Nasal ventilation measured in forced respiratory flow

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SUMMARY

First results of measurements of a forced respiratory flow for the evaluation of nasal ventilation performance are provided. The obtained data indicate that the chronometric registration of the flow-volume-curve provides a clearer indication as to the dynamism of nasal respiration than the measurement of statistical nasal resistance or, in other words, the respiration flow with a specific resistance.

THE forced expiratory spirogram permits the evaluation of obstructive and restrictive ventilation disturbances based on the data obtained from a single, as rapid as possible expiration following maximal inspiration. Apart from static values, this also provides information on the dynamic behaviour of the respiratory organ. By measuring the vital capacity, the expiratory 1-second-volume and the maximal flowrate extent, it is possible to obtain detailed data on the intensity and the time attitude of a respiratory stream which in turn depends on resistance in the respiratory tube and the ventilation-inducing strength of the respiratory muscle. An additional graphic illustration of the flow-volume curve can, apart from measuring numerical values of ventilation, provide further information about the chronometric course of the respiratory action (Doll, 1973; Schmidt, 1974; Steinmetz et al., 1974; Zeilhofer et al., 1973) as well as indications for the identification and localisation of respiratory tract obstructions (Hyatt, 1975). Based on test persons with subjectively free or obstructed nasal respiration we examined whether determination of the forced spirogram can also provide useful data for the function-diagnosis of nasal ventilation. In the process we measured, apart from the forced expirium, also the forced inspirium and compared nasal and oral respiration, in other words, the ventilation of the lung. From an airtight panorama face mask, the ex- and inspiration volumes were led to a semi-conductor measuring device (Figure 1). This provides equal circulatory conditions for oral and nasal respiration. After preliminary experiments, mask respiration provided, under certain conditions, practically the same results as the direct blowing

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Figure 1. Examination situation: Semi-conductor transducer is fitted in opening of a panorama face-mask.

into the transducer. Every measuring process was repeated five times. Evaluations of 50 measurements are available so far.

RESULTS

Preliminary results can be summed up as follows:

1. The ventilation values of the nose, when evaluating a forced respiratory action, can be determined in a direct numerical and graphic comparison with those of the lung. It turned out that the data of the expiration phase are subject to less statistical fluctuation than the inspiration data. The overall nasal respiration is, in normal cases, comparable with lung respiration regarding global values (VK, FEV_1). Especially the flow-volume curves are comparable (Figure 2).
2. By registering a flow-volume curve in nasal respiration, the dynamic relation of parameters is registered simultaneously in correspondence to the vital respiratory conditions. In this way, the ventilated air volume is measured chronometrically which, as opposed to the determination of nasal resistance, represents the direct physiological substrate of the respiratory performance. In other words, by this way the actual functional values of the system, namely the driving force (lung) and the conveying performance (flow rate = V/sec.)

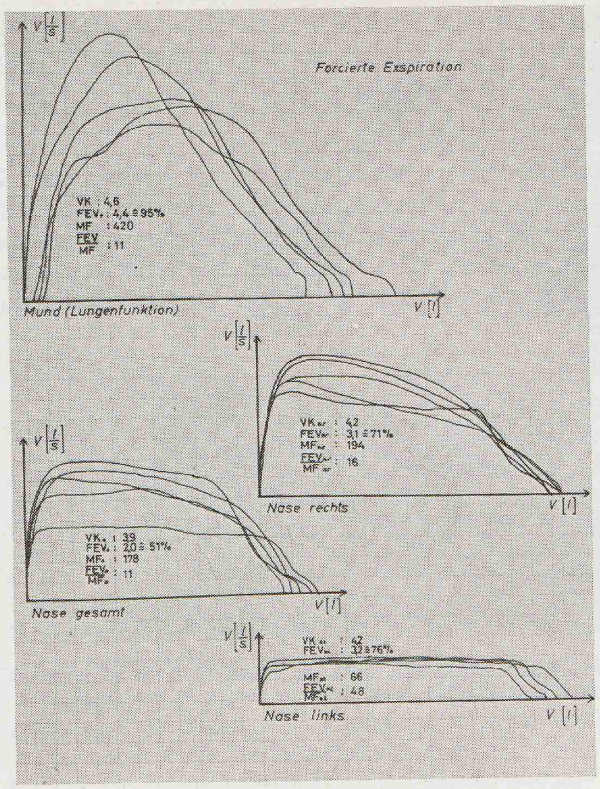

Figure 2. Example of relation between lung and nasal ventilation in forced expiration. Spirogram of left side of nose with breathing obstruction by valve-stenosis in the ostium-internum region; at right restriction of ventilation by nasal septal deviation.

can be registered in cases of flow resistance, and that not only for convention-fixated measuring points (for instance 0,5 1/sec.) but during the entire respiratory action. In other words, an obstruction of nasal respiration is not only characterized by stenosis, but is determined additionally by the individual pumping performance of the breathing muscles.

The evaluation of the flow-volume curves furthermore provides an indication whether there are fixed (ventilation obstructions in the in- and expirium) or varying intranasal ventilation obstructions (ventilation obstructions for in- or expirium). Conversely, it has been found that a patient becomes aware of an obstruction within the respiratory system only when the respiratory-time volume necessary for his well-being and performance is no longer functioning trouble-free. The causal analogy between these values which determine ventilation and the RC-links (capacity - resistence coefficient) of electronic circuits is evident and can help to illustrate the model-idea (Figure 3).

