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SHORT COMMUNICATION

The nasal cycle and age

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Abstract

Conclusion: The reciprocal nature of the nasal cycle declined with age in keeping with other published data, suggesting that studies of the nasal cycle may be a useful measure of central nervous system (CNS) disease and aging. *Objectives:* The aim of this study was to investigate changes in the nasal cycle with age. *Methods:* In one male subject changes in nasal airflow were measured by anterior rhinomanometry to determine the reciprocal nature of the 'nasal cycle' at age 28 and again at age 66 years. *Results:* Significant reciprocity was demonstrated in the historical study (age 28 years) with correlation coefficients for the 3 study days of –0.81, –0.83 and –0.79. compared with the current study (age 66 years) where non-significant correlation coefficients of 0.02 and –0.43 were obtained.

Keywords: *Anterior rhinomanometry, aging, CNS disease, nasal airflow, autonomic nervous system, sympathetic control, reciprocal changes*

Introduction

The nose is unique among organs in that it often exhibits reciprocal changes in nasal airflow over a period of several hours and this phenomenon is sometimes termed a 'nasal cycle' [1,2]. This is often described as an inverse correlation between the internal space of the right and left nasal cavities [3]. The changes in nasal airflow are caused by alternate congestion and decongestion of the venous sinuses lining the nasal turbinates and nasal septum [4] and the filling of the nasal venous sinuses is controlled by the sympathetic nerves that supply the nasal blood vessels [5–7]. The oscillation in sympathetic nervous activity that generates the reciprocal changes in nasal airflow is believed to originate from the vasomotor control areas of the medulla, as electrical stimulation of this area in the anaesthetized cat causes reciprocal changes in nasal vasomotor activity [8]. The hypothalamus has also been implicated in control of the nasal cycle via the sympathetic nerve supply to the nose [9]. An electroencephalogram (EEG)-based study linked predominance of airflow in the contralateral nasal cavity to a predominance in cerebral hemispheric activity [10].

Recent studies have reported that the nasal cycle changes with age and that these changes may be a marker for age-related changes in the brain, as the nature of the nasal cycle is controlled from centres in the brain [11]. The study by Mirza et al. in 1997 [11] looked at age-grouped cohorts and reported that reciprocal changes in nasal airflow associated with a nasal cycle decreased with age, and commented that this was the first study to examine changes in the nasal cycle associated with age. To our knowledge there are no reports comparing the nasal cycle in youth and older age in an individual, probably because of the difficulty in conducting a study over several decades. In this short report we present results for the nasal cycle in an individual at age 28 years (historical study) and at age 66 years (current study). This is made possible because the individual participated in a study on the central rhythm of the nasal cycle published in this journal in 1978 [2] and also participated in a similar study on the nasal cycle conducted in 2014.

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Material and methods

Both studies were conducted over 8 h periods in laboratory conditions with the subject at rest. The current study was conducted in Cardiff, UK during November 2014 and the historical study was conducted in Delhi, India, during August 1976 [2]. The subject was not judged to have developed any significant medical conditions in the interval between studies except for a history of mild hypertension over the last 12 months, treated with Lisinopril 5 mg daily. Measurements for the historical study were taken every 30 min over an 8 h period using anterior rhinomanometry similar in principle to the method used for the current study, which used an Otopront RHINO-SYS system (Happersberger otopront GmbH, Hohenstein, Germany) to measure unilateral nasal airway resistance. In the historical study nasal resistance was calculated by measuring the slope of the pressure flow curve between flow of ± 10 L/min, whereas in the current study resistance was calculated by measuring flow at a sample pressure of 75 Pa. The absolute resistances calculated for the two studies may be slightly different but this is of no consequence for interpreting the results, as it is the reciprocity of nasal airflow that is of interest and not the absolute resistance of each nasal passage.

To quantify the reciprocal changes in nasal airflow in historical and current studies the correlation coefficient for the nasal resistance data was calculated. The correlation coefficient represents the correlation of the two airflows of the left and right nasal passages, describing the relationship of their changes, with a value *r*. The value ranges from –1 to +1, where –1 represents a strict reciprocal relationship and +1 represents changes in airflow that are strictly in phase [12]. It has been used in several studies as a statistical test for the presence of a classic nasal cycle [11,12]. For the present study Pearson's method of calculation was used as this is more applicable to parametric data.

