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Cytoarchitecture of Oculomotor Nucleus in the Buffalo (*Bubalus bubalis*)

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Abstract:- The cytoarchitecture of the oculomotor nucleus in the buffalo has been described by materials collected from eight buffalos. Nissl and myelin stained serial and semi serial sections of brain stem were used for the study. The motor nucleus of oculomotor nerve was comprised of small and medium sized multipolar neurons while the parasympathetic nucleus was composed primarily of small and medium sized fusiform cells. The mean neuron population in the right and left motor nucleus of oculomotor nerve was 26,660 and 26,490 respectively and there was no significant difference in the neuron population of the left and right nuclei of the same specimen. The mean neuron population in the parasympathetic nucleus was 18,834. It was found that both the motor and sympathetic division of oculomotor nuclei was better developed in the buffalo. The structural variations that are present in buffalo when compared with other species are may be an expression of the evolutionary adaptations of the species to its environment.

Keywords:- *Cytoarchitecture, Oculomotor Nucleus, Buffalo.*

I. INTRODUCTION

The sense of vision in animals and human beings depends in part on the oculomotor system, which helps in quick localization of target objects and then to follow it during movement relative to the surrounding environment. The nuclei and nerves of oculomotor, trochlear and abducent are the integral part of this system. The nucleus oculomotor nerve belongs to general somatic efferent column that control and coordinate the activity of extraocular muscles, which is the motor component. The oculomotor nucleus in addition has a visceral component belonging to the general visceral efferent column that controls the pupillary light reflex and accommodation, which is the parasympathetic component.

Information on detailed morphology, extent and cytoarchitecture of oculomotor nucleus though extensive in man (6), cat (13,19), and pig (4). Reports on histomorphology of motor division of oculomotor nucleus in buaffalo is also available (17). But the studies on cytoarchitecture of oculomotor nucleus in buffalo is scanty. Hence, the present investigation was undertaken. The studies on cytoarchitecture of the oculomotor nucleus not only helps in understanding the control of normal ocular movements, but also helps in diagnosing the various pathological conditions encountered in animals.

II. MATERIALS AND METHODS

A. Brain samples

Brains of eight buffaloes, obtained from the Corporation Slaughter House, formed the material used in this study. The brainstems were cut and processed for routine paraffin technique.

B. Neuroanatomical techniques

Transverse serial sections of 20 μm thickness were prepared from the brains. The sections were stained with toluidine blue, neutral red and cresyl fast violet (8) for Nissl substance for cytoarchitectural studies and with Weil Weigerts and Luxol fast blue (9) as myelin stain. The true neurons population in the right and left side of the median raphae was determined by following the procedure described by (3).

C. Micrometry

An ocular micrometer was used to measure the size of the neurons. The cells were measured at a magnification of 600. Only those cells that had an intact nucleolus were measured. The length and width of a cell was measured and the average was taken to arrive at its diameter. These diameters were considered as the true diameters. The true diameter of the cell body formed the basis for classification of neurons in the nucleus. Neurons were considered large if they were over 50 μm, medium 26 to 50 μm and small below 25 μm in diameter.

D. Statistical methods

The data obtained with respect to neuron population was subjected to statistical analysis by unpaired ‘t’ test with the help of computer based statistical programme, SPSS version 20.0.

