Rhinology, 21, 67-72, 1983

Nasal responses to local unilateral stimuli in man

J. S. J. Haight and P. Cole, Toronto, Ontario, Canada

SUMMARY

The present study was designed to test the hypothesis that a feedback loop relaying information on the patency of one nasal cavity might be processed by the central nervous system to modify the vascular engorgement of the other, thereby minimizing total airflow resistance alterations during the nasal cycle. Histamine and xylometazoline were used to alter the degree of mucosal swelling and a cotton plug to alter airflow, in one nasal cavity and resistance measurements were made from its fellow. No changes in the latter were observed. It was concluded that this feedback arc does not exist.

INTRODUCTION

Most noses show spontaneous reciprocal airflow resistance changes between the two sides every few hours. Nevertheless, in the absence of marked fixed obstruction (Kern and Arbour, 1976) total nasal resistance remains remarkably constant. Therefore, it seemed possible that the fine control of this cyclical outflow from the central nervous system (Eccles, 1978a) might be aided by a feedback loop from the nasal mucosa of either the more or the less obstructed side modifying the engorgement of its fellow. In order to test this hypothesis, alterations in the patency of one side of the nose were induced experimentally, and resistance measurements made from the other.

Previous work (Connell, 1968) suggests that reciprocal changes in nasal airflow occur following a unilateral challenge with allergens.

METHODS

Subjects: Two healthy adult volunteers without nasal symptoms or gross abnormality to clinical examination.

Transnasal pressures were measured by posterior rhinometry, using an oral tube and a differential pressure transducer (Validyne MP 45).

Respiratory airflow was measured by a "head-out" displacement type body plethysmograph (Niinimaa et al., 1979).

Paper presented at the 9th Congress of the European Rhinologic Society and 3rd ISIAN, Stockholm (Sweden), September, 1982.

Respiratory airflow resistance was computed by high frequency sampling and averaging of pressure and flow signals for 5 breaths by means of a programmed microprocessor (Cole et al., 1980), their ratio provided a coefficient of resistance to breathing which was regarded as an index of airway patency.

EXPERIMENTAL

1. *Nasal vestibular occlusion* – Moist cotton batting was inserted gently into one nasal vestibule as a relatively inert means of preventing airflow. In its presence, nasal pressures on the obstructed side reflect those in the postnasal space instead of the pressure gradient encountered in normal breathing (Haight and Cole, 1982). Whereas flow and pressure gradients in the unobstructed side exceed normal resting levels. Care was taken to avoid distortion of the opposite side and to confine the cotton to the distal portion of the skin-lined vestibule. Serial measurements of nasal resistance were made during consecutive 10 minute periods of alternating occlusion for a total of 40 minutes.
2. *Vasodilation* – 1% histamine acid phosphate was applied to one nasal cavity by means of a small cotton applicator. Care was taken not to introduce histamine directly into the nasopharynx, from whence it might be sneezed into the other side. Sneezing and profuse secretion ceased after about 5 minutes and the mucosa remained congested for more than 30 minutes. Airflow resistance was determined repeatedly from the separate cavities over this period. Each procedure was performed on different days, the application being made on one day to the spontaneously more patent side, and on an other to the more congested.
3. *Vasoconstriction* – 0.1% xylometazoline HCl was applied to one nasal cavity. In other respects the prcedure was identical to that used in the histamine study.

RESULTS

Figure 1 shows that after obstructing one nostril with cotton, no changes in the resistance of its fellow occurred nor was the resistance of the occluded nasal cavity shown to be altered after removal of the cotton. In some studies, a brief decrease in resistance lasting about 30 seconds was noted after removing the cotton from one side and inserting it into the other. In others, a transient minor increase developed. These changes were ascribed respectively to pressure on, or irritation of, the nasal valve and the anterior end of the inferior turbinate, the principle resistive site in the normal nose (Haight and Cole, 1982).

The degree of congestion of the two nasal cavities is usually unequal. Vasodilatation with histamine of the more congested nasal airway (Figure 2a) or its vasoconstriction with xylometazoline (Figure 2b) did not change the resistance of the other side. Likewise, the application of these compounds to the less congested cavity did not alter the resistance of its fellow (Figures 2c and 2d).

