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The nasal provocation test: response patterns

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SUMMARY

We studied a group of allergic patients by active anterior rhinomanometry. We performed the nasal provocation test (NPT) and we observed two kinds of responses. The Type I pattern consists of an increase in ΔP and an increase in resistance. The type II pattern consists of an increase in the flow value ($\dot{V}$) and an increase in resistance. There are significant differences in the frequency of the two patterns among the allergens.

INTRODUCTION

The nasal provocation test (NPT) is a diagnostic technique that is widely employed in allergic rhinitis.

Some authors (Eriksson et al., 1977) employ it in the clinical evaluation (presence of sneezing, hydrorhinorrhea, pruritus and obstruction) of their patients. Other authors (Crifo et al., 1975); Pelikan et al., (1972); De Dioniggi et al., (1985) employ rhinomanometry - either anterior (active or passive) or posterior rhinomanometry. When an antigen-antibody reaction takes place in the nasal mucosa, the release of a variety of mediators, especially histamine and PGD2, is effected; this has been demonstrated by Naclerio et al. (1983). The consequence is a decrease in the nasal cross-sectional area. In order to maintain flow, therefore, the differential pressure (ΔP) increases in inverse relation to the fourth power of the radius (Poiseuille's Law). This leads to an increase in resistance, in accordance with the following equation:

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

In theory the increase in R can be due to:

- An increase in differential pressure (ΔP)
- A decrease in flow ($\dot{V}$)

The aim of this study is to identify the response patterns occurring in the NPT.

MATERIAL AND METHODS

1. *Patients*

Eight patients with positive skin tests to Alternaria (*V/H* 1.66; average age 17.5 ± 9.036 years); 14 patients with positive skin tests to Phleum (*V/H* 0.27; average age 27.07 ± 9.47 years) and 59 patients with positive skin tests to D.pteronyssinus (*V/H* - 0.25; average age 35.32 ± 11.13 years).

2. *Investigations*

Skin testing was carried out in all the patients with allergens standardized in BU/ml (HEP system), at dilutions of between 100 and 100,000 BU/ml, and with 1 mg/ml of histamine chlorhydrate. Skin tests were considered positive if the papule produced was equal to or greater than 75% of the papule obtained using histamine.

The NPT was performed with the same allergens from the same batch. The allergen (100-100,000 BU/ml) was administered by means of a nebulizer with standardized outlet, which delivers 0.1 ± 0.05 ml/pulsation. Two pulsations were administered during apnea and always into the same fossa, so that there is an accumulative effect.

The NPT was considered positive if the resistance increased by 100% with respect to the basal value.

We analysed the behaviour of the parameters ΔP, R and $\dot{V}$.

RESULTS

1. *With Alternaria:* In five of the patients the NPT was positive; in one patient, the trace (with 100 BU/ml) became flat and illegible. In the other cases, testing was negative (71.43% of positives).

In 71% of the cases, we see that the $\dot{V}$ values decrease and it is only in 29% of the cases that one observes an increase in the resistance, as a result of the increase in ΔP.

2. *With Phleum:* In 10 of the 14 cases (71.43%) the NPT was positive at concentrations of between 100 and 10,000 BU (in fact 111,100 BU); it was negative in 28.57% of the cases, although in two of the four cases, the test was positive with 100,000 BU.

The resistance increased because of an increase in ΔP in 42% of the cases and because of a decrease in flow in 58% of the cases.

3. *With D.pteronyssinus:* The NPT was positive in 52 patients (88.14%) and negative in 7 patients (11.86%).

In 22% of the cases there were increases in ΔP and R, whereas in 78% of the cases the decrease in flow ($\dot{V}$) was responsible for the increase in resistance.

By carrying out a proportional analysis of the results obtained, we see that the fre-

quencies of an increase in R with a decrease in $\dot{V}$(0.71) and of an increase in R accompanied by an increase in ΔP(0.29) differ at a p level of less than 0.05, in the case of Alternaria. In the case of D.pteronyssinus, the difference is significant at a p level of less than 0.01.

DISCUSSION

As we have shown, the resistance values can increase because of either an increase in differential pressure or a decrease in flow. We believe, therefore, that there are two response patterns:

Type I Pattern: This type of response consists of an increase in ΔP, the maintenance of flow and an increase in resistance. It occurs in 29% of the cases tested with Alternaria, in 42% of the cases tested with Phleum and in 22% of the cases tested with D.pteronyssinus.

Type II Pattern: The dominant feature of this response pattern is the decrease in flow, which is responsible for the increase in resistance with maintenance of the differential pressure; the latter may actually decrease.

We observed this pattern in 71% of the cases tested with Alternaria, in 58% of the cases tested with Phleum and in 78% of the cases tested with D.pteronyssinus.

Elucidation of the mechanism involved remains an important objective. It may be assumed that the antigen-antibody reaction leads to the release of a variety of mediators. These mediators, through their action on the capacitance vessels, cause vasodilatation and plasma exudation which, together with the hypersecretion, lead to a decrease in the radius of the nasal section. Therefore, if the flow is laminar, the differential pressure must be increased in order to be able to maintain the flow - this is in accordance with Poiseuille's equation. The result will be an increase in ΔP and a parallel increase in the resistance.

If the obstruction is severe enough - that is, if there is a marked decrease in the radius - there is an extraordinary increase in the resistance. Under such conditions, it is not possible to maintain the flow, because:

$$\dot{V}=\sqrt[n]{\frac{\Delta P}{R}}$$

which indicates that an adequate increase in the differential pressure is not physiologically possible.

Therefore, the flow decreases; this means that further increases in ΔP are not necessary and, consequently, the increase in resistance occurs at the expense of a decrease in flow.

Indirect evidence for the existence of this mechanism is provided by the observation that the amount of allergen required to obtain a positive skin test to Phleum is significantly greater ($t=1.8127$, $p<0.05$) than that required to obtain a positive skin test to D.pteronyssinus. But, in nasal provocation testing, there is

no significant difference ($p>0.05$) in the amounts of allergen required to obtain positive tests; this indicates that if the patients tested with D.pteronyssinus are more sensitive (demonstrated by skin testing), more allergen is required to produce a response in the NPT. A possible explanation for this phenomenon would be that these patients passed through a primary phase during which they gave a Type I Pattern response, which was not intense enough for the test to be considered positive; a positive test would only be obtained when they gave a Type II Pattern response.

The logical consequence of the afore mentioned observations is the employment of the resistance values (with exponent $n=1$ or with exponents 1, 85 or 2) in the evaluation of the NPT.

RESUMEN

Analizamos un grupo de pacientes con rinitis y rinitis-asma supuestamente alérgicos frente a Alternaria, Gramíneas, Epitelio de gato o D. Pteronyssinus. Realizamos el TPN mediante AAR.

Hemos hallado dos modelos de respuesta. El Modelo I consiste en el aumento de ΔP y de R y en Modelo II consiste en el descenso de $\dot{V}$ e incremento de R.

La distribución de las frecuencias de ambos modelos, en función del alérgeno, muestra diferencias estadísticamente significativas.

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