Somatotopic Localization of Neurons in the Motor Trigeminal Nucleus of the Dog

**—with special reference to the masseter
and temporal muscles—**

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Basing upon a comparative anatomical study of the laminar structure of the masseter muscle of the mammal, Yoshikawa et al. (1961, 1965 and 1969) reported that the masseter muscle consisted of the proper masseter muscle, which corresponded to the Pars superficialis and the Pars profunda in P. N. A., and the improper masseter muscle, namely the maxillomandibular and zygomaticomandibular muscles. Furthermore, Nagasawa and Suzuki (1973) investigated the nerve supply to the proper masseter, improper masseter and temporal muscles of the dog, and judged that each of the three muscles is independent respectively.

On the other hand, the somatotopic localization of neurons in the motor trigeminal nucleus of the cat, which was detailed by Szentágothai (1949), was confirmed by Vedral and Matzke (1967). Mizuno et al. (1974 and 1976), however, demonstrated another representation in the cat and rat.

In the present study, the neuronal representation in the motor trigeminal nucleus of the dog, with special reference to the proper masseter, improper masseter and temporal muscles, was investigated with the method of the retrograde degeneration of neurons.

Material and Method

Thirteen mongrel adult dogs (8-12 Kg body weight) were used for the present study. They were anesthetized with sodium pentobarbital

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(25 mg/Kg) i. v. The operative procedure was as follows.

Experiment A. The common trunk which was composed of the masseteric and caudal deep temporal nerves was transected near its origin from the mandibular nerve, and the cranial deep temporal nerve which arose in common with the buccal nerve was sectioned at the same time near its origin from the parent trunk. This operation which denervated the temporal, improper masseter and proper masseter muscles was carried out in five cases.

Experiment B. The masseteric nerve, which was composed of the improper masseteric and proper masseteric branches, was sectioned near its origin from the common trunk proximal to the mandibular notch in five cases.

Experiment C. The proper masseter muscle with its nerve branches of the masseteric nerve was removed in three cases.

Fourteen days after the operation the dogs were exsanguinated under the pentobarbital anesthetasia, and were perfused with 96% ethanol via both the common carotid arteries. Then the brains were removed and the blocks from the medulla oblongata to the mesencephalon were fixed with 96% ethanol for seven days. The blocks were embedded in celloidin. Transverse sections 30μ thick were cut serially and stained with 0.1% aqueous solution of thionin or cresyl violet.

The retrograde degeneration of neurons was judged from the chromatolysis, maldistribution of the cell-nucleus and swelling of the cell body. All the cells, in which the nucleoli were distinct, were observed.

Result

Small-sized neurons were excluded from the observation because of the difficulty in judging their degeneration. There were variable degrees of degeneration of the neurons in the motor trigeminal nucleus of the operated side.

The outline of the cross section of the motor trigeminal nucleus was a bended oval shape such as being convex laterad, concave mediad, narrow dorsad and broad ventrad.

Experiment A. The degenerated neurons were found throughout the lateral half of the motor trigeminal nucleus and spread dorsomedially at the cranial level of the nucleus.

Experiment B. The degenerated neurons appeared in the ventral half of the lateral part of the motor trigeminal nucleus at its caudal level. They increased gradually from the caudal to cranial levels, becoming maximal at the cranial level of the nucleus. The distributing area of the degenerated neurons spread near the dorsal border of the lateral half of the nucleus at its cranial limit.

Experiment C. The distributing area of the degenerated neurons was more localized than that of the Experiment B. The degenerated neurons were found in the narrow ventrolateral part of the motor trigeminal nucleus at its caudal level. The distributing area of the degenerated neurons gradually spread dorsally from the caudal to cranial levels and was located in the ventrolateral two third of the nucleus at its cranial level.

These results were enabled to determin the area of the neurons which supply to each muscle.