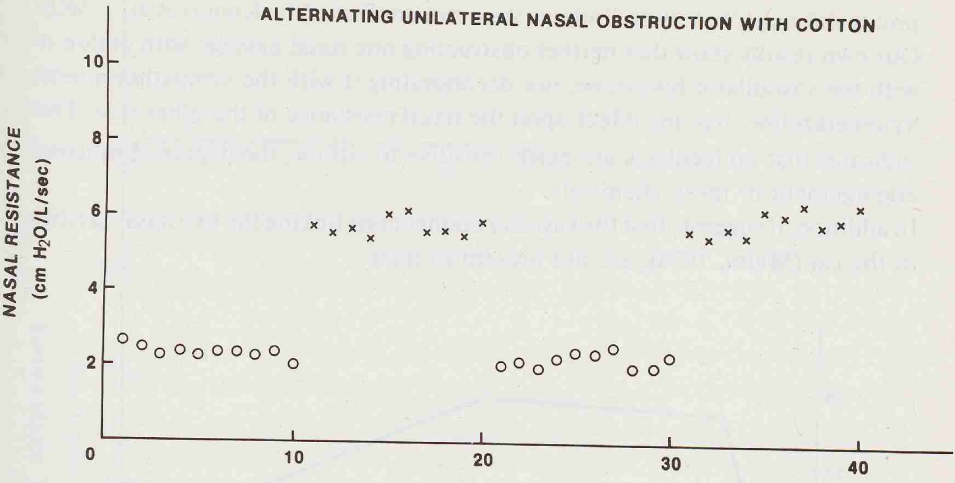


Figure 1. × = left
○ = right
Serial resistance measurements during consecutive 10 min periods of alternating occlusion show no significant change in either nasal cavity throughout 40 mins observation.

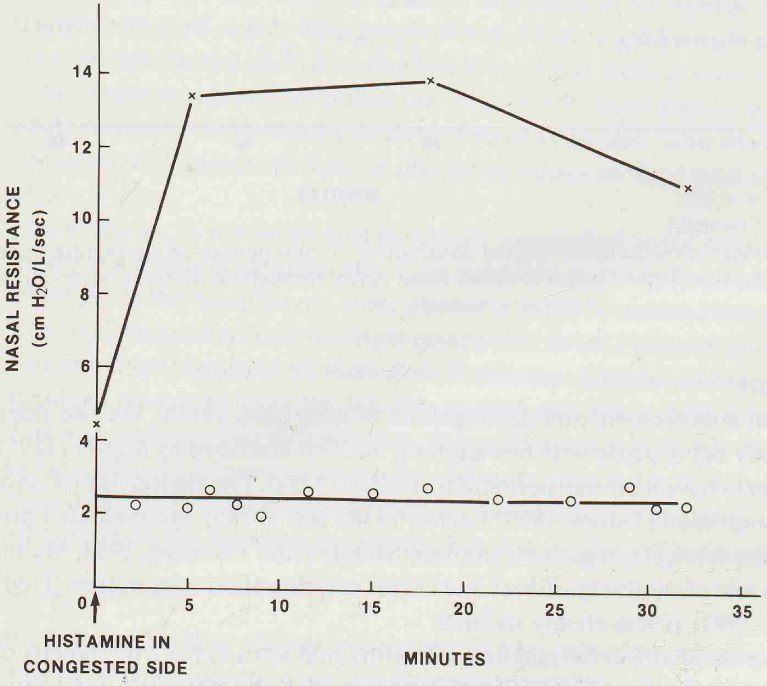
DISCUSSION

The cyclical engorgement and decongestion of each nasal cavity, the two sides being exactly out of phase with one another, was first discribed by Kayser (1895) and appears to have a diurnal periodicity (Eccles 1978a). The rhythm is probably centrally controlled (Tatum, 1927; Eccles, 1978a and 1978b) and mediated primarily by the cervical sympathetic outflow (Stoksted and Thomsen, 1953; Malm, 1974). The role of cholinergic fibres and nerves carrying other transmitters (Uddman et al., 1981) is less clearly defined.

The nasal cycle occurs in the majority of healthy subjects and has a periodicity of 2 to 8 hours (Heetderks, 1927; Stoksted, 1952 and 1953). Nevertheless, total nasal resistance remains remarkably constant (Stoksted, 1952; Hasegawa and Kern, 1977; Eccles, 1978a; Cole et al., 1979; Hasegawa, 1982). The same is true in lateral recumbency when the cyclical outflow from the central nervous system is overridden by a pressure sensitive reflex from one side of the body causing ipsilateral nasal congestion and contralateral decongestion (Cole and Haight, 1982). This raises the possiblility of a feedback loop from the nasal mucosa of either the patent or congested side, modifying the engorgement of its fellow and thereby minimizing total resistance alterations during the nasal cycle or lateral recumbency. Unilateral alterations in nasal patency induced experimentally might then be expected to cause reciprocal changes in contralateral resistance. Unilateral allergen-challenge experiments by Connell (1968), initially suggested that reci-

pricity did exist, but these findings were not confirmed by Konno et al., (1982). Our own results show that neither obstructing one nasal passage with cotton or with the vasodilator histamine, nor decongesting it with the sympathomimetic xylometazoline, has any effect upon the nasal resistance of the other side. This indicates that no feedback arc exists sensitive to airflow, the degree of mucosal engorgement or these chemicals.

In addition, it suggests that the vascular connections linking the two nasal cavities in the cat (Malm, 1974), are not present in man.



