Research Article

A study of the Structure of Mesencephalic Trigeminal Nucleus (Mes V) in the Rabbit

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Summary

Background: There is a dearth of information on the morphometric characteristics of mesencephalic trigeminal nucleus (Mes V) of the rabbit. Hence, the purpose of this study was to determine some fundamental morphologic parameters of the mesencephalic trigeminal nucleus (Mes V) in the adult rabbit.

Methods: Brains were isolated after intracardial perfusion and were sectioned at 30µm in the coronal and horizontal planes with a freezing microtome and stained with the Bielschowsky’s method of silver impregnation.

Results: It was observed that the Mes V nucleus commenced from the ventral region of the optic tectum to the mid-pons, running along the fourth ventricle and cerebral aqueduct outside the periaqueductal grey. The two Mes V nuclei contain about 1400 neurons. These neurons were mostly pseudounipolar consisting mainly of types “A” (35 -56 µm) and “B” (20-25 µm). Also present were a number of spindles and multipolar neurons.

Conclusions: The comparatively high number of neurons in the rabbit’s Mes V nucleus may be due to the fact that rabbits are instinctive behavioural chewers, since it is known that neuronal population and complexity of Mes V nucleus is proportional to the masticatory activities of the jaw muscles.

Key words: Mesencephalic trigeminal nucleus, Periaqueductal, Periventricular, Optic tectum

Özet

Giriş: Tavşanın mezensefaliğin trigeminal çekirdeğinin morfometrik özellikleri üzerine çalışma ve bilgiler çok azdır. Bu nedenle bu çalışmamızın amacı erişkin tavşanda mezensefalik trigeminal çekirdeğin (Mes V) bazı temel morfolojik parametrelerinin ortaya konmasıdır.

Yöntem: İntrakardiak perfüzyon sonrası beyinler Bielschowsky’in gümüş endirmeye yöntemi kullanılarak ışık mikroskobunda incelemek üzere parafin kesitler halinde hazırlanıdı.


Yargı: Tavşanın Mes V çekirdeğindeki oransal olarak çok sayıdaki nöronların varlığı, tavşanın içgüdüsel eğilme davranışının olmasıına bağlanabilir. Çünkü Mes V nükleusundaki oransal olarak nöronal popülasyonun kompleksitesi eğilme aktivitesindeki çene kasları ile oransal olarak etkileştiği bilinmektedir.

Anahtar Kelimeler: Mezensefalik trigeminal nükleus, Periaquaduktal, Periventriküler, Optik tektum
INTRODUCTION

The trigeminal mesencephalic (Mes V) is a unique feature of all jawed vertebrates\(^{(21,22)}\). Several studies have emphasized a distinctive feature of Mes V as being the only primary afferent neurons with their cell bodies located within the CNS\(^{(3)}\). The distribution of Mes V spans the mesencephalon and the rostral portion of the pons as set of large cells arrayed individually and in clusters along the edge of the midbrain periaqueductal gray, and caudally, additional Mes V neurons are distributed adjacent to the mesencephalic tract\(^{(22)}\). As primary sensory neurons, most Mes V neurons are pseudounipolar and appear to lack characteristic dendritic processes\(^{(13,22)}\). Peripheral branches of the axons of these neurons innervate muscle spindles of the jaw musculature and periodontal mechanoreceptors, whereas their central branches innervate jaw motor nuclei, the supratrigeminal nucleus, the principal sensory nucleus of the trigeminal nerve, and the parvocellular reticular formation\(^{(13)}\). It is now well established that Mes V controls the biting force of the jaws, and therefore modulates the occlusal vertical dimension (OVD) which determines an individual's ability to perform oral functions such as mastication, speaking, and swallowing effectively\(^{(4,20)}\).

MATERIAL AND METHODS

Two male New Zealand rabbits of 14-18 weeks postnatal age with an average weight of 2.5kg were used for this study. The animals were perfused intracardially with 10% formal saline under deep anaesthesia with ketamine HCl (intra peritoneal inj. at 1.5mg/kg). The brainstems were removed and sectioned at 30µm in the coronal and horizontal planes with a freezing microtome (cryostat) at -20ºC after adequate fixation with 30% sucrose formal saline. The Bielschowsky's method of silver impregnation was used. Histologic study was performed with the use of Karlkape KA 6334 Asslarwetzlarr binocular light microscope. With the aid of an atlas of the New Zealand rabbit's brain\(^{(16)}\) the nucleus locations were identified and were reconstructed with x10 objective and the neurons were mapped using x40 and x100 objectives. Photomicrographs were taken with Leitz Laborlux 12.

RESULTS

Location and Identification of Mes V neurons

These neurons were seen at the periaqueductal grey (PAG) of the midbrain and periventricular grey (PVG) in the pons (Fig 1A-C). The nucleus commences from the ventral region of the optic tectum PAG and courses to the PVG of the pons. Their unique nature of being pseudounipolar was established as each cell revealed emergence of a stout axon before dividing into a central and peripheral process (Figure 2B). Observed clustered neurons as delineated (Fig 1A-C).

