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学位論文名	Morphological Characteristics of Descending Projections from Orofacial Areas of the Secondary Somatosensory Cortex to the Lower Brainstem in Rats （大脳皮質二次体性感覚野口腔顔面領域から下位脳幹への下行投射の形態学的特徴に関するラットを用いた研究）
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論文内容の要旨

Introduction:

The orofacial sensory messages are generally transported to the secondary neurons in the pons and medulla including the trigeminal sensory nuclear complex (TSNC), and finally to the secondary somatosensory cortex (S2) as well as the primary somatosensory cortex (S1) on the contralateral side. Recently, it has been revealed that the orofacial S1 has descending projections almost exclusively to the contralateral TSNC, and that the descending projection sites in the TSNC possibly correspond to the projection sites of the primary afferents conveying sensory messages to the same S1. However, little is known about the descending projections from the orofacial S2. In the present study, therefore, to address this issue, we examined the morphological features of descending projections from the orofacial S2 to the pons and medulla by using retrograde and anterograde neuronal tract-tracing techniques in rats.

Materials and Methods:

Experiments were conducted on male Wistar rats in weight range 300–400 g. The care and treatment of animals were approved by the Osaka University Graduate School of Dentistry Intramural Animal Care and Use Committee. The animals were anesthetized with sodium pentobarbital (55 mg/kg).

In experiment 1, the lingual nerve, mental nerve, infraorbital nerve and frontal nerve were exposed for electrical

stimulation. The animals were placed in a stereotaxic apparatus. Then, we identified four areas of the trigeminal principal nucleus (Vp)/ the rostro-dorsomedial part of trigeminal oral subnucleus (Vor) where large-sized orthodromic field potentials were evoked by stimulation of the lingual nerve, mental nerve, infraorbital nerve, and frontal nerve through a glass microelectrode; these identified four areas were respectively referred to as the ling-V3 area, ment-V3 area, inf.orb-V2 area, and front-V1 area of Vp/Vor. The inf.orb-V2 area was further divided into its lateral part (l-inf.orb-V2 area) and medial part (m-inf.orb-V2 area), since the large-sized field potentials evoked by stimulation of the infraorbital nerve were recorded in the wider area. Then, injections of 1% Fluorogold (FG) in 0.1 M sodium acetate buffer were made iontophoretically into these five areas of Vp/Vor with 2 μA driving currents (application time 15–30 minutes) through a glass microelectrode.

In experiment 2, injections of 4% biotinylated dextran amine (BDA-10,000 MW) dissolved in saline were made into the S2 in reference to the position of the orofacial S2 areas where a large number of retrogradely FG-labeled neurons were found in experiment 1. The BDA was injected iontophoretically with 2 μA driving currents (application time 15–30 minutes) through a glass microelectrode.

After postinjection survival of 7 to 10 days, all animals were re-anesthetized deeply and perfused with a fixative solution of 4% paraformaldehyde in 0.1 M phosphate buffer. Then, the brain was removed and serial coronal sections (60-μm thickness) were cut on a freezing microtome. Sections with FG or BDA were processed to detect FG- or BDA-labeling histochemically.

Results:

Distribution of S2 neurons projecting to the Vp/Vor

In experiment 1, a large number of retrogradely FG-labeled neurons were found in the layer V of the S2 as well as the S1 bilaterally, but with a contralateral predominance to the FG injection site. In each case, the orofacial area where FG-labeled neurons were found was much smaller in the S2 than in the S1. The orofacial areas where labeled neurons were found after FG injection made respectively into the ling-V3 area, ment-V3 area, m-inf.orb-V2 area, l-inf.orb-V2 area, and front-V1 area were located in a rostrocaudal sequence in both the S2 and S1.

Projections from the S2 to the TSNC

Anterogradely BDA-labeled axon fibers and terminals in cases with BDA injection site covering the orofacial S2 showed the common distribution patterns as follows. A large number of labeled axon fibers descended in the ipsilateral pyramidal tract, and caudally entered in the pyramidal decussation. Some of them extended dorsally, crossed the midline, and traveled laterally toward the contralateral TSNC. BDA-labeled axon terminals were found almost exclusively in the contralateral TSNC, especially in the Vp, oral subnucleus (Vo) and caudal part of interpolar subnucleus (Vi), and the rostral or caudal part of the caudal subnucleus (Vc). Distribution of BDA-labeled axon terminals in the TSNC showed somatotopy in a dorsoventral direction and a superficial-deep direction, and also in a rostrocaudal direction in the Vc.

Discussion and Conclusion:

The present study demonstrated that the orofacial S2 neurons are somatotopically distributed in the S2, and that the orofacial S2 project almost exclusively to the contralateral TSNC with somatotopy which seems to well correspond to the somatotopy of primary afferents reported previously. The distribution patterns of axon terminals from the orofacial S2 were very similar to those from the orofacial S1 reported previously. The present results strongly suggest that the orofacial S2 projects feedback to the TSNC neurons which convey the sensory messages to the orofacial S2 in order to gate the sensory messages.

論文審査の結果の要旨

本研究は、口腔顔面の感覚が伝達される大脳皮質体性感覚領野の一つである二次体性感覚野口腔顔面領域から、橋、延髄への下行性投射の様態を、ラットを用いて検討したものである。二次体性感覚野口腔顔面領域からの下行性投射は、主に、反対側の三叉神経感覚群に認められた。この三叉神経感覚核内への投射では、吻側亜核の吻側部にはほとんど認められなかったが、他の部位への投射は体部位対応配列を示した。その体部位対応配列は、既に明らかになっている口腔顔面領域を支配する一次求心性神経の体部位対応配列に近似していた。以上の結果は、二次体性感覚野口腔顔面領域から三叉神経感覚群への下行性投射は、二次体性感覚野口腔顔面領域に伝達される口腔顔面の感覚を制御していることを示唆するものである。

よって本研究は、口腔顔面感覚を含む感覚情報の脳内伝達機序の解明に寄与するものであり、博士（歯学）の学位論文に値するものと認める。