Brain Stem Nuclei Implicated in Breathing Regulation Grow Neurochemically

Julien Wan*

Editorial Office, Journal of Neuroscience and Neuropharmacology, Brussels, Belgium

*Corresponding Author**

Julien Wan
Department of Neuropharmacology
Belgium
Email: Wan.j@gmail.com

Received: 4-Aug-2022, Manuscript No. NCOA-22-73501; **Editor assigned**: 6-Aug-2022, PreQC No. NCOA-22-73501 (PQ); **Reviewed**: 17-Aug-2022, QC No. NCOA-22-73501 (Q); **Revised**: 19-Aug-2022, Manuscript No. NCOA-22-73501(R); **Published**: 26-Aug-2022, doi. 10.4172/2469-9780.2022.8.4.179

Abstract

The integrative brainstem network that underlies swallowing and associated processes like respiration has been partially understood through neurophysiological studies of the nuclei of the Nucleus Tractus Solitarius (NTS) and surrounding regions. Although the NTS is likewise abundant in neuropeptides and other neuroactive compounds, there is little known about how these compounds affect the neurons engaged in swallowing in general. An expanded understanding of and focus on these regulatory mechanisms is necessary since their malfunction in the NTS region may play a role in pathophysiological disorders including dysphagia. This article summarises new findings in neurophysiology and neurochemistry that shed light on the afferent inputs and neurophysiological characteristics of neurons in the NTS and nearby caudal brainstem regions implicated in swallowing, respiration, and reflexes linked to breathing.

Introduction

The development of the brain stem respiratory nuclei in the rat, the main model for this review, is most dynamic during the first two postnatal weeks. Glutamate, glycine receptors, choline acetyltransferase, serotonin, norepinephrine, and thyrotropin-releasing hormone are among the neurochemicals whose expression rises with aging, while GABA, serotonin receptor 1A, substance P, neurokinin 1 receptor, and somatostatin see declines. Unexpectedly, a significant change happens in the rat on postnatal day P12. Glutamate, an excitatory neurotransmitter, and it's NMDA receptors drop rapidly, while GABA, GABAB, and glycine receptors rise rapidly. In parallel, respiratory neurons experience a decrease in cytochrome oxidase activity. During development, several receptor types experience subunit shifts. Notably, GABAA receptors in the rat's pre-Bötzinger complex change from a 3- dominant type to a 1-dominant type at *P12*. The respiratory system may be vulnerable to failure under stress because of the temporary dominance of inhibitory over excitatory neurotransmission around *P12*. It will be difficult for future studies to relate these neurochemical alterations to physiological responses in animals and sudden infant death syndrome in humans. Life cannot exist without breathing, which also sustains life. However, for generations, researchers have been baffled by its molecular methods of action. The brain, brain stem, spinal cord, cranial and spinal nerves, diaphragm, intercostal muscles, laryngeal and pharyngeal structures, lungs, and the vasculature all play a significant role in the highly interwoven process of respiration. Additionally, it involves a variety of neurotransmitters, neuromodulators, receptors, second messengers, and transcription factors—the majority of which have only recently been the subject of investigation. Early postnatal, fetal, and adult phases of development have different respiratory control mechanisms. The assumption is that the main foci of neurochemical development of the respiratory network would similarly exhibit smooth aging-related trends in either rising or decreasing expressions. This is not the case, at least not for several important neurochemicals in a few of the postnatally examined brain stem nuclei.

With the rat serving as the primary animal model of study, this review will focus on the postnatal development of certain neurochemicals in a few specific brain stem nuclei known or inferred to be important in respiratory regulation. Several prior evaluations offer further perspectives on the relevant subject matter. The brain stem's pons, dorsal medulla, and ventrolateral medulla are home to three key regions that control breathing. These have been dubbed the Pontine Respiratory Group (PRG), Dorsal Respiratory Group (DRG), and Ventral Respiratory Group (VRG), respectively. The PBL, PBM, and Kollicker-Fuse (KF) nuclei make up the majority of the parabrachial lateral and medial nuclei. It gets input from the medulla and participates in vocalization, diaphragmatic motor control, respiratory rhythm modulation, and control of airway muscles during exercise and sleep. The Ventrolateral Subnucleus (VSN), a key center of the NTS, serves as the primary representative of the DRG. The majority of its neurons are inspiratory, and they fire in time with phrenic nerve activity bursts. The real mediators of sensory, motor, integrative, and modulatory processing in the respiratory network are neurochemicals. They consist of a diverse range of neurotransmitters and neuromodulators, including excitatory, inhibitory, cholinergic, monoaminergic, neuropeptide, hormone, nucleoside, neurotrophic, transcriptional, and enzyme neurotransmitters and neuromodulators. The distinct sets of receptors that each of these neurochemicals has are crucial for the neural signal's propagation. However, more is known about the general functions of these neurochemicals than about their exact functions in controlling breathing or about how they arise in brain stem respiratory nuclei. Only a few better-known neurochemicals, mostly from rats, will be the subject of this review.

The two main inhibitory neurotransmitters in the network of respiratory neurons in the brain stem and spinal cord are GABA and glycine. All respiratory neurons' discharge patterns are influenced by GABA, which primarily acts on GABAA receptors, and glycine through chloride channels. The slower-acting metabotropic GABAB receptors, on the other hand, are connected to the $Ca2^{+}$ and K^{+} channels through G proteins and other second messengers. According to reports, they alter the respiratory rhythm in adult mammals. The GABAergic system is claimed to mature quickly in the mouse brain stem and is unaffected by aging, as shown by the Glutamic Acid Decarboxylase (GAD), which is responsible for its synthesis. In neonatal mice, knocking out the *GAD67* gene lowers GABA levels to 30% of those in the wild type and disturbs the typical inspiratory pattern, but has no impact on the fundamental formation of respiratory rhythm. From *P2 to P2*1, the *NTSVL, Amb, IOma,* and *XII* of the rat exhibit a general drop in GABA expression, but the *PBC* and *DMNX* exhibit a general increase with age. In the first two postnatal weeks, the levels of *GAD 65* and *67* mRNA in the spinal cord likewise decrease by nearly threefold. However, regardless of the general upward or downward trends of the GABA immunoreactivity with aging in the six nuclei under study, there is a clear increase at P12 and a lesser but statistically significant increase at *P3* or *P3-4*. The non-respiratory cuneate nucleus shows no evidence of such a pattern. During development, the rat brain exhibits significant geographical and pharmacological alterations in GABAB binding. A fully developed GABAergic system appears to be preceded by high levels of GABAB binding, which then tends to drop as people age, pointing to a role for these receptors in the growth of the central nervous system. During the first two weeks following birth, the GABAB receptor-mediated regulation of low- and high-voltage triggered $Ca2^{+}$ currents in the murine PBC experiences noticeable developmental alterations that may have an impact on the formation of respiratory rhythms. The *NTSVL, Amb, IOma, XII,* and *DMNX* exhibit a general drop from *P2* to *P21* in terms of GABAB receptor immunoreactivity, whereas the *Amb, IOma,* and *NTSVL* exhibit an upswing during the second and third postnatal weeks. These developments closely resemble those of GABA in the rat brain stem.

Cite this article: Wan J. Brain Stem Nuclei Implicated in Breathing Regulation Grow Neurochemically. J Neurosci Neuropharmacol. 2022, 8.4, 001.