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Nasal airflow asymmetry and the effects of a topical nasal decongestant

R.G. Williams and R. Eccles

Common Cold and Nasal Research Centre, Dept. of Physiology,
University of Wales, Cardiff, United Kingdom

SUMMARY

Nasal airway resistance (NAR) is normally asymmetrical due to the nasal cycle. The aims of this study were to determine the degree of this asymmetry in healthy subjects and those with acute rhinitis associated with common cold, and to investigate how the administration of a topical nasal decongestant (xylometazoline) influenced the asymmetry in NAR. Unilateral NAR was measured by active anterior rhinomanometry, and was shown to be asymmetrical in both healthy subjects and those suffering with acute rhinitis. The asymmetry in NAR was greater in those with acute rhinitis than in the healthy group, with a ratio between "high" and "low" sides of 2.3:1 in the rhinitis group compared to a ratio of 1.7:1 in the healthy subjects. Administration of a topical nasal decongestant caused a significant decrease in total NAR in both groups and abolished the asymmetry in NAR in the healthy subjects (ratio is 1:1 after decongestion). However, significant asymmetry of NAR was still present in the group with acute rhinitis following the administration of decongestant (ratio is 1.5:1 after decongestion). These findings show that the normal asymmetry in NAR was increased during acute rhinitis associated with common cold, and that in healthy subjects (but not in those with rhinitis) the asymmetry was abolished by administration of a topical decongestant. The results are discussed in relation to nasal sympathetic tone and nasal blood flow.

INTRODUCTION

Healthy volunteers normally show a marked asymmetry in nasal airway resistance (NAR) between the two nasal passages. This asymmetry too is termed the "nasal cycle", as over a period of hours the dominant nasal airflow alternates between the nasal passages (Heetderks, 1927; Stoksted, 1952).

Nasal congestion associated with the common cold is believed to be caused by the release of local mediators such as kinins, which cause vasodilation and congestion of the venous sinusoids in the nasal mucosa (Mygind et al., 1983; Bisgaard et al., 1984). It is not known how the nasal cycle is influenced by acute rhinitis

related to common cold, but it is reported that the asymmetry in NAR is increased during experimentally-induced coronavirus infection (Bende et al., 1989).

The aims of the present study were firstly to determine the effect of acute rhinitis on the normal asymmetry of NAR, and then to study the effects of a topical nasal decongestant on each side of the nose to determine if there was any difference in response related to the nasal cycle.

METHOD

Subjects were recruited from the staff and students of the University of Wales College of Cardiff, and from the general public. Because of the sympathomimetic actions of the nasal decongestant used in the study, all subjects taking monoamine oxidase inhibitors or those with a history of heart disease, asthma, thyroid disease, hypertension or glaucoma were excluded. Those allergic to nasal decongestants were also excluded. All subjects were examined, and those with obvious anatomical nasal obstruction as well as those with a history of persistent unilateral nasal obstruction were excluded.

Forty-seven adult subjects were included in the study. The mean age of the subjects was 24 years with an age range from 18 to 56 years. Twelve of the subjects were healthy asymptomatic individuals without any symptoms or signs suggestive of acute rhinitis. Thirty-five subjects had acute rhinitis attributed to the common cold. Confirmatory virology was not performed, and it is possible that some individuals were suffering from an acute exacerbation of an allergic or vasomotor rhinitis.

The NAR of each subject was measured using active anterior rhinomanometry (Rhinomanometer NR6, Mercury Electronics). The equipment was calibrated each day for pressure and flow, and a pressure reference value of 150 Pa was used for measurements (Clement, 1984). Measurements were made with the subjects sitting upright and, provided that the coefficient of variation was less than 20%, the average of twelve readings of NAR for each nostril was taken. If the coefficient of variation exceeded 20%, the readings were repeated.

After baseline NAR measurements a topical nasal decongestant spray was administered in the form of 0.1% (w/v) xylometazoline.HCl, two puffs to each nostril. Subjects were allowed to clear their nose by gently blowing the nose prior to baseline unilateral measurements of NAR, but once the spray was administered no nose-blowing was allowed for 5 min in order to prevent expulsion of the decongestant spray. The subjects sat quietly for 10 min, and then the unilateral measurements of NAR were repeated. According to the baseline measurements of unilateral NAR, nasal passages for each subject were classified as either the high NAR side (H) or the low NAR side (L).

Numerical results are presented as means (± standard error of the mean), and the

tests of significance were done using both paired and non-paired t-tests, as appropriate.

RESULTS

The baseline mean total NAR for the healthy group was 0.2±0.01 Pa/cm^3/s, which was significantly lower than in the group with acute rhinitis with a mean of 0.36±0.04 Pa/cm^3/s ($p=0.003$).

