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Short communication

Bilateral projection of functionally characterized trigeminal oralis neurons to trigeminal motoneurons in cats

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Abstract

Intracellular Neurobiotin-injections were used to label functionally identified neurons in the rostro-dorsomedial part of the trigeminal oral nucleus (Vo.r) in the cat. The labeled Vo.r neurons with the mechanoreceptive field in oral tissues innervated bilaterally either jaw-opening motoneurons or jaw-closing motoneurons. This result suggests that Vo.r neurons play an important role in sensory-motor reflexes responsible for coordination of bilaterally symmetrical jaw movements.

Theme: Motor systems and sensorimotor integration
Topic: Reflex function

Keywords: Jaw movement; Commissural; Interneuron; Intracellular

Tract tracing studies have revealed that the rostro-dorsomedial part (Vo.r) of the trigeminal oral nucleus (Vo) contains few neurons projecting to the posteromedial ventral nucleus (VPM) of the thalamus [3,4,8,14]. The result of these studies suggests little functional contribution of the Vo.r to sensory discrimination. In addition, intracellular labeling studies have shown that Vo.r neurons terminate in the trigeminal and facial motor nuclei, trigeminal principal nucleus, Vo, and pontomedullary reticular formation adjacent to the trigeminal sensory nuclei [9,15], thus indicating that the Vo.r is a pool of interneurons or local-circuit neurons. We have also shown that Vo.r neurons stained intracellularly with horseradish peroxidase (HRP) make synaptic contacts with either jaw-closing (JC) or jaw-opening (JO) α-motoneurons [11,16]. In these studies, we noticed that the stem axon of most Vo.r neurons crossed the midline of brainstem after giving off branches in the ipsilateral JC or JO nucleus, but we could not identify its final destinations because of fading of HRP-filled axons. Therefore, neurons projecting bilaterally to JC or JO motoneurons have not yet been demonstrated in the Vo.r. Thus, the aim of the present study was to identify Vo.r neurons that innervate trigeminal motoneurons bilaterally in cats by means of intracellular labeling with Neurobiotin (Nb), which is a more effective tracer than HRP for long distance labeling of nerve axons.

Experiments were conducted on 16 adult cats. The care and the experimental procedures of animals were approved by the Osaka University Graduate School of Dentistry Intramural Animal Care and Use Committee in accordance with the guidelines of NIH, USA. Anesthesia was initially induced by ketamine (35 mg/kg, i.m.) followed by sodium pentobarbital (40 mg/kg, i.v.), with supplementary doses of

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sodium pentobarbital being given to maintain a deep level of anesthesia throughout the experiment.

Intracellular labeling and histochemical procedures were almost identical to those described previously [11,15,16], except for survival periods of 10–20 h after Nb-injections. The possible contacts between the pre- and post-synaptic neurons were only accepted if there was no gap between the Nb-labeled boutons and the soma or proximal dendrites of motoneurons counterstained [2,7,13]. Small counterstained neurons with a diameter of less than 20 μm in the trigeminal motor nucleus (Vmo), which had piriformis-like or spindle-like soma with less than six primary dendrites, were defined as intranuclear neurons [10].

In the present study, Nb-injections were attempted in 16 animals, in which 10 single Vo.r neurons were successfully injected. After histochemical processing, we found that four and six Vo.r neurons had axon collaterals terminating in the ipsilateral JO and JC nucleus, respectively. Two (cases T-10 and T-11) of the four Vo.r neurons also had axon collaterals terminating in the contralateral JO nucleus (Vo.r-JO neurons; Fig. 1), and two (cases T-21 and T-22) of the six Vo.r neurons had axon collaterals also terminating in the contralateral JC nucleus (Vo.r-JC neurons; Fig. 2). All of the stem axons of the remaining six Vo.r neurons crossed the midline, but fading of Nb labeling prevented observations of their axon collaterals on the contralateral side. No Vo.r

