Relative Positions of Motor Neuron Somata of Median Nerve in Spinal Cord of Rabbit

Israr Ahmad Khan[1], Farhan Kirmani[2], Mohd Imran[3]

ABSTRACT

Introduction: Median nerve is the main nerve supplying muscles of flexor compartment of forearm. The study was conducted with an aim to see the relative positions of motor neuron somata of median nerve in different segments of rabbit spinal cord.

Material and methods: This study is conducted by using New Zealand white rabbits. Median nerve of left side was cut under general anaesthesia. The right side was used as control. The animals were sacrificed at an interval of 8 to 28 days after operation and perfusion fixed in 10% buffered formalin. Cervical spinal cord segments (C4-C8) and thoracic spinal cord segments (T1 and T2) were processed for paraffin embedding. 40-micron thick serial transverse sections were obtained and stained with thionine. The stained sections were examined microscopically to identify the neuron somata showing retrograde changes including chromatolysis.Then they were projected over reconstructed columns of spinal cord by Elliot's method. Position of motor neuron somata with retrograde changes was noted.

Results: It was observed that motor neuron somata with retrograde changes were present in the medial part of dorsolateral (DL) column of fifth (C-5) and sixth (C-6) cervical segments, in the medial part of dorsolateral (DL) column and whole of the retrodorsolateral (RDL) column of seventh (C-7) and eighth (C-8) cervical segments and in the retrodorsolateral (RDL) column of first thoracic(T-1) segment.

Conclusion: In fifth (C-5) and sixth (C-6) cervical segments motor neuron somata were located in dorsolateral (DL) column, in seventh (C-7) and eighth (C-8) cervical segments they were located in dorsolateral (DL) and retrodorsolateral (RDL) column and in retrodorsolateral (RDL) column of first thoracic (T-1) segment.

Keywords: Motor neuron somata, spinal cord segment, median nerve, chromatolysis

INTRODUCTION

Nervous system is the most complex system of the body. It controls and co-ordinates other systems of the body. It consist of highly specialized cells neuron. Most neurons consist of a central mass of cytoplasm within a limiting cell membrane, the cell body (perikaryon or soma), from which extend a number of branched processes, or neurites. One of these, called as axon, is usually much longer than the others and conducts information away from the cell body. The other processes are termed as dendrites and information travels towards the cell body through these dendrites.

There is plenty of rough endoplasmic reticulum associated with ribosomal RNA present in the neuron cell body. When these are stained with basophilic dyes such as thionine, cresyl violet, toluidine blue etc., they appear as numerous microscopic clumps. These clumps are called as Nissl's granules or Nissl bodies.[1]

The typical morphological changes in the cell body after axotomy were first recognized by Nissl.[1] It includes swelling of the cell and disappearance of basophilic material or Nissl's granules from the cytoplasm. The prominence of the latter phenomenon led to the general application of the term "chromatolysis" for the response to axotomy.[2] Basically chromatolys is the dissolution of the Nissl bodies in the cell body of a neuron. It is an induced response of the cell usually triggered by axotomy, ischemia, toxicity of the cell, cell exhaustion, and virus infections. The event of chromatolysis is characterized by a prominent migration of the nucleus towards the periphery of the cell and an increase in the size of the nucleus, nucleolus, and cell body. However, it has become increasingly clear that the morphological manifestations of this response are different in different cells, and the chromatolysis itself is not invariably seen.[3] Hence the term "axon reaction", "retrograde reaction" or "cell body response"(CBR) have come to be considered more appropriate to designate the whole range of alterations that may occur.[4-6] We can see the location of motor neuron somata of different nerves by producing chromatolysis or cell body response (CBR) in different animals. Location of motor neuron somata of different nerves supplying forelimb muscles have been studied by retrograde cell degeneration technique in dog, rabbit, rat, monkey etc., by electrophysiological method in cat, and by retrograde axonal transport of horseradish peroxidase (HRP) in cat, monkey, dog and in albino rats.[3,7-18] These studies have shown the locations of motor neuron somata of major forelimb nerves in the cervical enlargement of spinal cord.

The aim of present study is to localize the positions of the motor neuron somata of median nervein the ventral grey horn of the spinal cord of rabbit.

MATERIAL AND METHODS

This study is conducted by using New Zealand white rabbits in the Department of Anatomy, Jawaharlal Nehru medical college, Aligarh muslim university, Aligarh, uttar Pradesh, India. Ethical clearance was taken from Central Animal house, JNMC, AMU, Aligarh. Total six rabbits were used in this study, three of them were females and three of them were males.

