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The nasal provocation test in the diagnosis of allergic rhinitis. Behaviour and dynamics of nasal flow during the test

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SUMMARY

We analyzed the value of the (n) coefficient of nasal flow in the formula of nasal resistances in order to: (]) calculate nasal flow during the course of the nasal provocation test, and (2) tty to find out whether nasal flow maintains the same characteristics during the test. Our results show that values va,y between 1.6589 and 1.8801, with a weighted mean of l. 7645 - suggesting that the flow is of a mixed character - without significant differences during the course of the test. At the same time we carried out an analysis of the dynamics of nasal flow during nasal provocation.

INTRODUCTION

Nasal provocation with allergens or mediators such as histamine and substance P, is frequently used in the study of allergic rhinitis or vasomotor cholinergic rhinitis. We have standardized the test with allergens (Olive, 1986; 1988). We have also tried obtaining the mathematical description (Olive, 1989) of the behaviour of resistances in relation to the dose. We used the following classical formula to calculate the resistances:

$$R = \frac{\Delta P}{\dot{V}_n}$$

in which coefficient (n) is critical. The value of the coefficient (n) depends on the characteristics of the flow, which in turn depends on the Reynolds number. The calculation of the coefficient is always made in relation to a given flow. Thus., using an artificial model with a nasal flow of 0.05 1/s, Fisher (1965) calculated average values of 1.85: Solomon (1965) obtained a value of 1.16 for flows less than

0.02 l/s. Eichler and Lenz (1985) considered the value of a mixed nasal discharge and found a value of 1.85248 ± 0.06 (that is, ranging from 1.79 to 1.91).
Since the nasal provocation test (NPT) is based on the study of nasal resistances when the nasal mucosa is stimulated with increasing concentrations of the allergen, we think it is essential not only to know the characteristics of the existing nasal flow during the testing, but also whether these characteristics are maintained throughout the test, and this has been the objective of this study.

MATERIAL AND METHODS

Selection of patients

Twenty-three patients with positive NPT to *Dermatophagoides pteronyssinus* were studied. All of them had a positive medical history, skin tests and RAST. Their ages were between 15 and 60, with a male/female ratio of 0.47.

Provocation

The NPT was carried out by means of anterior active rhinomanometry, with a Rinospir 164 rhinomanometer (Sibelmed, Spain), using allergens (HEP system, Pharmacia, Uppsala) in concentrations ranging from 10 to 10,000 biological units (BU)/ml, according to the previously described technique (Olive, 1989). An increase in basal resistance ≥ 100% was considered as positive.

Calculation of the coefficient

The following expression was used to calculate the (n) coefficient:

$$n = \frac{.1P_{(100)} - .1P_{(75)}}{\log (\dot{V}_{100}) - \log (\dot{V}_{1s})}$$

For the calculation we used nasal flow pressures between 75 Pa and 100 Pa; the nasal flow was expressed in ml/s. The (n) coefficient of the stimulated nasal fossa was calculated for the above conditions, with 5-min readings at the different concentrations of allergen used.

Statistical method

We analyzed the (n) values for each concentration and, using the Smirnoff-Komogorov test, we analyzed their normality with a level of 95%. We calculated the averages of the results and compared them in a paired means analysis for p = 95%. The Pearson correlation coefficient was calculated for the allergen doses and the (n) coefficients, as well as a second- and third-order polynomial regression analysis at the same level of significance. In order to determine the (n) value during provocation we used the weighted mean as well as the combined variance.

Table 1. Coefficient values (n) according to the allergen dose.

dose-normal distribution	basal yes	10 BU yes	110 BU yes	1,110 BU yes
average	1.7984	1.6944	1.8801	1.6589
standard deviation	0.83076	0.47216	0.88607	0.25532
number	23	21	15	7

Table 2. Correlation between the different values of the coefficient (n).

exponent	basal n	n with 10 BU	n with 110 BU	n with 1,110 BU
basal n	1	0.11027	-0.048	-0.8865
n with 10 BU	0.11027	1	0.1868	0.70874
n with 110 BU	-0.048	-0.1868	1	-0.153
n with 1,110 BU	-0.8865	0.70874	-0.153	1

