NASAL RESISTANCE MEASURING WITHOUT BREATHING

H. A. E. van Dishoeck, Leiden, the Netherlands
and San Diego Medical research Institute, San Diego, Calif., U.S.A.
E. A. van Dishoeck II, Baarn, the Netherlands

Introduction

In common active rhinomanometry the airstream through the nose is provided by the lungs; in our, passive, rhinomanometry a pump provides this airstream, the patient holding his breath. In both cases we measure the resistance encountered by the airstream in the nose at the nostril by means of a sensitive water- or oil manometer.
The value recorded depends on the volume of air that passes in the unit of time. A small aircurrent, as during quiet breathing, will meet with a much smaller resistance than a strong airstream. The same holds true for a small or strong aircurrent from a pump blown through the nose. This means that we must express the resistance of the nose in relation to a certain well defined airstream. In the common active rhinomanometry this is the airstream that passes through the nose when the patient is in rest in the upright position. However a well defined and steady state of breathing is often impossible for two reasons: 1. the patient is nervous and breathes irregularly either abnormally superficially or abnormally deeply. 2. in measuring the narrow half of the nose, we connect and shut off the other side. This is another reason for abnormal breathing, simply because the patient feels very soon oppressed. Because of this he increases the action of his lungpump in order to maintain the same oxygen supply he enjoyed during breathing through both nosehalves. Thus the breathing curve we obtain reflexes mainly the action of the lungpump, overshadowing the value we want to measure, viz. the resistance of the nose as an independent and stable value.
In our measurement of passive resistance these disturbing factors are absolutely eliminated, because a constant airstream provided by an airpump, is blown for a few seconds through the nose while the patient holds his breath. The resistance is measured at the nostril and read off a sensitive manometer. The whole procedure takes a few seconds. Nervous instability or oppression are of no consequence.

Principle

The resistance of a tube is determined by its length, diameter, irregularities of the lumen, curvatures and friction. In the nose all these factors together build up the resistance, viz. the force (pressure) needed to blow or suck a certain airstream through this system. As at one side the atmospheric pressure is present, the pressure measured at the site of input (nostril or mouth) actually represents the nasal resistance for the chosen flow.

Instruments

A suitable nozzle with a side tube, connected to an airpump, provides the positive or negative pressure to blow or suck air through the nose. The resistance is measured at the nostril by means of the side tube and an inclined sensitive manometer.

The airstream may be provided by a de Villbiss airpump or any other office pump which is at hand of enough capacity to deliver 10-16 L. pro minute. This pump should have a connection for blowing as well as sucking. The airstream can be measured by a simple flow-meter at the nozzle. The tubing should be wide enough.

The nozzle needs special attention. We have three oval shaped specimen with openings of different size, to be used according to need. The nozzle should fit in the nostril with a minimum of pressure — in order not to disturb the internal ostium. The negative pressure which may result in a side tube when an airstream is blown through a pipe with irregular diameter must be avoided by smooth walls. Moreover the airstream — when entering this nozzle is divided in small streams by a number of small canals. Thus a laminar stream results.

The manometer is made more sensitive in incliny it at 60 degrees and by replacing one leg by a balloon with a broad surface. One millimeter of lowering of this surface will result in an important excussion of the water or oil in the inclined leg. On the inclined leg is a second balloon with a simple provision against spilling the fluid by too high pressures. This manometer can be calibrated with a simple U tube water manometer.

However, we prefer to calibrate this manometer by means of a disc with openings of known sizes from 150 mm^2 down. The nasal resistance is in this system expressed in the hydraulic diameter. This diameter is the opening which provides the same resistance as the nose — whatever the shape of