[1]Senior Resident, [2]Associate Professor, [3]Assistant Professor, Department of Anatomy, JNMC, AMU, Aligarh (U.P.) India

Corresponding author: Israr Ahmad Khan, Department of anatomy, JNMC, AMU, Aligarh (U.P.) India

How to cite this article: Israr Ahmad Khan, Farhan Kirmani, Mohd Imran. Relative positions of motor neuron somata of median nerve in spinal cord of rabbit. International Journal of Contemporary Medical Research 2016;3(5):1431-1433.

The operation to cut the median nerve was performed under general anaesthesia and aseptic conditions. Ether was used for general anaesthesia and inhalation route was used. The median nerve of left side was exposed in axilla and cut. A small segment of the trunk of nerve was also removed to prevent reunion. The right side was used as control. Then the animals were kept alive for 1-4 weeks. After that they were sacrificed with an overdose of chloroform. They were immediately perfused, firstly by about 500 ml of normal saline (0.9% sodium chloride solution) followed by about 1500 ml of 10% formal saline.

On next day rabbit was dissected. Vertebral column was exposed after removing skin and muscles of the back. Spine and laminae of vertebrae were cut through bone cutter and spinal cord was exposed. Complete spinal cord including hindbrain was taken out. Segments of spinal cord was counted with the help of emerging spinal nerves. Fourth cervical to second thoracic segments of spinal cord were separated and kept in numbered containers filled with formalin solution. For identification of side a vertical nick was given on right side of the spinal cord. Tissue blocks of each segment were prepared after paraffin embedding. Sections were cut from tissue blocks with the help of a rotary microtome. Sections were cut at the thickness of 40 micrometers. The sections were stained with thionine stain and examined under light microscope. Nerve cell body with cell body response and typical chromatolysis were identified and marked.(Figure-1). Reconstruction of the longitudinal cell columns (cell groups) of the ventral grey horn of the spinal cord was doneby the method of Elliot (1942).[19]

RESULTS

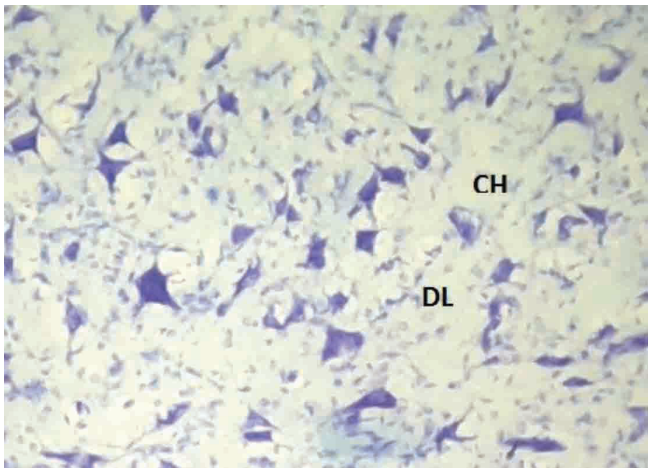
It was observed that motor neuron somata with retrograde changes were present in the medial part of dorsolateral (DL) column of fifth(C-5) and sixth(C-6) cervical segments, in the medial part of dorsolateral (DL) column and whole of the retrodorsolateral (RDL) column of seventh(C-7) and eighth(C-8) cervical segments and in the retrodorsolateral (RDL) column of first thoracic(T-1) segment (Figure-2,3,4).

DISCUSSION

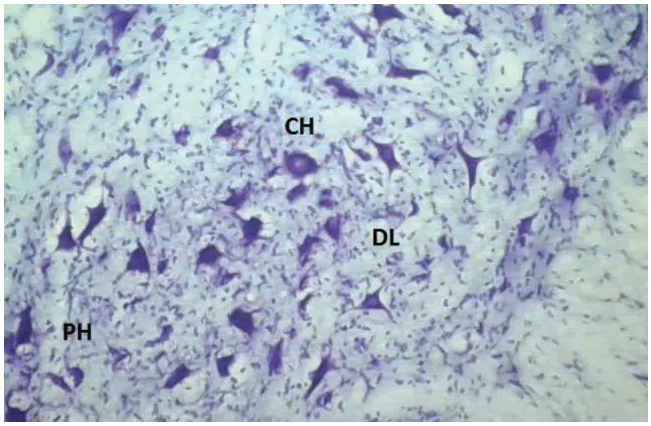
The findings of the present study are in close agreement with the study on buffalo where, in the ventral grey horn of the cervical region, ventromedial and dorsomedial columns (on the medial side) and ventrolateral, dorsolateral and retrodorsolateral columns (on the lateral side) were present.[20] Crosby et al. studied the longitudinal cell columns in cervical enlargement of human spinal cord.[21] In his study he described the presence of ventromedial and dorsomedial cell columns on the medial side and ventrolateral, dorsolateral and retrodorsolateral columns on the lateral side of the ventral grey horn in the cervical enlargement of human spinal cord. The same findings were observed in our study as far as the presence of longitudinal cell columns is concerned.

