Cuneiform nucleus stimulation modifies laryngeal activity and subglottic pressure in spontaneously breathing anaesthetized rats

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Background

Abduction and adduction of the vocal folds are performed by two populations of motoneurons located in the caudal portion of the nucleus Ambiguus (nA). In the rat, the loose formation of the nA contains motoneurons innervating the laryngeal muscles. In previous studies we have demonstrated a functional interaction between hypothalamic (DMH-PeF), mesencephalic (dlPAG) and pontine nuclei (PBc, A5 region) involved in cardiorespiratory control and in changes of laryngeal caliber (López-González et al., 2020; Lara et al., 2002). The Cuneifom nucleus (CnF) of the mesencephalon has afferent and efferent connections with all these nuclei. The aim of this study was to characterize the electrophysiological relationships between the CnF and those pontine-medullary neuronal circuits to understand their role in laryngeal control and its effect on vocalization.

Objectives

The aim of this study was to characterize the relations between mesencephalic regions (CnF) involved in cardiorespiratory control and their possible role in modulating laryngeal activity and their effects on vocalization.

Methods

Experimental studies were carried out with non-inbred male rats (n=14), SPF, Sprague-Dawley (250-300 g) housed under standard conditions. Animals were anesthetized with sodium pentobarbitone (60 mg/kg i.p., initial dose, supplemented 2 mg/ kg, i.v., as necessary). A double tracheal cannulation to develop the classical technique of the "isolated glottis in situ" and for the recording of respiratory airflow was carried out. Subglottic pressure was recorded with an aneroid transducer (Hugo Sachs Elektronik D-7801, ± 0,1 psi) by passing a stream of humidified warm medical air upwards through the larynx at a constant rate of 30-70 ml/min with a thermal mass digital air flow meter controller (Bronkhorst Hi-Tec F-201CV-AGD-22-V). Thus, at constant air flow, changes in pressure indicate changes in laryngeal resistance.

Bilateral parietostomy allowed access to CnF. Microinjections of PBS-Evans Blue (250 nl, pH 7.4 ± 0.1, 5-s duration) or glutamate (0,25M, 250 nl) were performed. Respiratory flow, pleural pressure, blood pressure, heart rate and ECG activity were also recorded.

Results

CnF PBS-Evans Blue microinjections did not produce any significant changes in any of the cardiorespiratory variables recorded. However, glutamate microinjections within the CnF evoked a decrease of laryngeal resistance (subglottal pressure) ($p<0,001$) accompanied with an inspiratory facilitatory response consisted of an increase in respiratory rate ($p<0,001$), together with a pressor ($p<0,05$) and tachycardic response ($p<0,001$).

Conclusions

The results of our study contribute with new data on the role of the mesencephalic neuronal circuits in the control mechanisms of subglottic pressure and laryngeal activity.

Keywords

Subglottic Pressure, Laryngeal Motoneurons, CnF, DMH-PeF, dlPAG, Nucleus Ambiguus