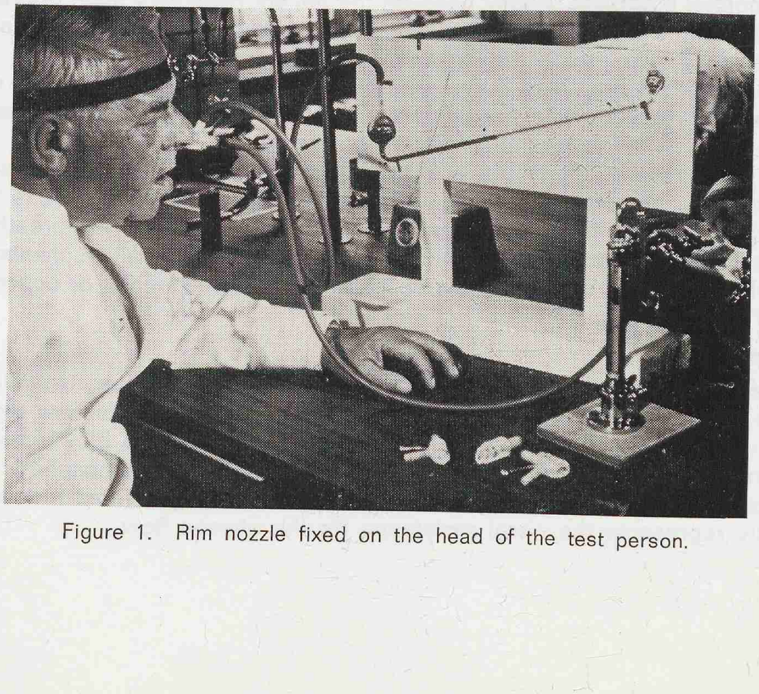

Figure 1. Rim nozzle fixed on the head of the test person.

the nasal airway. These instruments are so simple that every technician can help you to arrange this very useful set-up.
In some prolonged experiments a rim-nozzle, fixed on a head band, is used (van Dishoeck, 1938).
As the resistance of a tube depends on the flow, a convenient flow should be selected, giving easily readable values. We used a flow of 16 L. pro minute, giving 2 mm. inflow resistance, being equal to a round opening of about 50 mm^2. When applied to the mouth the test person should start with hyper-ventilating and learn to relax his tongue and pharynx muscles during the very short test. With these precautions no difficulties are met and the values are obtained in a matter of seconds. The lowest value is most probably the right one.

Varieties of experiments

With this set-up no less than 14 different values can be obtained:

1. Inblow in R. nostril with mouth closed 2. Same in L. nostril with mouth closed	resistance of both nasal chambers linked one after the other is measured
3. Inblow in R. nostril, L. closed: mouth open 4. Same in L. nostril, R. closed: mouth open	resistance of one nasal chamber is measured
5. 6. 7. 8. Same with negative pressure: (sucking-out)	
9. Inblow in mouth: both nostrils open	resistance of the nose in normal expiration is measured
10. Inblow in mouth: R. nostril closed	resistance of one nasal chamber is measured
11. Inblow in mouth: L. nostril closed	resistance of one nasal chamber is measured
12. 13. 14. Same as 9. 10. 11. with negative pressure (sucking-out)	simulates normal inspiration

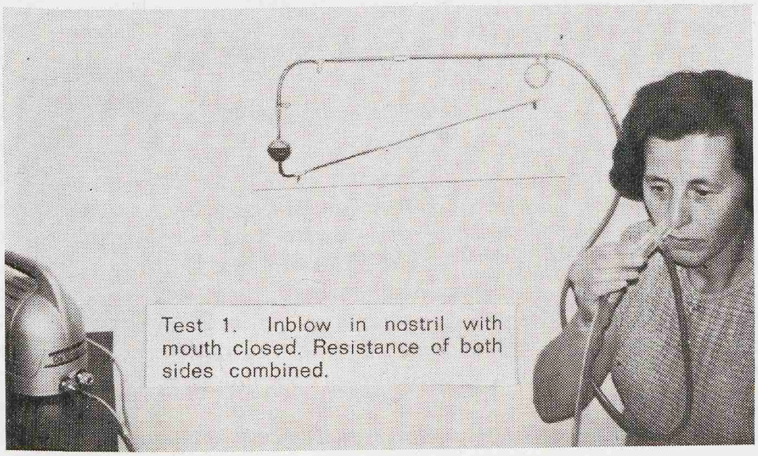
Test 1. Inblow in nostril with mouth closed. Resistance of both sides combined.

Figure 2.