The findings of the present investigation are in near agreement with Thomas and Wilson in cat both in respect of location of median nerve motor neuron somata and their longitudinal extent in the ventral grey horn of the spinal cord.[22]

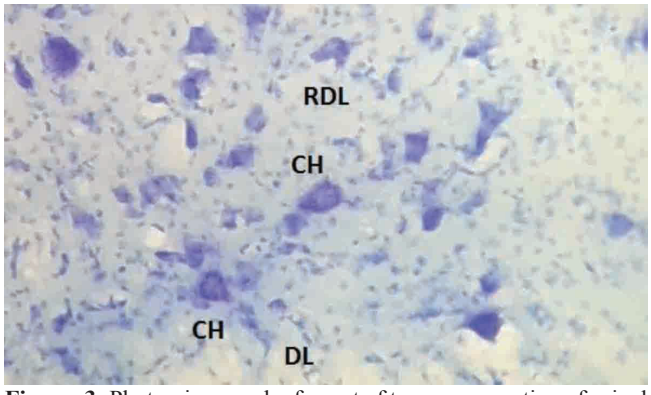
The findings of the present investigation do not agree with



Figure–1: Photomicrograph of transverse section of spinal cord showing chromatolysed neuron soma (CH). Thionine stain X100

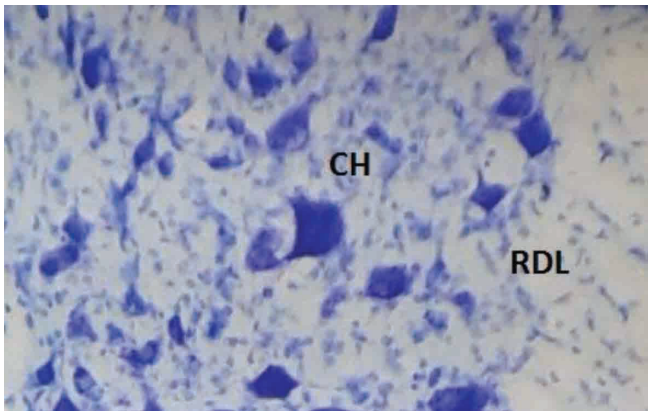


Figure–2: Photomicrograph of a part of transverse section of spinal cord passing through caudal part of fifth cervical (C-5) segment showing a chromatolysed neuron soma(CH) in dorsolateral column (DL) of ventral grey horn.Thionine stain X100.DL = Dorsolateral column



Figure–3: Photomicrograph of a part of transverse section of spinal cord passing through eighth cervical (C-8) segment showing a chromatolysed cells (CH) in dorsolateral (DL) and Retrodorsolateral (RDL) column of ventral grey horn. Thionine stain X100. DL = Dorsolateral column, RDL = Retrodorsolateral column

Fritz et al. in cat who found that the median nerve motor neurones occupied a single representation area in seventh cervical segment whereas in present study we find the two representation area in seventh cervical segment.[23] In eighth cervical and first thoracic segmentstwo median nerve



Figure–4: Photomicrograph of a part of transverse section of spinal cord passing throughfirst thoracic (T-1) segment showing a typical chromatolysed cell (CH) in Retrodorsolateral (RDL) column of ventral grey horn. Thionine stain X100. RDL = Retrodorsolateral column

representation area were found by the Fritz et al. whereas in present study we find two representation area in eighth cervical segment and one representation area in first thoracic segment.

Jenny and Inukai in monkey found that the motor neuron somata of median nerve were located in dorsolateral column of eighth cervical and first thoracic segments, whereas in our study we found that the motor neuron somata of median nerve were located in the dorsolateral and retrodorsolateral columns of the eighth cervical and first thoracic segments.[24]

CONCLUSION

The length of the spinal cord harbouring motor neuron somata of median nerve extends from the caudal part of fifth cervical (C-5) segment up to the middle of first thoracic (T-1) segment. Positions of motor neuron somata of median nerve in different segments of spinal cord of rabbit were as, in dorsolateral (DL) column of fifth (C-5) and sixth (C-6) cervical segments, in dorsolateral (DL) and retrodorsolateral (RDL) column of seventh (C-7) and eighth (C-8) cervical segments and in retrodorsolateral (RDL) column of first thoracic (T-1) segment.

