SENSORIMOTOR CHANGES FOLLOWING LESION OF MID-DORSAL CAUDATE NUCLEUS IN RATS

V. K. MULGAONKER AND M. G. GOGATE

Department of Physiology,
Goa Medical College,
Bambolim, P.O. Santa Cruz, Goa – 403 005

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Summary : Effects of mid-dorsal caudate nucleus on sensorimotor changes were studied in rats. After electrolytic lession of this area of brain there was impairment in sensory functions and decline in motor component was observed to be statistically significant.

Key words : sensorimotor changes rats mid-dorsal caudate nucleus electrolytic lesion

INTRODUCTION

It has been documented that electrolytic lesion of lateral hypothalamus causes sensory inattention, limb dysfunction, catalepsy and akinesia (10,11,13,22). Sensorimotor impairment is also reported following lesion of ascending dopaminergic (DA) nigrostriatal pathway (6,9,12,20). Indeed damage to mesotelencaphalic dopaminergic projections display several behavioural disturbances including neglect manifested by inability to orient towards somatosensory, visual or olfactory cues (11,21,23).

Both regulatory and learning functions have been shown to be heterogeneously organised within the caudate-putamen (1,2,3,4,15,16,17,24). Therefore it is of interest to know whether caudate-putamen manifests a similar role in sensorimotor function in conjunction with cerebral cortex. In fact it is shown by Marshall *et al.* that chemical lesion of DA terminals in striatum by 6-hydroxydopamine (6-OHDA) induces transient sensorimotor impairments (8). Dunnett and Iversen (5) have documented that unilateral lesion of caudate nucleus affects somatosensory responses on the contralateral side. These effects however depended upon the area of caudate nucleus destroyed and also upon the method employed for such a destruction of the area (such as local instillation of neurotoxin, kainic acid, or selective destruction of DA fibres by 6-OHDA).

The present work is based on the study of the effects of bilateral electrolytic lesions of mid-dorsal caudate nucleus on sensorimotor orientation.

MATERIAL AND METHODS

The study was carried out in 20 male albino rats of age between 120 and 150 days. The animals were housed in individual cages under a natural light-dark cycle and with *ad libitum* access to food and water.

The sensorimotor test battery consisted of orientation tests which mainly are concerned with sensory component while the motor component was studied under different limb use tests (5).

Orientation tests consisted of :—

1 *Whisker touch* – Vibrissae touched lightly with tooth pick from behind and below the rat on each side so as to reduce the visual cues.

2. *Snout probe* – An hair aesthesiometer lightly brushed slowly against the snout of rat approaching from each side.

3. *Olfaction* – A cotton swab soaked in ammonia solution brought slowly towards the animal's nose from either side and below.

4. *Somaestheses* – Light pin prick applied to rostral, middle and caudal aspects on the lateral surface of the body on each side.

The orientation of the head to the above stimuli was rated on a 3-point scale : absent (0), weak (1) or strong (2).

Limb use tests consisted of :—

1. *Catalepsy* – Animal's forepaws were placed on a wooden block 3 inches above the examination table, and latency to bring these paws down was recorded with a stop watch. The procedure was then repeated for hindpaws.

2. *Forelimb placement* – The animal was held with head downwards and slowly lowered towards the table surface. The accuracy to extend and place the forelimbs on the approaching surface was noted.

3. *Forelimb support* – The animal was grasped by one forepaw and raised off the table. The latency to pull itself up with the help of free forepaw was recorded by stop watch.

4. *Climbing grid* – The animal placed vertically with head facing upwards over a rectangular wire net (8" x 5") hanging along the side of examination table. The ability of the animal to grasp at the wire net was noted.

5. *Limbs withdrawal* – The animal was held dorsally with hand and with all the limbs remaining free. Each paw was lightly pinched with a pair of toothed forceps. The speed and strength of limb withdrawal was rated.

6. *Wooden probe* – A toothpick was gently inserted into the side of animal's mouth. The response whether ignored, grasped or bitten was recorded.

The coordinated limb use was rated for each limb as appropriate on 3-point scale : ineffectual (0), poor (1) or good (2). On tests involving latency measure, the times in seconds were subdivided into 3 ranges : >10s (0); 3-10s (1) or >3s (2).

The test battery provided a maximum score of 24 points for orientation tests and a similar score for limbs use tests.

These sensorimotor responses were studied on three successive days and the mean score was determined.