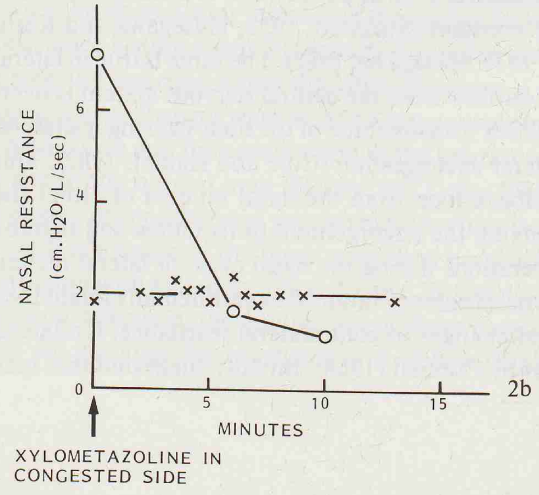
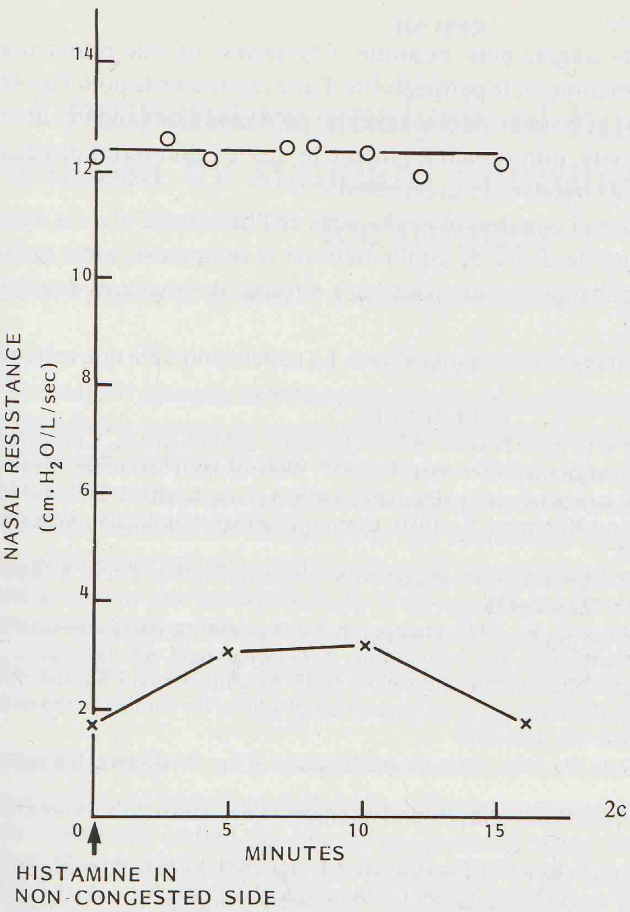
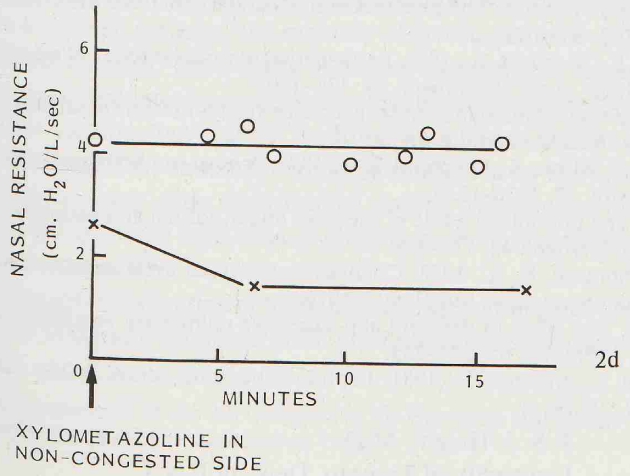


Figure 2a, 2b, 2c and d.
× = left
○ = right
Application of vasoactive substances to either a spontaneously congested or decongested nasal cavity brought about no change in airflow resistance of the opposite side.


14
12
10
8
6
4
2
0
NASAL RESISTANCE
(cm. H_2O/L/sec)
5
10
15
MINUTES
HISTAMINE IN
NON-CONGESTED SIDE

2c


6
4
2
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NASAL RESISTANCE
(cm. H_2O/L/sec)
5
10
15
MINUTES
XYLOMETAZOLINE IN
NON-CONGESTED SIDE

2d

RÉSUMÉ

La présente étude a été conçue pour examiner l'hypothèse qu'une rétroaction transmettant de l'information sur la perméabilité d'une cavité nasale pour l'air serait peut-être traitée par le système nerveux central pour modifier l'engorgement vasculaire de l'autre cavité, minimisant en même temps les altérations de résistance totale au flux d'air pendant le cycle nasal.

Après avoir appliqué dans l'une des cavités nasales de l'hystamine et de la xylometazoline pour changer le degré de gonflement de la muqueuse, ainsi qu'un tampon de coton pour changer le flux d'air, on a effectué des mesures de résistance de l'autre cavité.

On n'a pas observé de changements dans celle-ci. La conclusion a été que cette rétroaction n'existe pas.

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J. S. J. Haight, M.D.
University of Toronto, Dept. of E.N.T.
Sunnybrook Medical Centre, 2075 Bayview Avenue
Toronto, Ontario, Canada M4N 3M5