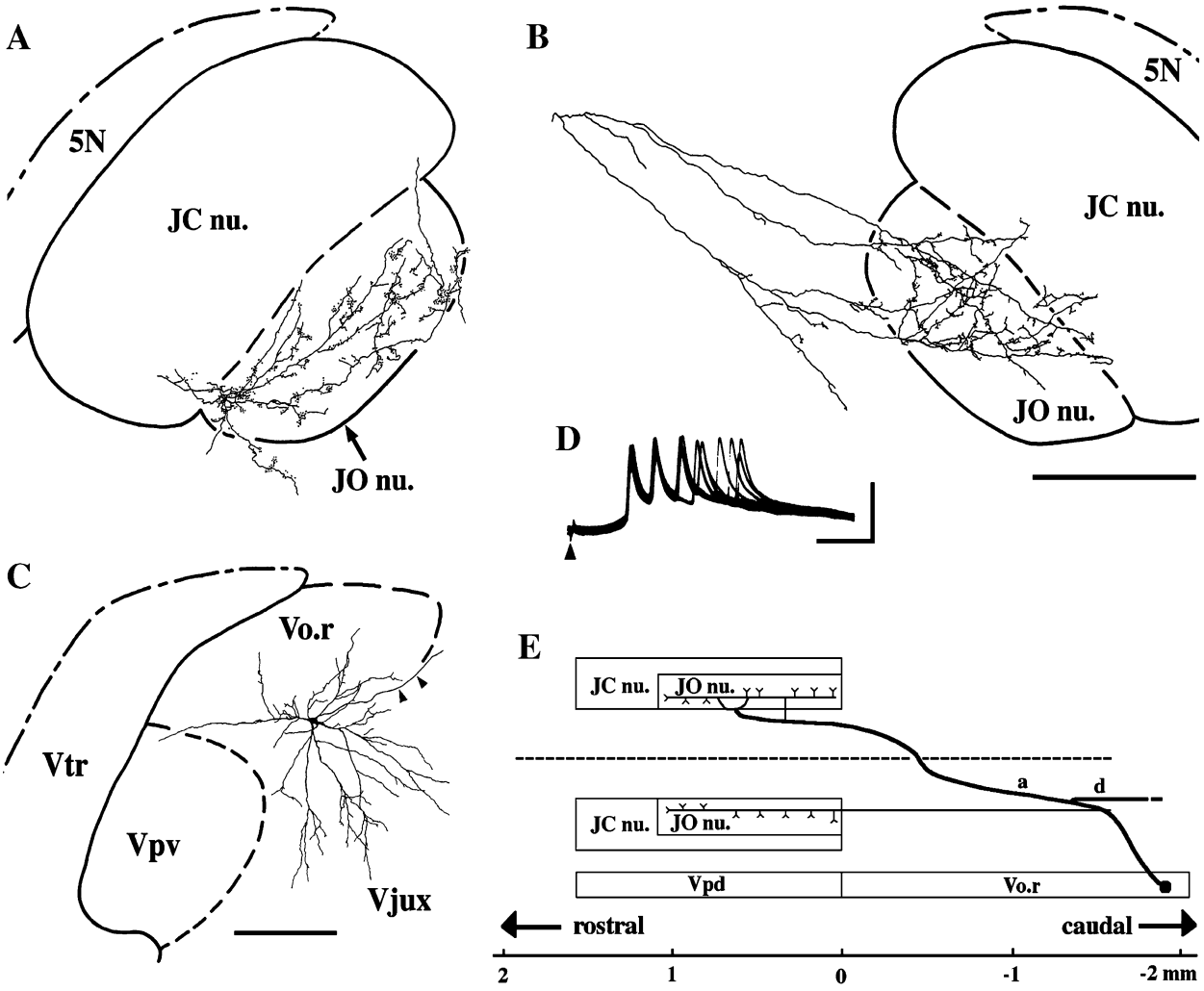

Fig. 1. Camera lucida drawings (A–C), intracellular responses (D), and diagram illustrating axonal trajectory (E) of a Neurobiotin (Nb)-labeled neuron T-10 in the rostro-dorsomedial part (Vo.r) of the trigeminal oral nucleus projecting bilaterally to the jaw-opening motor nucleus (JO nu., Vo.r-JO neuron). (A, B) Reconstructions illustrating axon collaterals and terminal arbors in the JO nucleus ipsilateral (A) and contralateral (B) to the cell body of the Nb-labeled neuron (C). (C) Reconstruction illustrating the soma-dendrites and stem axon (arrowheads) of the Nb-labeled neuron. (D) Intracellular responses (10 superimposed traces) to electrical stimulation of the infraorbital nerve. An arrowhead indicates the artifact of the electrical stimulation. (E) A stem axon was divided into an ascending stem axon (a) and a descending stem axon (d). The dashed line indicates the midline. Note that, in the present study, detailed observation of axon branches in regions other than the JO nucleus and the jaw-closing motor nucleus (JC nu.) was not performed. Vjux, juxtatrigeminal region; Vpd, dorsomedial subnucleus of the trigeminal principal nucleus; Vpv, ventrolateral subnucleus of the trigeminal principal nucleus; Vtr, spinal trigeminal tract; 5N, trigeminal nerve. Horizontal scale bars = 0.5 mm in panel (B) (also applies to panel [A]) and panel (C); 4 ms in panel (D). Vertical scale bar = 20 mV in panel (D).