DISCUSSION

Rhinology and nasal surgery can no longer be conceived of without a technically measured registration of parameters of nasal ventilation. As the only usable

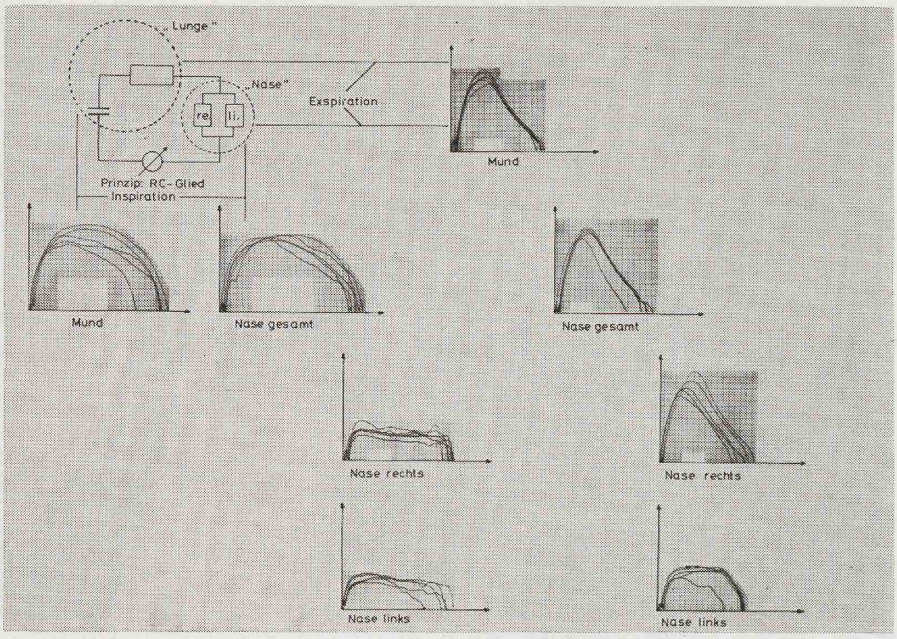

Figure 3. Comparative depiction of the breathing organ in model form as RC-member and of the flow-volume curves in lung and nasal ventilation for forced in- and expiration.

procedure to date, rhinomanometry, especially in the form of simultaneous registration of $\dot{V}$ and $\triangle p$ in the 2-axis system of coordinates as developed by Bachmann and Masing (1973), has latterly provided new insights and experience. Surgical indications and functional evaluations of rhino-surgical measures, as well as the registration of pharmacokinetic and mucous membrane effects can be objectivised by means of rhinomanometry. In the past 14 months, we ourselves carried out close to 900 rhinomanometric examinations, the results of which are now being evaluated.

Despite this progress, it has also been found that there remains a certain discrepancy between the rhinomanometric diagnoses and the patient's own indications as to his subjective feeling about his nasal breathing and that rhinomanometry does not provide — or, if so, only in a costly and roundabout way — the desirable correlation of nasal and lung ventilation. And since, moreover, the diagnosis of the ventilation performance is derived not so much from the relation between pressure and volume (rhinomanometry) but rather from the continuous time-oriented relation of flow and volume (Bridger and Proctor, 1970), we resorted to measuring facilities by means of the novel mini-spirometer in an open system and transferred this method to nasal ventilation as described in this first documentation.

The definite suitability of this technique will still have to be evaluated by checking the physical measuring conditions and expanding the result material.

RÉSUMÉ

Les premiers résultats de mesures d'un courant respiratoire forcé sont exposés dans le but d'apprécier la performance ventilatoire nasale. Les informations obtenues montrent que l'enregistrement chronométrique de la courbe débit-volume fournit des indications sur le dynamisme de la respiration nasale moins ambiguës que la mesure du débit respiratoire avec une résistance déterminée.

REFERENCES

1. Bachmann, W., 1973: Probleme der Rhinomanometrie — Ihre Lösung durch XY-Schreibung. Z. Laryng. Rhinol. 52, 872-878.
2. Bridger, G. P. and Proctor, D. F., 1970: Maximum nasal inspiratory flow and nasal resistance. Ann. Oto-Laryng., 78, 481-488.
3. Doll, E., 1973: Methoden der Lungenfunktionsanalyse in der Klinik. Med. Klin., 68, 11-18.
4. Hyatt, R. E., 1975: Evaluation of major airway lesions using the flow-volume loop. Ann. Oto-Laryng., 84, 635-642.
5. Masing, H. and Frimberger, R., 1974: Ein neues Rhinomanometer für die Praxis. Z. Laryng. Rhinol., 53, 717-722.
6. Schmidt, O. P., 1974: Wichtiger pulmonaler Funktionstest: Spirographie. Deutsches Ärzteblatt, 3082-3085.
7. Steinmetz, H., Debelic, M. and Günthner, W., 1974: Leitfaden für Lungenfunktionsuntersuchungen in der Praxis, Lübeck.
8. Zeilhofer, R. and Eickeler, R., 1973: Möglichkeiten und Grenzen der Lungenfunktionsanalyse in der Praxis. Med. Klin. 68, 19-24.

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The measurements were carried out with the instrument M 403 made by Sandoz AG, Nürnberg, W.-Germany.