A major problem in studying the phenomenon of the nasal cycle is that there is no generally agreed way of quantifying the complex and often reciprocal changes in nasal airflow that are observed over an observation period of several hours. The patterns have been ascribed to different categories such as 'classic', 'irregular' and 'noncyclic' [13] but this subjective classification does not allow for any scientific and numerical comparisons of data such as can be made when a correlation coefficient is used to compare data.

Ethical approval for this study was granted by the School of Biosciences Research Ethics Committee, Cardiff University.

Results

In the historical study numerical data were available for analysis over 3 consecutive days and an example of 1 day's data is shown in Figure 1, which is representative of all 3 days. In the current study, data were recorded over 2 separate days 1 week apart. The data from the second study day of the current study are shown in Figure 2.

The correlation coefficients for the historical 3 study days were –0.81, –0.83 and –0.79, all significant results ($p < 0.001$) representative of reciprocal changes. The correlation coefficients for the 2 current study days were 0.02 and –0.43, with neither representing any significant reciprocal changes ($p > 0.2$).

Discussion

The reciprocal changes in airflow of the nasal cycle, quantified here by the correlation coefficient, are caused by reciprocal changes in sympathetic activity in the central nervous system (CNS). Peripheral effects of sympathetic stimulation have only been shown to cause mainly ipsilateral effects with a smaller in phase response on the contralateral side. As demonstrated by Stoksted and Thomsen in 1953, a stellate ganglion block caused profound ipsilateral congestion with a smaller contralateral congestion response [7]. In a porcine model in 1981, Eccles and Eccles showed that stimulation of the cervical sympathetic nerve caused ipsilateral vasoconstriction response in the nasal cavity with a much smaller contralateral vasoconstricton [14]. The contralateral in phase response is around 5–10% of the ipsilateral response. Experimental evidence from a feline model demonstrated that unilateral electrical stimulation within the brainstem results in an ipsilateral vasoconstriction and a contralateral vasodilation within the nasal cavity [8], indicating that the control of the reciprocal changes in nasal airflow associated with the nasal cycle occurs centrally.

Change in the amplitude of the nasal cycle associated with age could be due to peripheral changes in elasticity of blood vessels and nasal mucosa, as well as changes in peripheral sympathetic nerves and receptors [15]. But, assuming that the nasal blood vessels are able to respond to sympathetic nervous activity even in a limited way, any changes in reciprocity of nasal airflow must be due to changes in the CNS control of sympathetic activity.

A confounding factor in comparing the historical and current data is that they were obtained when the subject was exposed to different climatic conditions (current study, temperate conditions in Cardiff, UK; historical study, tropical conditions in Delhi, India).

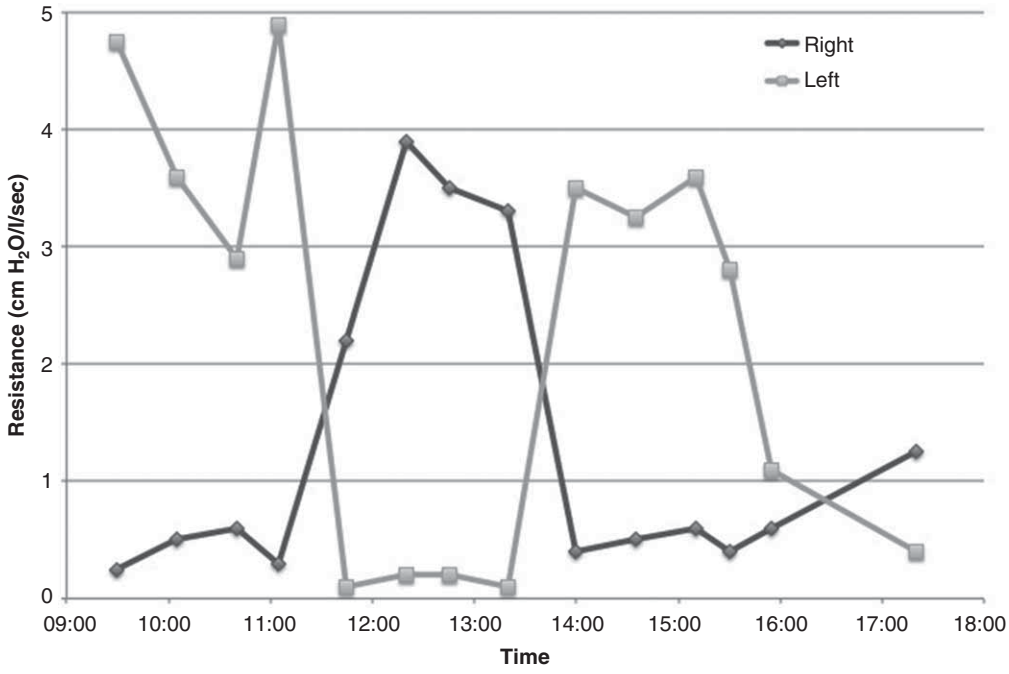

Figure 1. Left and right nasal airway resistance measured in a male subject (age 28 years) over an 8 h period during August 1976. The changes in nasal airway resistance have a reciprocal relationship.