RESULTS

The distribution of (n) coefficient values found in all the concentrations is normal ($p < 0.05$). Table 1 shows the average values of the (n) coefficient for each concentration. The means analysis shows the absence of significant differences between the different values. Table 2 shows the results of the linear correlation coefficients between the (n) values obtained with respect to the dose. A significant correlation only exists between basal values and the values obtained with a cumulative dose of 1,110 BU ($r = 0.8865$; $p < 0.05$); the value obtained for the (n) values at 10 BU and 1,110 BU being 0.70874 ($p < 0.1$). The regression equation that links the initial (n) values with the predicted values at the concentration of 1,110 BU is:

$$n_{1,110} = 5.4312 - 2.27074\ n_0$$

The correlation coefficient between the dose and the (n) coefficient is -0.6536 **(N8)** and the regression equation is:

$$n = 1.789 \times 10^{-5} \text{ allergen concentration}$$

We carried out the polynomial regression analysis. If it is studied with a second-order polynomial, the r value is 0.91345 (NS): In a third-order polynomial the r value is 0.9889 and r2 is 0.9799 **(NS).** The same analysis is carried out among the (n) values for the different doses. It is only significant ($p < 0.05$) for the basal n value and then of the concentration of 1,110 BU ($r = 0.89341$ and $r2 = 0.9818$). Finally, we calculated the mean value of (n) during NPT. For this we looked at the weighted mean of the (n) coefficients between 0 (basal value) and 1,110 BU. The value obtained is 1.7645 with a combined variance of 0.3874.

DISCUSSION

It is well known that **NPT** is a valid technique in the diagnosis of allergic rhinitis. In previous studies (Olive, 1988; 1989), we showed its high clinical reliability and proved that the modification of nasal resistance depends on the accumulated dose.

However, the characteristics of nasal flow were unknown to us, as was the question whether they were modified during the **NPT.** If this should happen, the theoretical basis of the calculation of resistances and their use would be severely affected. It would therefore be necessary to search for another flow variation parameter, which is difficult and complex (Olive, 1987) since the dose-flow relations are of a non-linear nature. Eichler and Lenz (1985) suggest that the values of the **(n)** coefficient of the equation:

$$R = \frac{P}{I}$$

are a clear indicator of the nature of the flow, since with n = 1 the flow is linear, with n = 2 turbulent, and with intermediate values it is mixed. At the same time, our study (Olive, 1986) showed the same clinical reliability with the use of (n) values of 1.85 and 2. The analysis carried out shows that the values of the (n) coefficient are not significantly modified during NPT, the values always being between 1 and 2. This suggests that the flow is of a mixed nature. At the same time, the nature of the flow does not depend on the allergen concentration, but is an independent variable.

Also, the mean value of the coefficient is 1.7545, close to that proposed by Eichler and Lenz (1985), for mixed flow. It is also significant that the (n) variations are never greater than 10%, and are independent of the value of the coefficient obtained under basal conditions, with the exception of the (n) value found with 1,110 BU, which shows a good negative correlation with the basal one. But this (n) value, which was only studied in a few patients, is dependent on the (n_{10}) value and independent of the (n_{100}) value, which may be due to either the size of the sample or the fact that only those that are less sensitive reach this concentration.

From the analysis of the data in Table 1 it seems that the testing dynamics would be: (1) flow fall (Type II response; Olive, 1988); (2) an attempt to maintain flows by an increase in differential pressure (Type I response); and (3) failure in the attempt when the physiological limits are exceeded and new flow fall (Type II response). All of this would justify the results that have been obtained, especially the correlation between the final (n) value and the (n) values at certain allergen concentrations.

It would perhaps have been interesting to analyze the gradual rise in nasal fossa concentrations - this will be the object of another study - as well as to carry out

the analysis with higher differential pressure values, of between 100 Pa and 150 Pa. But in the course ofNPT, many patients cannot register values at 150 Pa. We therefore believe that it is better to carry out the test evaluation either at 75 Pa or at 100 Pa, since in all patients we can obtain the register of this section of the rhinomanometric curve.

It is interesting to observe that the nasal flow obtained was always between 64 1 and 5421, that is within the range ofvalues studied by Fisher (1965), for which the latter obtained a value ofn = 1.85, which is very similar to our value ofl.7645. Our value is also in the same order of magnitude as that found by Solomon (1965), that is 1.7. However, the flows he used are notably smaller, while the differences with Clement (1988) can be explained by either methodological differences or the fact that the latter author works with pressures of 78.43 Pa.

In conclusion, we believe that: (1) the nasal flow in the NPT is of a mixed nature; and (2) this remains invariable during testing, which allows it to maintain its practical validity in the diagnosis of allergic rhinitis.

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