Neuronal population and morphology

Each nucleus contained approximately 700 neurons of various shapes. Some neurons were oval to spherical while others were polygonal or spindle shaped (Figures 2A-D). Based on morphology, we observed:
“type A” pseudounipolar neurons (35-65 μm, Figs 2B and C), “type B” pseudounipolar neurons (20-25 μm, Figs 2A and 2D), spindle pseudounipolar neurons (Fig 2B) and small multipolar neurons < 20 μm] (Fig 2E). However, types A and B neurons were more prominent. Type A neurons were more prominent in the caudal part of the nucleus while type B were more prominent rostrally. However both were scattered throughout the entire length of the nucleus. Of the total neuronal population, the large Type ‘A’ neurons constituted 65%, while the smaller Type ‘B’ neurons represented 35% of the population. All neuronal types lacked dendritic trees. Nissl granules were also seen in the neurons (Fig 2F). The average length and lateral extension of the nucleus was estimated at 9.45 mm and 0.96 mm respectively (Fig 2B). Also present were glial cells (Fig 2E).

Figure 1: Location of Mes V nucleus in rabbit. Rostral limit is at the PAG of the Midbrain (Fig 1C) and caudal limit at the PVG of Pons (fig 1A). Also shown are clusters of neurons (delineated) in the nucleus (1A-C x 100).

Figure 2: The main morphologic neuron types of the rabbit Mes V nucleus. Present were pseudounipolar neurons type “A” (fig 2A, black arrow x500 and fig 1C x1000, oil-immersion); pseudounipolar neuron type “B” (fig 2A white arrow x500 and fig 2D x1000); spindle pseudounipolar neurons (fig 2C x500) with a stout axon (white arrow) dividing into a central and peripheral processes (white arrowed heads); multipolar neurons and glial cells fig 2E (X400 ). Also observe types “A” and “B” neurons with nucleoli and Nisil granules (fig 2F X1000, oil-immersion).
DISCUSSION
Judging from the volumes of scientific works that have been done on this species, it is impossible to claim any novelty in our findings, although, evidences are scant to the contrary. However, this study has provided information on the morphometric features of the Mes V nucleus in young adult male rabbits. The location, neuron types and shape of Mes V nucleus were described (Fig 1 and 2). Our study revealed that the Mes V nucleus in rabbits is made up of a ribbon shaped clutter of neurons located in the central gray of the midbrain along the outer border of the periaqueductal gray mater. The nucleus extends in a rostrocaudal direction from the superior colliculus to the level of the trigeminal motor nucleus, along the periaqueductal grey (PAG) of the midbrain to the periventricular grey (PVG) of the pons, respectively. This agrees with previous observations. Our study also confirmed earlier reports that though the various neuron types are predominant in some locations, they are however, scattered all through the Mes V nucleus. There is however some variations in the neuronal morphology between species. Saigal et al described two neurons types based on their projections in the sheep: type A, large unipolar neuron which project to the medulla, and type B, small fusiform, multipolar neurons, that innervate the cerebellum. Sugiura et al distinguished four types of neurons based on their Nissl granule arrangement. In other studies, three types of neurons were distinguished based on their shape: polygonal, spindle and oval. Sivanandasingham and Warwick identified two types of neurons: types A and B based on their size. Type A neurons are scattered throughout the entire length of the nucleus and are mostly restricted posteriorly and, type B neuron which are generally confined to the rostral half of the nucleus and were scattered amongst the larger cells. Terashima suggested that the large

Figure 3: Showing other morphologic variant of rabbit Mes V (3A, B & D). A type B neuron (3C) showing nucleoli and Nisil granules.
globular perikarya of Mes V are derived from the neural crest and probably are analogous and homologous to dorsal root ganglion cells. This study also showed that the total neuronal population of Mes V nucleus is about 1400 neurons (700 neurons per Mes V nucleus). This was higher than the values observed in similar studies in other species. It was reported that Protopterus and Neoceratodus (Lungfishs) contain about 570 Mes V neurons\(^{(21)}\); the frog Rana ridibunda is about 120 neurons that are scattered on both sides of the rostral mesencephalic tectum\(^{(12)}\). The comparatively high number of neurons in the rabbit's Mes V nucleus may be due to the fact that rabbits are instinctive behavioural chewers, as they need to chew in order to wear down their incisors which grow continuously throughout their lives\(^{(2)}\). There are evidences that the neuronal population and complexity of Mes V nucleus is proportional to the bulkiness and masticatory activities of the jaw muscles\(^{(6,9,25)}\).

**CONCLUSION**

In conclusion, our study revealed that the Mes V nucleus of the New Zealand rabbit contains about 1400 neurons; 700 neurons per Mes-V nucleus, consisting of four neuron types which are mostly type A and type B cells. There were also a number of spindles and multipolar cells scattered within the nucleus.

**REFERENCES**