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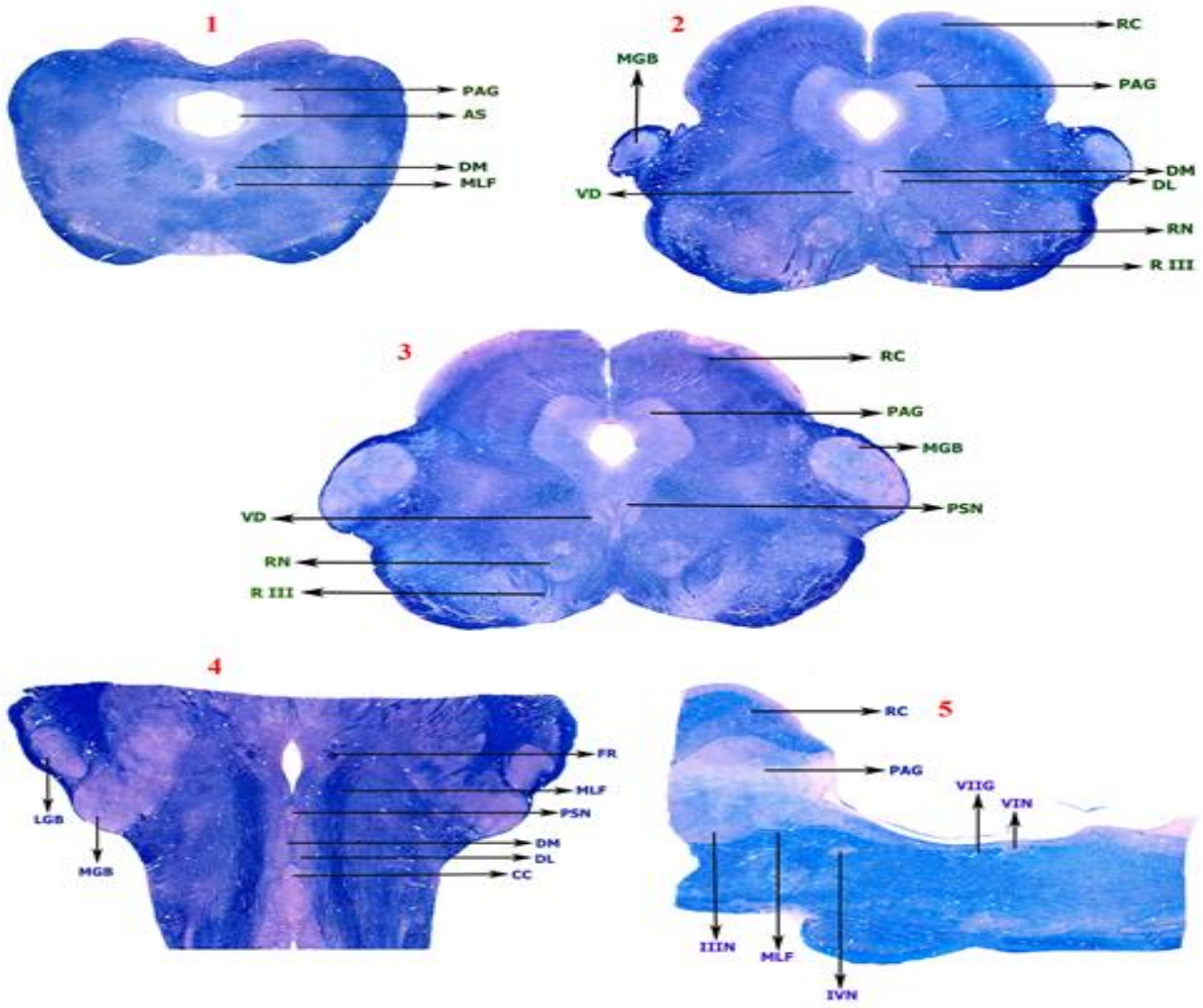
III. RESULTS AND DISCUSSION

A. Subdivisions of the nucleus

The Motor Nucleus of Oculomotor nerve (MNO) in the buffalo was subdivided into a caudal central, dorsomedial, dorsolateral and ventral divisions The caudal central division was unpaired and was located in the midline. The parasympathetic division did not showed any subdivisions (Figs. 1-5). The subdivisions of the nucleus in the buffalo are in accordance with the subdivisions in the chameleon (7) and cat (13). (6) subdivided the nucleus in man into dorsal, intermediate and ventral portions.

B. Type and structure of neurons

The MNO of the buffalo was comprised of small and medium sized neurons. Majority of the medium sized neurons were found to be multipolar stellate type. The nucleus of these cells was central or eccentric and the position of the nucleolus was variable. The small cells were oval, round or triangular in shape with a large central nucleus. The Nissl substance was prominent, coarse and deeply staining (Figs. 6&7). In cats, the large neruons were multipolar stellate shaped or polygonal and the smaller ones were elongated and fusiform (20).



