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Research Report

A comparative study of axon-surrounding cells in the two nasal nerve tracts from mouse olfactory epithelium and vomeronasal organ

Mitsunari Nakajima, Momoko Tsuruta, Hisamichi Mori, Chisa Nishikawa, Satoshi Okuyama, Yoshiko Furukawa*

Department of Pharmaceutical Pharmacology, School of Clinical Pharmacy, College of Pharmaceutical Sciences, Matsuyama University, 4-2 Bunkyo-cho, Matsuyama 790-8578, Ehime, Japan

ARTICLE INFO

Article history:
Accepted 31 January 2013
Available online 11 February 2013

Keywords:
Main olfactory bulb
Accessory olfactory bulb
Olfactory ensheathing cell
GFAP
p75
Vomeronasal organ

ABSTRACT

The olfactory and vomeronasal systems are the two nasal chemical detectors in mammals. While glial cells in the olfactory nerve tracts have been well-investigated, little is known about cells in the vomeronasal nerve tracts. In the present study, we compared the expression patterns of marker proteins in the cells comprising the two nasal nerve tracts in mice. Neural crest-derived cells surrounded the olfactory nerve axons in the lamina propria of the olfactory epithelium. These cells expressed glial fibrillary acidic protein (GFAP) and p75 glycoprotein, which are markers of olfactory ensheathing cells. Neural crest-derived cells also surrounded the vomeronasal nerve axons in the lamina propria of the vomeronasal epithelium. These nerve axon-surrounding cells, however, did not express GFAP or p75. Rather, the vomeronasal nerve axons expressed GFAP and p75. These results suggest that axon-surrounding cells functionally differ between the olfactory and vomeronasal nerve tracts.

1. Introduction

In mammals, odors are detected by two sensory systems, the main olfactory system (MOS) and the vomeronasal system (VNS; Halpern and Martínez-Marcos, 2003). Both systems comprise sensory epithelium, nerve axon tracts, and central nervous system axon terminals. The olfactory epithelium is connected via the olfactory nerves to the main olfactory bulb (MOB) and the vomeronasal epithelium is connected via the vomeronasal nerves to the accessory olfactory bulb (AOB). In addition to the olfactory epithelium, the MOB also has two small segregated chemosensory apparatuses in the nasal cavity, the septal organ of Masera and the Grueneberg ganglion (Fleischer et al., 2007; Grosmaitre et al., 2007).

A prominent feature of these sensory systems is that they undergo neural replacement during adulthood (De La Rosa-Prieto et al., 2009; Graziadei and Graziadei, 1979). The newly generated neurons extend processes from the cell body to

Abbreviations: AOB, accessory olfactory bulb; GFAP, glial fibrillary acidic protein; MOB, main olfactory bulb; MOS, main olfactory system; OEC, olfactory ensheathing cell; p75, low-affinity nerve growth factor receptor; VNO, vomeronasal organ; VNS, vomeronasal system

*Corresponding author. Fax: +81 89 926 7069.
E-mail address: mnakajim@cc.matsuyama-u.ac.jp (M. Nakajima).

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http://dx.doi.org/10.1016/j.brainres.2013.01.053

