transections were performed on dogs by a technique described elsewhere (4). Inasmuch as this technique involved only minor manipulations of cranial tissue, transections were performed following local lidocaine anesthesia and immobilization with decamethonium. Artificial respiration was maintained throughout. Great care was taken to insure abolition of all nociceptive influences. It was possible to compare blood pressure before and after midpontine transection, up to the time some long acting vasoactive drug was administered. Measurements of blood pressure were obtained in 15 dogs, before transection, and both 1/2 and 1 hour after transection. Eight dogs were followed for 1-1/2 hours and 5 dogs for 3 hours after transection. The blood pressure means and the mean differences ± SE between pre- and post-transection blood pressures are summarized in Table 1.

TABLE 1

Blood Pressure Before and After Midpontine Brainstem Transection in the Dog

No.	Control	Post Transection					
Dogs	B.P.	1/2 hr	Mean diff.±SE	P	1 hr	Mean diff.±SE	P
15	137.2	115.6	21.6 ± 4.40	<.001	120.4	16.8 ± 3.32	<.001
8	131.2	113.2	18.0 ± 4.36	<.001	1-1/2 hr 117.2	14.0 ± 2.46	<.001
5	139.6	116.4	23.2 ± 5.90	<.02	3 hr 124.0	15.6 ± 5.85	<.01

One-half hour following intercollicular, midpontine pretrigeminal brainstem transection, blood pressure was 13.7 - 16.6% lower than before transection. In the larger groups of animals, the reduction in blood pressure is highly significant, the *P* value for a paired comparison being <.001. The fall in blood pressure in the group of 5 dogs is also statistically significant, the P value being $<.02$. As measured in 15 dogs, 1 hour after transection, blood pressure was 12.1% lower than before transection. In 8 dogs, measured 1-1/2 hours after transection, blood pressure was still 10.6% lower than that recorded before transection. One hour and 1-1/2 hours after transection, the reduction in blood pressure is also highly significant, the P value being $<.001$. In the small group of 5 animals which could be followed for 3 hours after transection, blood pressure was 11.1% lower than before transection. This reduction in blood pressure, however, is not statistically significant, the P value being $<.1$. A group of 6 dogs given decamethonium, artificial ventilation, local lidocaine anesthesia and a sham operation for purposes of control had a mean blood pressure $\pm$ SE of 133.7 $\pm$ 3.5 mm Hg one hour later.

Discussion

There is little doubt that neuronal elements of the medulla serve both in the integration of a variety of impulses arriving from peripheral receptors and in the modulation of the activity of the efferent nerves which in turn modify vasomotor tone and cardiac function. At first glance, the findings of Owsjannikow, Dittmar, and Alexander (1,2,3) tend to discount the influence of the supra-bulbar portion of the central nervous system in the regulation of blood pressure. On the other hand, it is common knowledge that a wide variety of psychic stimuli can influence blood pressure and indeed electrical stimulation of many parts of the brain above the medulla can give rise to changes in blood pressure. It is important to note that the studies of Alexander were performed on open-chested cats lightly anesthetized with chloralose, or on "decerebrate cats studied without the use of continuous anesthesia." In such preparations it is obvious that influences of suprabulbar portions of the central nervous system would be obscured. In the studies of Owsjannikow and Dittmar the use of curare, which is known to have ganglionic blocking properties, further complicates the interpretation of their results. That the higher centers can modify the activity of neurons ultimately involved in alterations of cardiac output and total peripheral resistance seems clearly indicated by the fall in blood pressure seen after midpontine transection in the dog. Because concomitant cardiac output was not determined, a definitive statement cannot be made regarding the relative contributions of cardiac output and total peripheral resistance in the post-transection fall in blood pressure. The fact that blood pressure did fall after this relatively high level of brainstem transection implies the removal of some tonically active influence which had served to maintain blood pressure at the level recorded before transection. It should be noted that the average blood pressure of these transected dogs slowly increased with time. Statistical analyses of these gradual rises revealed no statistically significant increase in blood pressure, the P value in all 3 groups being $<.5$. Nevertheless, a trend was clearly noted. Whether this slow rise in blood pressure may represent recovery from a shock-like state, accommodation, or possibly the influence of increased intracranial pressure remains problematical. Consideration of the possible role of the "higher centers" in the regulation of blood pressure may be importantly involved in the design and interpretation of experiments in cardiovascular research.

Summary

Blood pressure was compared before and after midpontine pretrigeminal brainstem transection in the dog. Statistically significant decreases in blood pressure were observed 1/2, 1, and 1-1/2 hours after brainstem transection. It is suggested that portions of the central nervous system above the midpontine level are active in maintaining blood pressure at the level recorded before transection.

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