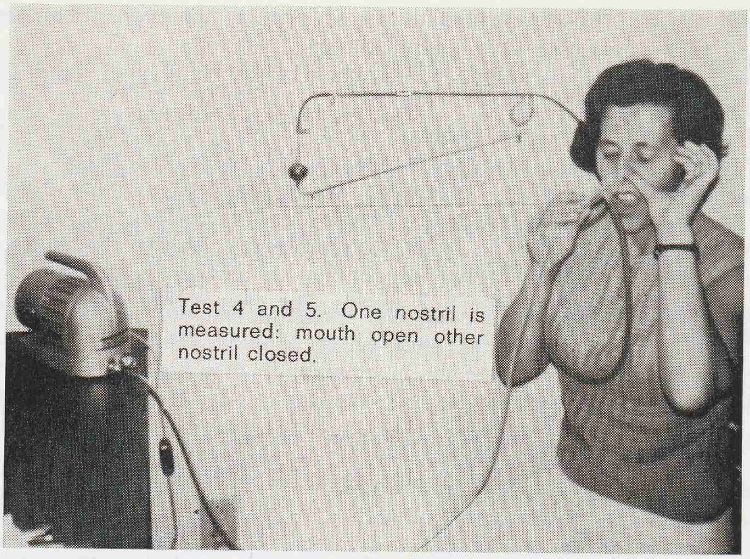

Figure 3.

Four of these experiments give essential information, the others additional information on special points such as the function of the valve, position of the head, etc. These four are:

1. resistance of airstream passing through both nasal chambers while mouth is closed. Thus resistance behind the ostium is more readily measured. In this experiment f.i. induced congestion of the turbinates by jugular compression can be studied.

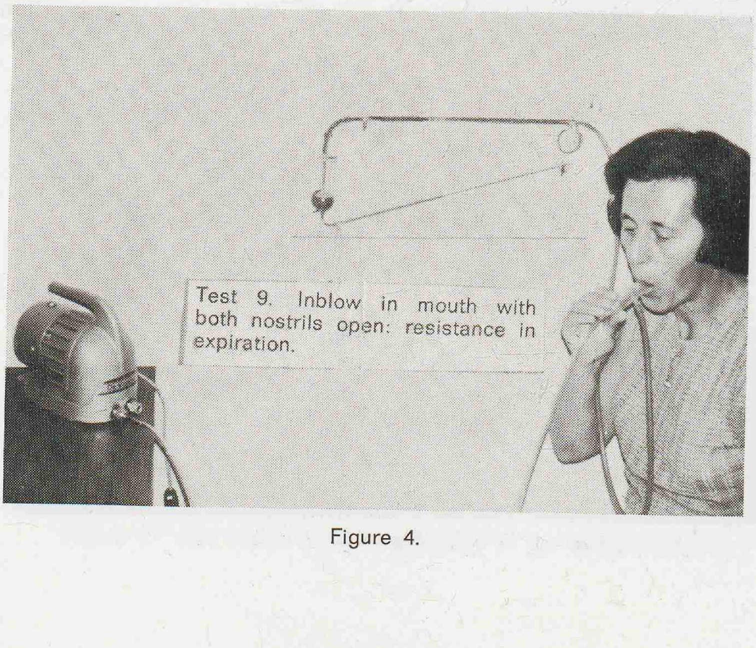

Figure 4.

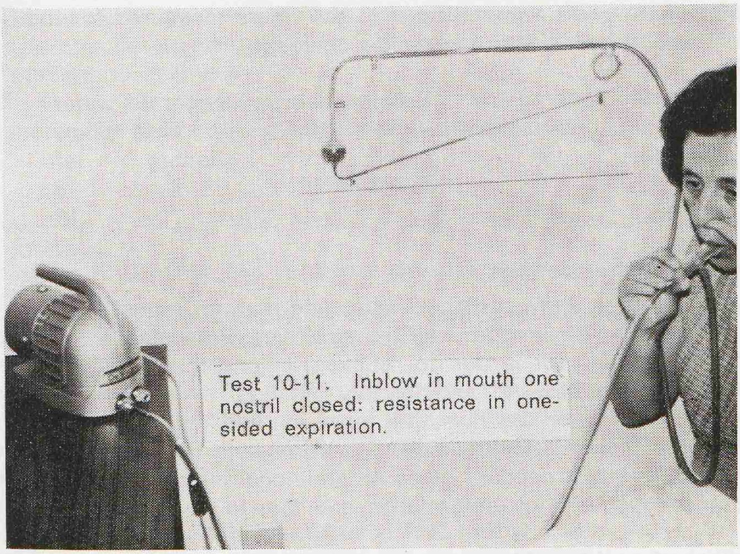

Figure 5.