REFRENCES

1. Nissl, F., Uber die Veranderungen der ganglionzellen am Facialiskern des Kaninchens nach Aisreossimg der Nerven. All. Z. Psychiat. Ihre Grenzg. 1892;48:197-198.
2. Grafstein, B., The nerve cell body response to axotomy. Experimental Neurol. 48;1975:32-51.
3. Romanes, G.J., The development and significance of the cell columns in the ventral grey horn of the cervical and upper thoracic spinal cord of the rabbit. J. Anat. 1941;76:112-130.
4. Cragg, B.G., What is the signal for chromatolysis? Brain Res. 1970;23:1-21.
5. Lieberman, A.R., The axon reaction: a review of the principal features of perikaryal responses to axon injury. Int. Rev. Neurobiol. 1971:14;49-124.
6. Lieberman, A.R., Some factors affecting retrograde neuronal responses to axonal lesions. In: bellaris R, Gray E. G. (Eds.) Essays on the Nervous System. Clarendon Press: Oxford, pp. 1974;71-104.
7. Marinesco, G., Recherchén experimentales sur les localizations motrices spinales. Revue Neurol. 1901;6: 463-470.
8. Elliott, H.C., Studies on the motor cells of the spinal cord. I Distribution in the normal human cord. Am. J. Anat. 1942;70:95-117.
9. Goering, J.H., An experimental analysis of the motor cell columns in the cervical enlargement of the spinal cord in the albino rat. J. comp. Neurol. 1928;46:125-151.
10. Reed, A.F., The nuclear masses in the cervical spinal cord of Macaca mulatta. J. comp. Neurol. 1940;72,: 187-206.
11. Sterling, P. and Kuypers, H.G.J.M., Anatomical organization of the brachial spinal cord of the cat. II. The motor neuron plexus. Brain Res. 1967:4;16-32.
12. Thomas, R.C. and Wilson, V.J., Recurrent interactions between motor neurons of known location in the cervical cord of the cat. J. Neurophysiol. 1967;30:661-674.
13. Jenny, A.B. and Inukai, J., Principles of motor organisation of the monkey cervical spinal cord. J. Neurosci. 1983;3:567-575.
14. Iwamoto, G.A., Haber, L.H., Dixon, J.A. and Gonyea, W.J., Anatomical distribution of flexor carpi radialis and flexor carpi ulnaris motor nuclei in the cat spinal cord. Neurosci. Lett. 1980;20:25-30.
15. Fritz, N., Illert, M. and Reeh, P., Location of median and ulnar motor nuclei in the cat. Neurosci. Lett., 1982: 30;103-108.
16. Fritz, N., Illert, M. and Reeh, P., Location of motoneurons projecting to the cat distal forelimb. II. Median and ulnar motornuclei. J. comp. Neurol. 1986; 244:302-312.
17. Mutai, M., Shibata, H. and Suzuki, T., Somatotopic organisation of motor neurons innervating the pronators, carpal and digital flexors and forepaw mucles in dog. Brain Res. 1986;375:90-95.
18. Rao, G.S., Sahu, S. and Saigal, H.P., The phrenic nerve and localisation of phrenic nerve nucleus in the spinal cord of buffalo (Bubalus bubalis). Acta anat. 1972;83: 468-477.
19. Elliott, H.C., Studies on the motor cells of the spinal cord. I Distribution in the normal human cord. Am. J. Anat. 1942;70: 95-117.
20. Rao, G.S., Nuclear pattern of the spinal grey in the buffalo (Bubalusbubalis). J. Anat. Soc. India. 1970;19: 5-11.
21. Crosby, E.C., Humphrey, R. and Lauer, E.W., Correlative anatomy of the nervous system. Macmillan, New York. 1962;315-357.
22. Thomas, R.C. and Wilson, V.J., Recurrent interactions between motor neurons of known location in the cervical cord of the cat. J. Neurophysiol. 1967;30:661-674.
23. Fritz, N., Illert, M. and Reeh, P., Location of median and ulnar motor nuclei in the cat. Neurosci. Lett. 1982; 30:103-108.
24. Jenny, A.B. and Inukai, J., Principles of motor organisation of the monkey cervical spinal cord. J. Neurosci., 1983;3:567-575.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 22-03-2016; **Published online**: 22-04-2016