EFFECTS OF PARTIAL HYPOTHALAMIC DEAFFERENTATIONS ON ADRENOCORTICAL RESPONSES

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ABSTRACT

The effects of ether stress and photic and acoustic stimulation on adrenocortical responses were studied in normal rats and in three groups of animals with partial hypothalamic anterior, anterolateral and posterolateral deafferentations, respectively. Animals with anterior deafferentation only, show the same responses as the intact rats, while in the two other groups the response to ether was normal, but that to photic and acoustic stimulation was significantly inhibited. These data would indicate that the transmission of impulses in the medial forebrain bundle and possibly posterior sensory inputs to the hypothalamus play an important role in the adrenocortical responses following neurogenic stimulation.

Various factors regulate the adrenocortical activity and some of them are known to be active through the hypothalamus which affects ACTH secretion (Mangili et al. 1966). The effects on the hypothalamus may be humoral or may be mediated by nervous pathways. In our previous studies, using rats with complete hypothalamic islands, we have divided stresses into "systemic", i.e. mediated by a humoral activation and "neurogenic", depending upon whether or not they have produced adequate adrenocortical responses following the application of these stimuli. Thus, ether was found to be a "systemic" stress,
while photic and acoustic stimuli were found to be «neurogenic» stresses (Feldman et al. 1968, 1970a). With the purpose of determining the neural afferent pathways mediating the «neurogenic» stresses, different partial deafferentations of the hypothalamus were performed and the effects of ether, photic and acoustic stimulation on adrenocortical responses determined.

MATERIALS AND METHODS

Experiments were performed on male albino rats of the Hebrew University strain weighing approximately 225 g. Ether stress, and photic and acoustic stimulation were applied to both intact rats and to three different groups of animals in which partial anterior, anterolateral and posterolateral deafferentation of the hypothalamus was performed one week previously, using the method of Halasz & Pupp (1965). The ether stress and the neurogenic stimuli were applied at 5–7 days interval and rats were alternated as to which procedure was used first. The ether stress consisted of rapidly removing the rats from their cages, placing them in a jar containing ether. Following anaesthesia, a skin incision was made and a sample of blood removed from the jugular vein. The whole procedure took no more than two minutes, during which time no significant increase in plasma corticosterone is found. The initial sample was used for the determination of basal plasma corticosterone levels (Glick et al. 1964) and a second sample, removed 15 minutes later under ether anaesthesia, was used for the determination of the ether stress value. Photic stimulation consisted of exposing the animals to a Grass Photostimulator emitting flashes at the rate of 5/second for 30 minutes in a dark room; immediately following this the animals were anaesthetized with ether and a sample of blood removed within two minutes as described above. Acoustic stimulation consisted of exposure of the rats for a period of 30 minutes to a constantly ringing domestic alarm clock. Immediately following this, the animals were anaesthetized and bled as described above. The brains were examined histologically in order to determine the extent of the deafferentation (Fig. 1).

RESULTS

In the three different groups of animals with anterior, anterolateral and posterolateral deafferentations, the basal levels of plasma corticosterone were 10.6 ± 0.8, 8.7 ± 0.5 and 9.2 ± 0.8 μg/100 ml, respectively. The basal level in the intact rats was 9.6 ± 0.9 μg/100 ml. As demonstrated in Fig. 2, anterior deafferentation had no effect on the adrenocortical response to ether stress (P > 0.5) or to photic (P > 0.1) and acoustic (P > 0.5) stimulations, as compared to intact animals. Anterolateral deafferentation too did not affect the response to ether (P > 0.1), while photic (P < 0.001) and acoustic (P < 0.001) responses were markedly inhibited by 47.1 % and 45.5 % respectively. Similarly, in animals with posterolateral deafferentation the response to ether was normal (P > 0.05), but once again the corticosterone plasma levels were very significantly reduced after photic (P < 0.001) and acoustic (P < 0.001)
stimulation by 33.2% and 42.8% respectively, when compared with intact animals.

The histological examinations of the brains show that the anterior cut was just behind the optic chiasm, and in anterolateral deafferentation it extended posteriorly 1–1.5 mm laterally to the midline, reaching the mammillary region. The posterolateral cuts involved the mammillary region and extended rostrally to the anterior hypothalamic area.

**DISCUSSION**

The present experiments demonstrate that the various partial deafferentations of the hypothalamus have no effect on adrenocortical responses to ether stress, as was also found in animals with complete hypothalamic islands (*Feldman et al. 1970b*). Anterior deafferentation of the hypothalamus also had no effect on the adrenocortical responses to neurogenic stimuli, while the anterolateral
Effects of partial hypothalamic deafferentation on adrenocortical responses.

N = indicates the number of animals in each experimental group.

The arrows indicate the front of the brain.

and posterolateral deafferentations inhibited these responses very significantly. This must be considered as a true inhibition since the basal corticosterone levels in the partially deafferented animals were similar to those found in intact rats and in those with complete hypothalamic islands (Feldman et al. 1968, 1970a; Makara et al. 1970). These data would indicate that the neurogenic impulses probably do not reach the hypothalamus from the preoptic area, which had been separated from the hypothalamus by the anterior cuts. Furthermore, they demonstrate that the retino-hypothalamic tract, the presence of which is the subject of considerable controversy (Kiernan 1967), does not seem to play any important role in the activation of the adrenocortical responses produced by photic stimuli.

The common lesion in the animals with anterolateral and posterolateral deafferentations is the lateral cut involving both sides of the hypothalamus. This cut has traversed the medial forebrain bundle (MFB) or was situated more medially to it, thus interrupting the input from the lateral to the median hypothalamus, which plays an important role in the mechanisms regulating ACTH secretion. The MFB is an important multisynaptic pathway which traverses the lateral hypothalamus and connects forebrain limbic structures with a large zone of the midbrain and serves as a modal point in the »limbic system – midbrain circuit« (Nauta & Haymaker 1969). It receives afferent inputs from various structures and within it is situated the inferior fasciculus of the accessory optic tract, which separates from the optic tract and terminates in a nucleus which lies in the ventral midbrain tegmentum, near the mammillary peduncle (Moore et al. 1968). The latter contributes to the MFB.
Photic impulses are mediated by this accessory optic tract and may be transmitted rostrally to the hypothalamus through the MFB. Similarly, acoustic impulses may reach the MFB from the brain stem and subsequently be related to the medial basal hypothalamus which regulates ACTH secretion. In fact, recent experiments have shown that anterolateral hypothalamic deafferentation reduces the rise in plasma corticosterone induced by noise and vibration (Makara et al. 1969). This sequence of events is supported by electro-physiological studies which have demonstrated shorter evoked potentials in the lateral hypothalamus than in the medial hypothalamus, following photic and acoustic stimulation (Sarne & Feldman 1971).

The important role of the MFB in the transmission of sensory impulses to the hypothalamus has been demonstrated in another series of experiments in which it has been found that localized lesions in this pathway will diminish the adrenocortical responses to neurogenic stimuli (Feldman et al. 1970b and unpublished data).

The present results do not resolve the problem whether conduction only along the MFB in the hypothalamus is essential for the adrenocortical activation or whether the posterior input into the hypothalamus also plays a part. This problem may be resolved by selective posterior deafferentation. Such studies are now in progress and preliminary data in a small number of rats indicates that centrally placed posterior cuts can also reduce the adrenocortical responses following photic and acoustic stimulation.

REFERENCES

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