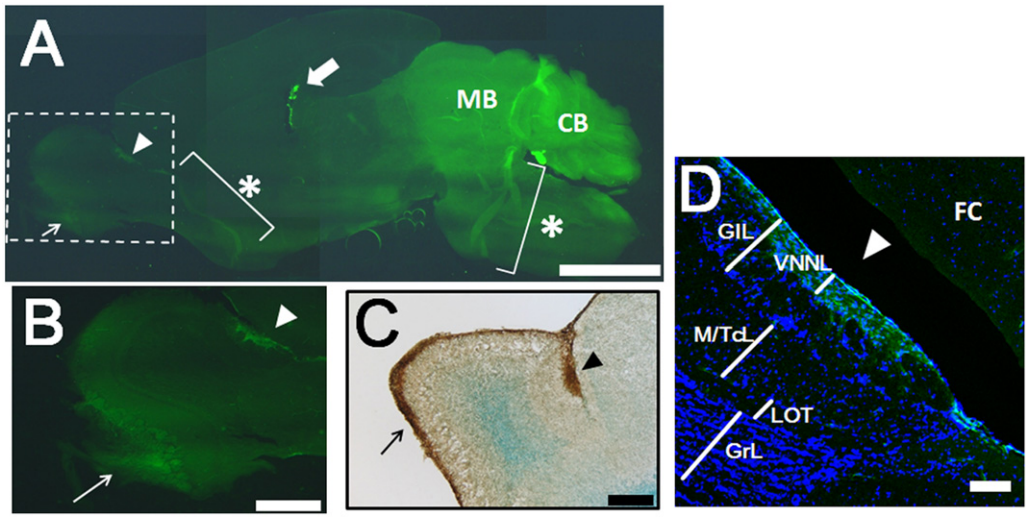

Fig. 1 – Distribution of neural crest-derived cells in mouse brain. (A) Wnt1-cre/floxed-EYFP adult mice were fixed. The mouse brains were embedded in OCT compound, and sectioned sagittally. The sections were observed with a fluorescence stereoscopic microscope. Brain areas fluorescing in green are derived from the neural crest. Fluorescence was detected in the cerebellum (CB), midbrain (MB), choroid plexus (see arrow), and meninges. ∗ indicates overlapping regions. (B) Photograph highlighting the olfactory bulb indicated by the dotted line in (A). Peripheral parts (see thin arrow) of the MOB and a part (see arrowhead) of the AOB were labeled with the fluorescence. (C) Wnt1-cre/floxed-lacZ newborn mice were subjected to immunohistochemistry using the anti-β-galactosidase antibody. After immunostaining, the sagittal sections were counterstained with 1% methyl green. Immunoreactivity was detected in brown in the same regions as in (B), such as the peripheral parts of the MOB and a part of the AOB. (D) Wnt1-cre/floxed-EYFP adult brains were fixed, sectioned sagittally, counterstained with H33342, and observed with confocal microscopy. The area fluorescing in the AOB was restricted to the vomeronasal nerve layer (VNNL). FC, frontal cortex; GIL, glomerular layer; M/TcL, mitral/tufted cell layer; LOT, lateral olfactory tract; GrL, granular layer. Bar=2 mm in (A), 0.5 mm in (B), 0.2 mm in (C), and 0.1 mm in (D).

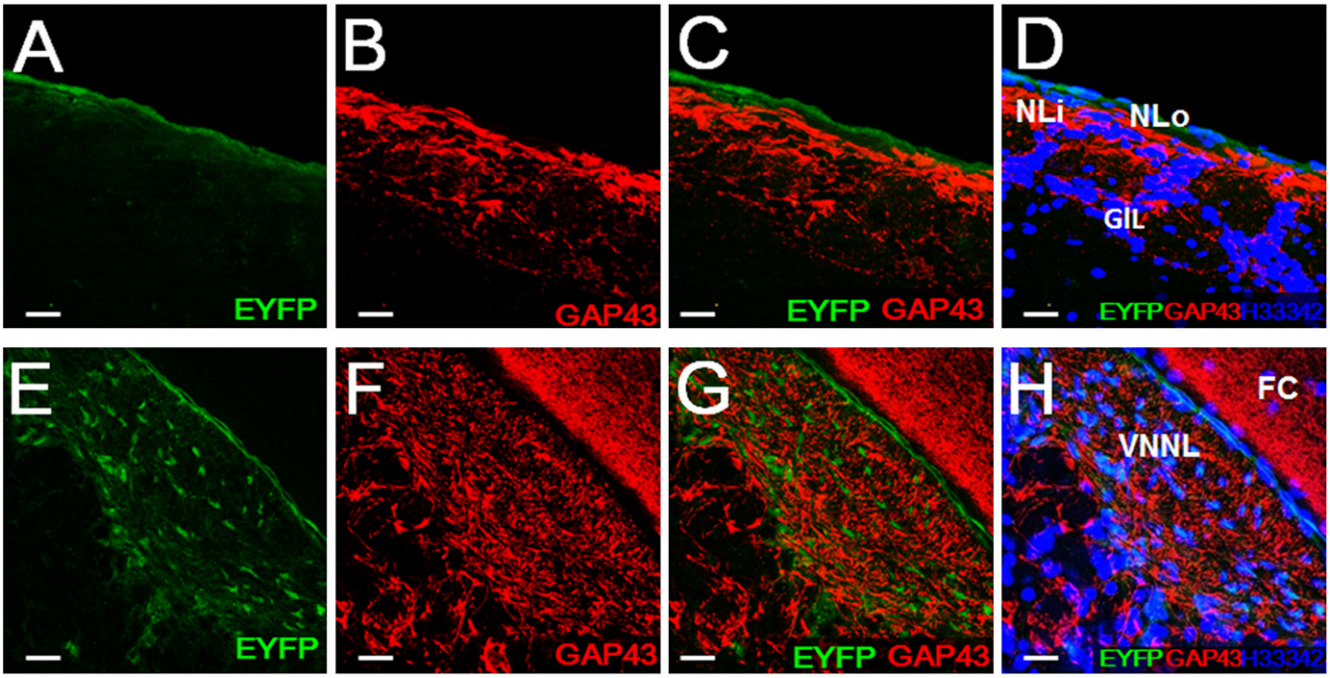

Fig. 2 – Scattered distribution of neural crest-derived cells in the vomeronasal nerve layer (VNNL) of the AOB. Wnt1-cre/floxed-EYFP adult mouse brains were fixed, sectioned sagittally, subjected to immunohistochemistry using anti-GAP43 antibody, and counterstained with H33342. Green fluorescence indicates the presence of cell bodies or fibers of cells derived from the neural crest. (A)–(D) are confocal images of the MOB. Green fluorescence is most prominent in the outer nerve layer (NLo) and diminished in the inner nerve layer (NLi); (E)–(H) of the AOB. Green fluorescence is detected in the cells scattered in the VNNL. FC, frontal cortex; GIL, glomerular layer. Bar=20 μm.