Figs 1-5. Photographs showing:-

1. T.S. of mesencephalon of buffalo to show the caudal pole of motor nucleus of oculomotor nerve.
2. T.S. of mesencephalon of buffalo to show the middle portion of the motor nucleus of oculomotor nerve.
3. T.S. of mesencephalon diencephalon junction through the rostral pole of the motor nucleus of the oculomotor nerve.
4. Horizontal section of mesencephalon of buffalo through the motor nucleus of oculomotor nerve.
5. Sagittal section of mesencephalon, pons and medulla oblongata of buffalo through the motor nucleus of oculomotor nerve.
(Luxol fast blue with neutral red, X2) PAG- Periaqueductal gray,AS-Aqueductus sylvius, DM-Dorsomedial subdivision of motor nucleus of oculomotor nerve, MLF- Medial longitudinal fasciculus RC- Rostral colliculus, DL-Dorsolateral subdivision of motor nucleus of oculomotor nerve, VD-Ventral subdivision of motor nucleus of oculomotor nerve, RN- Red nucleus, R III- Root of oculomotor nerve, MGB- Medial geniculate body, PSN- Parasympathetic nucleus of oculomotor nerve, FR-Fasciculus retrofluxus, CC- Caudal central subdivision of motor nucleus of oculomotor nerve, IV N- Motor nucleus of trochlear nerve, VII G- Genu of facial nerve, VI N- Motor nucleus of abducent nerve.

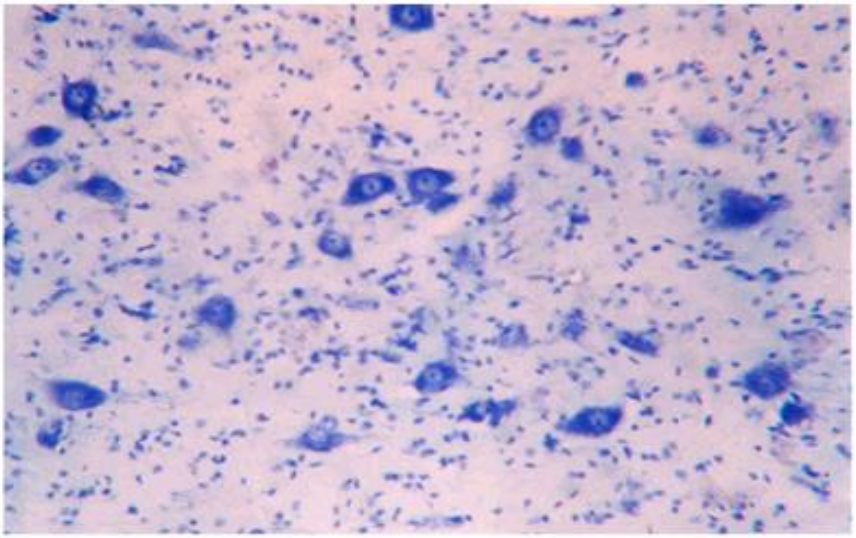


Fig 6:- Photomicrograph showing types and distribution of neurons in the motor nucleus of oculomotor nerve (Toluidine blue-X100)

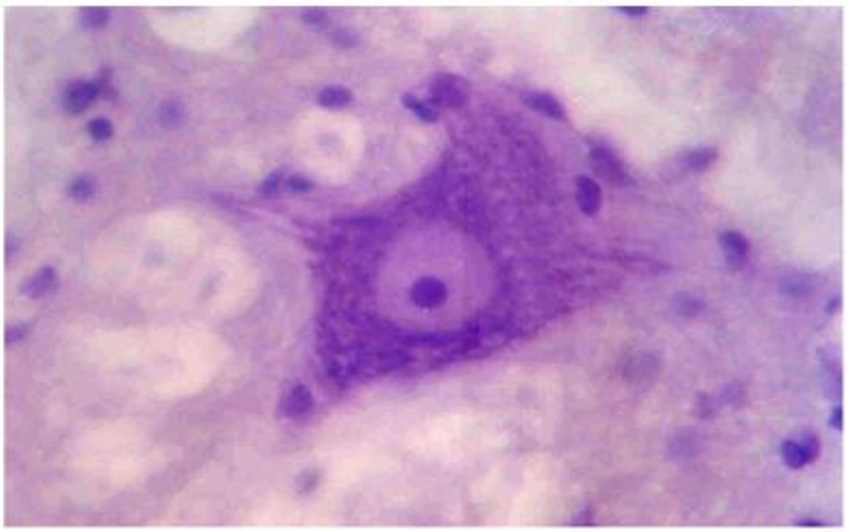


Fig 7:- Photomicrograph showing medium sized neuron in the motor nucleus of oculomotor nerve (Cresyl fast violet-X600)

C. Neuron population

The neuron population in the right motor nucleus of oculomotor nerve ranged from 25,980 to 27,530 with a mean of 26,660 ± 268 and in the left (17) reported that somatic oculomotor nucleus in European bison contains four different types of neurons viz. large and small multipolar, triangular and pear shaped neurons whereas in man the majority of neurons were large multipolar type (6).