The mean unilateral baseline NAR for the two groups of subjects classified as high (H) or low (L) sides are shown in Figure 1A. In the healthy subjects, the mean value for the high side (H) was 0.6±0.04 Pa/cm^3/s (range 0.32 to 0.75 Pa/cm^3/s) and the mean value for the low side (L) was 0.36±0.02 Pa/cm^3/s (range 0.28 to 0.52 Pa/cm^3/s). In the acute rhinitis group of subjects, a significant asymmetry between the individual nasal passages was found which was greater

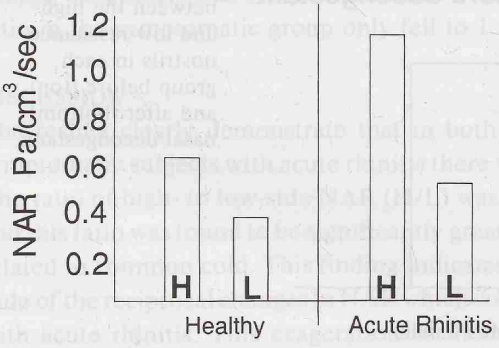

Figure 1a

Figure 1. Figure 1A shows the mean nasal airway resistance (NAR) for the individual nostrils in both groups of volunteers before the administration on decongestant. Figure 1B shows the mean NAR after the administration of decongestant. Column H represents the high-resistance nostril and column L the low-resistance nostril.

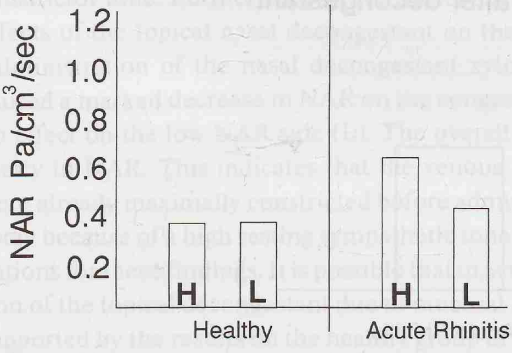

Figure 1b

than the asymmetry seen in the normal volunteers as shown in Figure 1A. The mean value for side H was 1.16±0.16 Pa/cm^3/s (range 0.3 to 4.7 Pa/cm^3/s) and the mean value for side L was 0.5±0.03 Pa/cm^3/s (range 0.26 to 1.15 Pa/cm^3/s).

After the administration of a topical nasal decongestant there was a significant fall in the mean total NAR in the healthy group from 0.2±/0.01 Pa/cm^3/s to 0.17±0.16 Pa/cm^3/s (range 0.12 to 0.27 Pa/cm^3/s) with $p=0.003$, and also a significant fall in the mean total NAR in the acute rhinitis group from 0.36±0.02 Pa/cm^3/s to 0.23±0.01 Pa/cm^3/s (range 0.13 to 0.39 Pa/cm^3/s) with $p=0.001$. The mean total NAR after the administration of a topical nasal decongestant was still significantly greater in the acute rhinitis group (0.23±0.01 Pa/cm^3/s) compared to the healthy group (0.17±0.16 Pa/cm^3/s) with $p=0.02$.

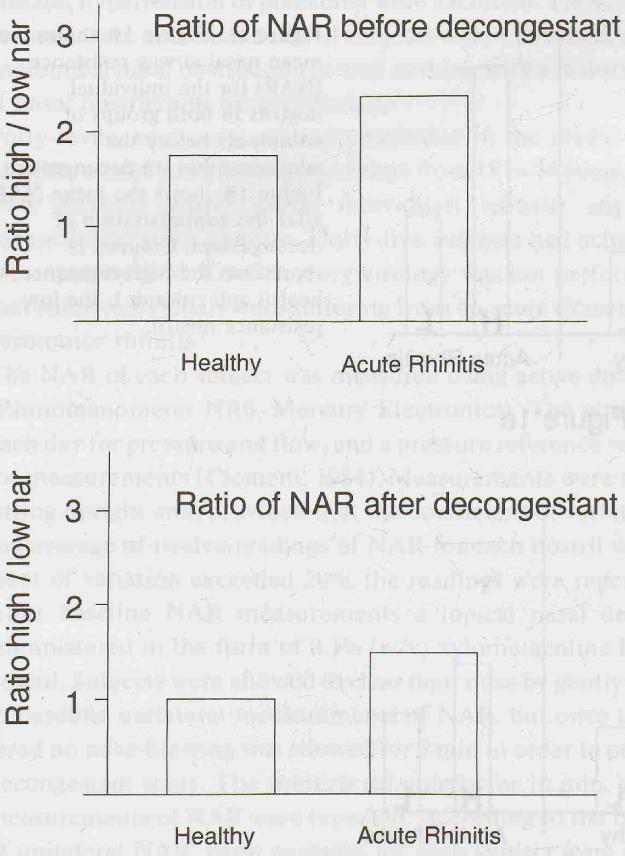

Figure 2. The ratio between the high- and low-resistance nostrils in each group before (top), and after (bottom) nasal decongestant.