Proper masseter muscle: The area of the neuronal representation of the proper masseter muscle is located in the ventrolateral one third of the motor trigeminal nucleus at its caudal level. This area spreads dorsally from the caudal to cranial levels of the nucleus and is located in the ventrolateral two third of the nucleus at its cranial level.

Improper masseter muscle: The area of the neuronal representation of the improper masseter muscle is located just dorsal to that of the proper masseter muscle. This area is narrow at the caudal and cranial level, and is broad at the intermediate level of the nucleus.

Temporal muscle: The neuronal representation of the temporal muscle is located just dorsal to that of the improper masseter muscle. This area is located in the dorsal two third of the lateral part of the motor trigeminal nucleus at its caudal level. It gradually becomes narrow toward the cranial level of the nucleus and is limited to the narrow dorsal and dorsomedial parts of the nucleus at the cranial level.

Fig. 1. Distribution of the degenerated neurons in the left motor trigeminal nucleus of the dog in experiment A, B and C.

Fig. 2. Neuronal representation of the proper masseter, improper masseter and temporal muscles in the left motor trigeminal nucleus of the dog.

Discussion

Somatotopic localization in the motor trigeminal nucleus of the cat was systematically investigated by examining degenerated motor endplates and motor fibers after placing small lesions stereotaxically in the motor trigeminal nucleus by Szentágothai (1949). And it was confirmed by detecting the retrograde cell reaction following removal of the motor nerves to the masticatory muscles by Vedral and Matzke (1967). According to Szentágothai (1949) and Vedral and Matzke (1967), the temporal muscle was represented ventromedially and the masseter muscle intermediately in the motor trigeminal nucleus. Jacobs (1970) also postulated on the basis of the embryologic study of the human fetus that the motoneurons innervating the temporal and masseter muscle were localized in the intermediate and ventral parts of the motor trigeminal nucleus. Recently, Mizuno et al. (1974 and 1976) demonstrated that, in the dorsolateral division of the nucleus, the temporal muscle was represented dorsally and dorsomedially and the masseter muscle ventrolaterally in the cat and rat by utilizing the method of retrograde axonal transport of horseradish peroxidase. In that study, Mizuno et al. (1974 and 1976) also reported that the pattern of nuclear representation of the masticatory muscles was essentially the same in the cat and rat. The findings of Mizuno et al. (1974 and 1976) were not in accordance with those reported by Szentágothai (1949), Vedral and Matzke (1967) and Jacobs (1970).

On the other hand, the masseter muscle is divided into the proper masseter and improper masseter muscles (Yoshikawa et al., 1961, 1965 and 1969). But the muscular division, especially to the improper

masseter muscle, by above mentioned authors was insufficient.

The present study demonstrates that the temporal muscle is represented dorsally and dorsomedially, the proper masseter muscle ventrolaterally and the improper masseter muscle between the proper masseter and temporal muscles in the motor trigeminal nucleus of the dog. In these respects, the present findings are essentially in agreement with those of Mizuno et al. (1974 and 1976).

Summary

By using thirteen adult dogs, the somatotopic localization in the motor trigeminal nucleus, specially references to the proper masseter, improper masseter and temporal muscles, was studied. The motoneurons of these three muscles are localized in the lateral part of the nucleus within its full length. There is a clear dorsoventral localization. The proper masseter muscle is represented ventrolaterally and the improper masseter muscle just dorsal to that of the proper masseter muscle, whereas the temporal muscle is represented dorsally and dorsomedially in the motor trigeminal nucleus. There also is a cranio-caudal representation. These representations in the dog are essentially the same in the cat and rat (Mizuno et al., 1974 and 1976).

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PLATE

Explanation of Figures

Plate I

- Fig. 3. A normal neuron in the motor trigeminal nucleus of the dog. $\times 600$.
Fig. 4. Variable degrees of the degeneration of the neurons. $\times 150$.
Fig. 5. Distribution of the degenerated neurons in the experiment A, intermediate level. $\times 60$.
Fig. 6. Distribution of the degenerated neurons in the experiment B, intermediate level. $\times 60$.