Side of Brain	**Buffalo number**						**Mean ± SE**	**'t' * (P< 0.05)**
	B1	B2	B3	B4	B5	B6		
Right	27530	26110	27270	26180	26870	25980	26660±268	0.56
I. LEFT	26750	26940	26590	25970	26540	26120	26490±151	
II. TOTAL	54280	53050	53860	52150	53410	52100	53142±363	

Table 1:- Comparison of neuron population in the left and right motor nucleus of oculomotor nerve in the buffalo

Note: The mean neuron population in the right and left motor nucleus of the oculomotor nerve showed no significant difference (P≤ 0.05).

From 25,970 to 26,940 with a mean of 26,490 ± 151. However, there was no significant difference in the neuron population of the left and right nuclei of the same specimen ($P \leq 0.05$)(Table-1).

According to (2)) the number of fibers in the nerve corresponds to the number of cells in the nucleus. The number of fibers in oculomotor nerve in man varied from 24,892 to 36,814 while the number of neurons varied from 21,500 to 36,940, with mean value of 25,330. They also found that the number of fibers in the nerve of the adult dog was about 10,000. In cow, it varied from 23,033 to 31,201 with a mean value of 28,165. Thus the number of neurons in the buffalo averaged to the number in man and the cow.

The number of neurons in the oculomotor nucleus of the rat was 1476 ± 140 (19) and in the mouse it was 262 ± 63 (12). Thus the total number of the neurons in the oculomotor nucleus of different animals is probably related to the size of the animal and the size of the eyeball.

D. Size of neurons

The neurons were classified into small and medium sized neurons based on their diameter. The mean true diameter of the cell body of medium sized neurons in the MNO were found to be 35 ± 0.46 µm. The diameter of small sized neurons were 23.18 ± 0.44 µm.

The mean diameter of the cell body for medium sized neurons in the parasympathetic nucleus of oculomotor nerve, were found to be 29.87 ± 0.41 µm. In small sized neurons the diameter was 23.1 ± 0.29 µm.

From the observations of (10) it was found that the average diameter of neurons in the somatic portions of the oculomotor nucleus in man was 33 µm while the multipolar neurons in the caudal central nucleus measured 28.5 µm in diameter. The mean size of large multipolar neurons in the motor nucleus of oculomotor nucleus in the one humped camel was 30±5µm (1). The present study did not reveal any significant difference in the average diameter of neurons as compared to man and camel. In monkey, the mean diameter of neurons belonging to different regions of the nucleus ranged from 21.6±3.7 µm to 28.9 ±5µm (5) and in chameleon the size of neurons were 25-30µm (7).

IV. CONCLUSION

It has been observed in the present study that the size range of the cells in parasympathetic nucleus in the buffalo varies when compared with the size of neurons other species. Often, cells of a given shape are seen also to vary in number in the same nucleus of different species. These variations in size and shape of the constituent cells may be suggestive of functional potential of the nucleus.

It is an accepted fact that the oculomotor nerve supplies five muscles of eyeball and the abducent nerve supply the retractor bulbi and lateral rectus muscles (14). But in contrast, studies in cats (15) and rabbits (11) using retrograde horseradish peroxidase (HRP) labeling technique revealed that retractor bulbi motoneurons were also found predominantly in the dorsolateral region of the ipsilateral oculomotor nucleus other than the abducent nucleus. Thus according to these authors the retractor bulbi muscle receives axons from both abducent and oculomotor nerves in the cat and the rabbit. Further studies with the help of electron microscopy, histochemistry and retrograde tracer techniques can elaborate the present knowledge of oculomotor nuclei in the buffalo. Even though we are still far from the concepts of integrated brain activity, electrophysiological and anatomical inquires into the behavior of individual neurons and synapse, and their associations in small functional networks seems to afford a prospect of joint success.

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