Mean unilateral NAR values after administration of the nasal decongestant are shown in Figure 1B. In the healthy volunteers, the mean unilateral NAR were almost identical, with side H at 0.35±0.02 Pa/cm^3/s (range 0.23 to 0.5 Pa/cm^3/s) and side L at 0.36±0.04 Pa/cm^3/s (range 0.23 to 0.75 Pa/cm^3/s) with $p=0.8$. In the acute rhinitis group, there remained a significant asymmetry between the two sides, with the mean NAR for side H at 0.6±0.07 Pa/cm^3/s (range 0.26 to 2.4 Pa/cm^3/s), and the mean NAR for side L at 0.4±0.02 Pa/cm^3/s (range 0.24 to 0.9 Pa/cm^3/s) with $p=0.004$.

The effects of the nasal decongestant on unilateral NAR in both groups can also be illustrated by calculating the ratio between the NAR of each side, i.e. H/L. Figure 2 shows the ratios for H/L in each group before and after the administration of the nasal decongestant. Before the administration of the decongestant the ratio H/L in the healthy group was 1.7:1, and in the acute rhinitis group the ratio was 2.3:1. After the administration of the decongestant the ratio H/L in the healthy volunteers was 1:1 (no difference between sides H and L), whereas the ratio in the symptomatic group only fell to 1.5:1.

DISCUSSION

The results clearly demonstrate that in both the healthy subjects and in the symptomatic subjects with acute rhinitis there was a marked asymmetry in NAR. The ratio of high- to low-side NAR (H/L) was used as a measure of asymmetry and this ratio was found to be significantly greater in the group with acute rhinitis related to common cold. This finding indicates that there is an increased amplitude of the reciprocal changes in NAR which constitute the nasal cycle in subjects with acute rhinitis. This exageration of the nasal cycle may be related to an increase in nasal blood flow due to nasal inflammation. The increased blood flow causes an increased filling pressure in the venous sinusoids, and this has a greater effect on the high NAR side of the nose (H) due to a low resting sympathetic vasoconstrictor tone. Further support for this explanation can be obtained from the effects of the topical nasal decongestant on the nasal cycle.

Administration of the nasal decongestant xylometazoline to normal subjects caused a marked decrease in NAR on the congested side of the nose (H), but had no effect on the low NAR side (L). The overall result was to abolish the asymmetry in NAR. This indicates that the venous sinusoids on the low NAR side were already maximally constricted before administration of the xylometazoline spray because of a high resting sympathetic tone. There are many possible explanations for these findings. It is possible that in acute rhinitis there is poor penetration of the topical decongestant due to mucosal congestion. However, this is not supported by the results on the healthy group in which the greatest decongestant effect was seen on the high NAR side (H) and, in fact, no change was seen in the mean NAR on the low NAR side (L). It may be that this simply reflects the fact

that in healthy individuals the low NAR side (L) has maximum sympathetic vasoconstrictor tone, and is therefore not capable of further decongestion.

Rhinomanometry combines the most accurate and convenient method available for assessing nasal obstruction. Many investigators and surgeons rely on rhinomanometry in the assessment and treatment of individuals complaining of nasal obstruction. Approximately 80% of normal individuals have asymmetrical nasal airflow because of the nasal cycle (Lenz et al., 1985). Pharmacological decongestion is used by some investigators to eliminate the effect of the nasal cycle in their patient assessment. By measuring NAR in the decongested state it is assumed that the effect of mucosal congestion is eliminated, and any remaining asymmetry is assumed to be due to either a septal deviation or other anatomical problems affecting the airway. Our results show that asymmetry of NAR due to the nasal cycle is abolished in healthy subjects by application of a topical nasal decongestant and this finding agrees with other studies on healthy subjects (Jessen and Malm, 1988). We have demonstrated that the asymmetry in NAR is greater in individuals with acute rhinitis than the asymmetry seen in healthy individuals. The fact that this asymmetry is not abolished by the application of topical decongestants has important implications for the use of such decongestion in the assessment of patients with nasal symptoms. The implication is that in an individual subject with unsuspected acute rhinitis the application of a decongestant may significantly reduce the NAR, but not completely reverse a so-called functional (mucosal) effect, and that any residual asymmetry may be wrongly attributed to an anatomical (structural) cause.

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R. G. Williams, MPhil, FRCS
Dept. of Otolaryngology
University Hospital of Wales
Heath Park
Cardiff
United Kingdom