However, studies of the effects of temperature on nasal resistance in 50 healthy subjects have concluded that environmental changes in the tropics between 18–22°C and 30–33°C have no significant effect on nasal resistance and it seems unlikely that there would be any effect on the central control of nasal airflow [16].

It is well established that the olfactory system declines in sensitivity with age due to both peripheral and CNS changes, and that olfactory decline has

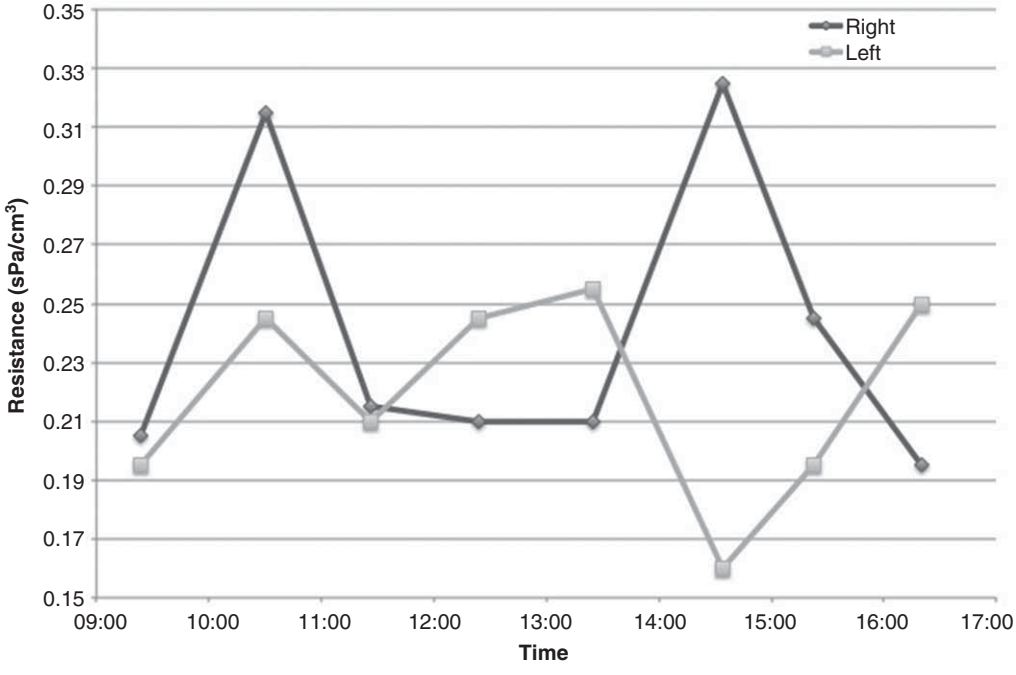

Figure 2. Left and right nasal airway resistance measured in a male subject (age 66 years) over an 8 h period during November 2014. Compared with the recordings in Figure 1 the changes in nasal airway resistance do not have the same reciprocal relationship except over the last few hours of recording.

been proposed to be an early measure of CNS changes associated with degenerative CNS diseases such as Alzheimer's disease [17]. Similarly, changes in the reciprocity of the nasal cycle have also been proposed to be an early marker of CNS degenerative disease [11].

This short report on the changes in the nasal cycle in one subject over an almost 40-year period supports the results of the cohort study on the effects of age on the nasal cycle conducted by Mirza et al. in 1997 [11], in that there does appear to be a decline in reciprocity of nasal airflow in the subject. The results of the current study are unique and unlikely to be repeated, but they must, like all case histories, be interpreted with caution. What the current study does highlight is that there is a great need for more numerical descriptors of the nasal cycle if studies are to progress beyond merely subjective assessments of changes in the nasal cycle with age. Since the reciprocal changes in airflow are controlled by oscillations in the CNS, measures of reciprocity could be investigated as early markers of CNS disease and aging.

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