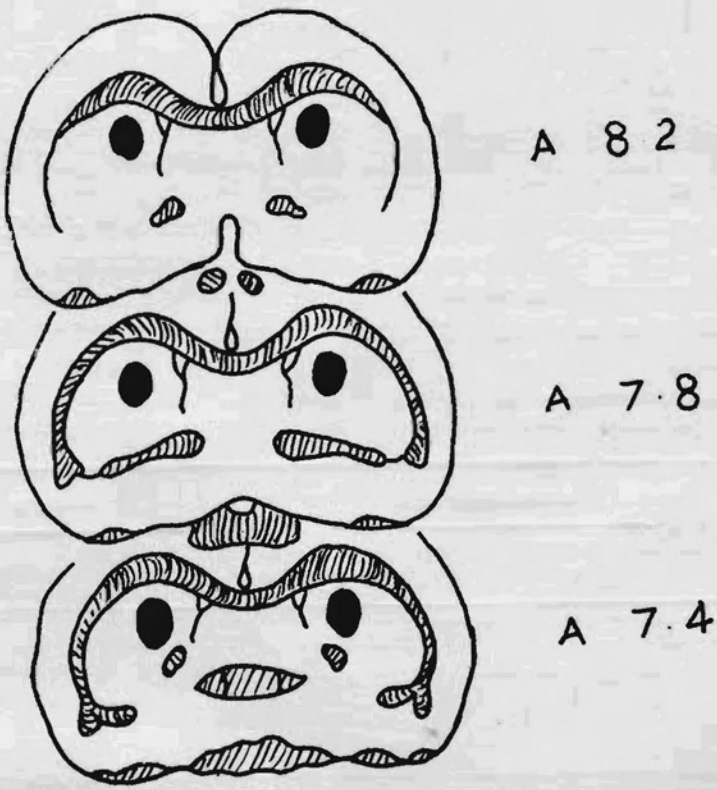

Fig. 1. Coronal section of rat's brain at the levels A 8.2, A 7.8 and A 7.4 (De Groot stereotaxic coordinates). The extent of the lesion is shown in black on both sides.

Thirteen animals were then lesioned bilaterally at 7.4 to 8.2 mm. anterior to vertical zero plane (A 7.4 to A 8.2); 2 to 3 mm lateral to midline (L_2 to L_3) and 6.5 to 7.5 mm. above the intraural line (H+1.5 to H+2.5). Cathodal current of 1.5 mA was passed for 30 seconds on each side to make an electrolytic lession.

Seven animals were sham operated.

Four days were allowed to pass after the operation and the animals were tested for sensorimotor responses on following 3 successive days. Results of mean score before and after the operation were compared.

At the end of the experiment the animals were sacrificed and the site of lesion was confirmed histologically by staining the brain sections with cresyl violet. Fig. 1 displays the anteroposterior extent of lesion in all the animals.

RESULTS

The results indicate that the sensory and motor components show decline in mean scores after the bilateral lesion of mid-dorsal caudate nucleus in the experimental series (Table I). Limb use tests indicate that there was uniform decline of score in all the 13 animals, while the orientation test score did not show this uniformity after the lesion. In fact in 2 animals the score after the lesion was increased while in the other two animals the score remained unchanged. The sham series did not show any significance in either of the tests (Table I). Statistical analysis with the results obtained after the bilateral destruction of mid-dorsal caudate nucleus revealed significance in the decline of limb use tests score ($P<0.001$) while there was no significance in the mean decline of orientation test score.

TABLE I : Results of orientation tests score and limb use test score (mean±S.D.) in 13 experiemental and 7 Sham operated animals before and after lesion/sham operation.

	Orientation tests		*Limb use tests*	
	Before	*After*	*Before*	*After*
Experimental series	18±2.6457	17.23±1.5359 NS	21.33±1.42	17.23±1.9758 **
Sham series	19±0.4435	19.19±0.3761 NS	20.34±0.9537	20.33±0.7633 NS

** P<0.001
N.S. – Not significant

DISCUSSION

The present results suggest that bilateral electrolytic lesion of mid-dorsal caudate nucleus predominantly affects the motor behaviour as compared to the sensory component. Dunnett and Iversen also observed that destruction of the same area does not affect the sensory and motor behaviour to the same extent (5).

Our earlier studies (14) have demonstrated that lesion of the same areas under study increases the pain threshold for nociceptive stimuli. This area thus seems to modify the pain sensation. In the present study the sensory component is not affected. This may be because the present study was undertaken four days after the lesion while the earlier studies were carried out for a period till 15 days after the bilateral destruction of mid-dorsal caudate nucleus. A similar result might have perhaps been obtained if the present study was continued for a period of 15 days after the lesion.

It is known that the ascending DA containing neurons play a critical role in the capacity of animals to perform tasks requiring complex sensorimotor integration and bilateral damage to these fibres by intracerebral injection of 6-OHDA show profound impairments in orienting their heads towards somatosensory stimuli emanating from either side of the body (12). Such animals have difficulty in guiding their limbs through space and they maintain awkward position for prolonged periods – catalepsy (12,18,19).

The electrolytic lesion in the present study might have damaged the dopaminergic neurons in mid-dorsal caudate nucleus resulting in impairment of motor functions. Further work is required with local instillation of DA or DA-receptor stimulant such as apomorphine (7) to study the progress in the motor impairment followed after the mid-dorsal caudatal destruction and study whether DA fibers from motor cortex to this area control the motor activity of animal. Identification of more localised cortical focus projecting upon this area of caudate nucleus and modify the motor functions is also required.

The present study indicates that mid-dorsal caudate nucleus appears to be heterogenous in the mediation of sensorimotor orientation – the sensory component not being much affected as compared to the motor functions after electrolytic lesion.

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