9. simulated expiration through both nose halves
10. simulated expiration through R. nasal chamber
11. simulated expiration through L. nasal chamber

Translation of nasal resistance in hydraulic diameter

The nasal resistance measured in mm water for a flow of 16 L. per minute can be expressed in square mm of a round opening, the so called hydraulic radius. This means that the unequal cross section and length of the nose can be expressed, according to a graph, into a known cross section. Thus on the manometer for a flow of 16 L. or any other chosen airstream, for any measured resistance the matching cross section can be noted. So actually we can "translate" measured pressures in cross sections of narrow and wide noses and decide according to rules which ones need operation.

Nasal and oral inflow rhinomanometry compaired

In double sided nasal inflow rhinometry (with mouth closed: exp. 1 and 2) the figure measured is mainly determined by the narrowest side. In the decongested nose we measure mainly the resistance of the combined internal ostia. This method is the best for studying all volume changes behind the ostia — provided that the turbinates are not too small as compared to the ostia — in which case the ostium resistance predominates. This is not the case if the swelling of the turbinates, resulting from jugular compression, can distinctly be measured. Likewise congestion caused by irritants or by heat and decongestion by cooling or by nose drops, can be studied by this procedure.

In oral inflow rhinometry, on the contrary, the figure measured is the resistance of both sides together and thus the widest side with the lowest resistance

will predominate and be about equal to the figure measured for that side by the one-sided method (with other side closed).
Example:

	Resistance in millimeter of water 16 L.					
	Nasal inflow			Oral inflow		
	double	left	right	double	left	right
Pat. A.	9	8	5	4	8	6
Pat. B.	15	15	3	7	16	4

Consistancy of the readings

First readings often show a higher resistance than on repetition. So to some extent the nose is "blown-open" by the airstream. Presumably this is not only a mechanical effect, but is due to reflexes, among them cooling. The same is seen after nose blowing and forcibly inhaling, even when no secretion is removed. The higher the flow, the more marked this increase of patency caused by the test. After shrinkage with adrenaline readings are more constant. Moreover this procedure gives an additional information on the amount of resistance due to bony deformaties and due to soft tissue swelling.

Advantages of passive rhinomanometry

The advantages of this method consist in:

1. independance of the ever changing depth of breathing
2. tests are very quickly done — no special training is needed
3. can be repeated at any sequence
4. indications for operation, medication etc. can be obtained in a matter of minutes
5. apparature inexpensive and handling is easy
6. in its simplest form these measurements provide a figure to be noted in the case history. However, repeated observations in the course of several days or under different circumstances can be noted as a graph.

This method was developed in 1938 to study nasal swelling caused by infrared radiation. Malcolm (1958) used this method and independently in the same year (Seebohm and Hamilton, 1958) for studies on nasal drugs.

SUMMARY

Passive resistance rhinomanometry consists in blowing or sucking a known airstream through the nose and measuring the inflow or outflow resistance. This can be done in 14 different ways, such as blowing or sucking from one side of the nose towards the other or towards the mouth with one nostril closed or from the mouth towards both nostrils or one nostril. Only four of them give essential information.
This method is quick, reliable, simple and inexpensive, giving figures which are independent of the depth of breathing, viz. the ever changing lung-pump. The method gives satisfactory results in the clinic.

RÉSUMÉ

La rhinomanométrie de résistance se fait par injection ou suction d'un courant d'air par le nez, en mesurant la résistance rencontrée par ce courant.

Il y a 14 manières de le faire, par example d'une narine à l'autre, d'une narine à la bouche ouverte, de la bouche au nez, etc. Seulement 4 entre eux sont d'importance clinique.
La méthode est sûr, l'appareil simple et les chiffres sont obtenus en quelques minutes. La méthode est satisfaisante en clinique.

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Houtlaan 5, Leiden, the Netherlands.
Prinses Marielaan 1 A, Baarn,
the Netherlands.

This method was introduced by one of us in 1938 for the study of infrared skin radiation on nasal patency. We are very grateful to Dr. Herman Semenov from Los Angeles for pointing again in 1965, during a meeting in Portland (Oregon) to this method. Since then we developed independently this method for clinical use. On visiting Dr. Semenov in 1969 during mystay at the San Diego Medical research Institute, we both were astonished how we had come to the same results. However I think he uses a better airpump and his clinical application is more sophisticated. I hope he wil publish this soon.