Nasal pressure flow studies in adults and children

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SUMMARY

Nasal resistance in adults and children has been investigated. It was found that nasal resistance in children is higher than in adults. The decrease in resistance after shrinkage of the mucous membranes was found twice as large in adults as compared with children. Nasal resistance measurements in correlation to pulse and flow rate were studied in well trained sport-students under strong physical exercises.

MEASUREMENTS of nasal pressure difference have been performed in adults since about more than 70 years. Posterior rhinomanometry was introduced by Spiesz 1899 and the anterior technique by Courtade 1902. The history of rhinometry has been discussed in this journal some years ago by Williams (1968). Many methods of rhinomanometry have been developed in order to calculate nasal resistance or conductivity (van Dishoeck, 1942; Aschan, 1958; Drettner, 1961; Cottle et al., 1963; Masing, 1967; Ingelsted et al., 1969; Büsser and Schibli, 1973 and Barré and Feenstra, 1974). The importance of aerodynamics for functional nasal surgery was particularly stressed by Cottle.

Pressure flow studies in children have not been published as far as we know. The purpose of this paper is to make a few remarks on rhino-rheo-manometry and to discuss the problem of the "normal" nasal resistance in adults and children. Furthermore flow pressure studies will be presented in well trained sport-students under physical exercises. Posterior rhinomanometry would be the optimal method in recording total and partial nasal resistance. However in routine work and particularly in children we found the anterior method easier to work with as around 30% of our patients was not able to produce reliable records of pressure difference.

The mask we used (Figure 1) is suitable for both methods. The pressure applicator is movable in order to guide it into one nostril or into the oral cavity. On investigation of children the same technique was performed (Figure 2). The measurements require more time and sometimes the child will not cooperate sufficiently. The youngest children in which we were able to determine nasal resistance were 5 years of age. In case the child was not tolerating the mask a nozzle as described by Cottle was used.

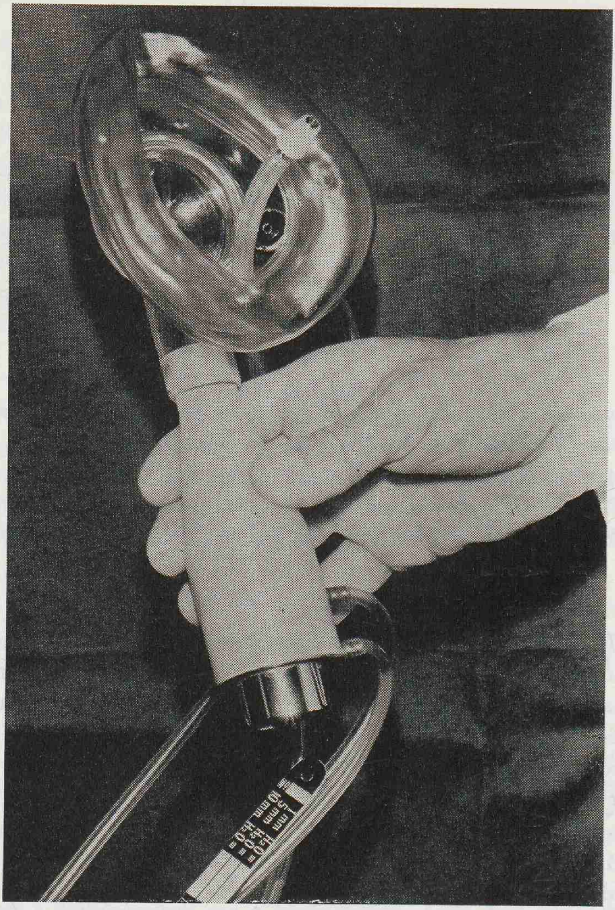


Figure 1. Mask for rhinomanometry in adults and children. The polyethylene tube with the nozzle is moveable in purpose for posterior and anterior rhinomanometry. The handle consists the pneumotachograf by Fleisch.

30 Children aged 5—12 and 40 adults of both sexes with normal breathing noses were examined. The results revealed no obstructions. The nasal resistance was recorded with the pressure-flow-meter Type Elema-Siemens developed by Masing, 1966. This apparatus is equipped with an analogous computer which records the nasal resistance simultaneously according to the equation $R_N = \frac{V^2}{P}$. Nasal resistance was measured in each person before and after shrinking the nose. The standard deviation of each value was calculated by means of a computer.

RESULTS

Nasal resistance in adults was found 1.35 on inspiration and 0.94 on expiration.

Figure 2. Nasal resistance test in a 8 years old boy.

	RESISTANCE (R) = $\frac{\text{mm } H_2O}{(\ell/\text{min.})^2}$			
	BEFORE SHRINKAGE		AFTER SHRINKAGE	R (Loss) %
ADULTS (n= 3o)	INSP.	1.35 St.dev. 1.6o	o.67 St.dev. o.61	5o %
	EXSP.	o.94 St.dev. 1.o1	o.4o St.dev. o.36	58 %
CHILDREN (n=4o)	INSP.	2.63 St.dev. 1.83	1.87 St.dev. 1.17	29 %
	EXSP.	1.o8 St.dev. o.83	o.79 St.dev. o.54	28 %

Table 3. Comparison of nasal resistance, R_N between adults and children (5—12 years) before and after shrinking the nose. A remarkable difference between the groups is obvious.

After shrinkage the values dropper to insp. 0.67 and exp. 0.4 (Table 1). The resistance loss was calculated 50% for inspiration and 58% for expiration which means roughly half of the previous values.

In children the nasal resistance was remarkable higher than in adults, i.e. insp. 2.6 and exsp. 1.0. After shrinkage of the mucous membranes the values dropped around 28% both for in- and expiration which means one third of the previous values.

In both groups the nasal resistance was remarkable higher in inspiration as in expiration. This result differs from those of Büsser and Schibli (1973) who found expiration more dominant than inspiration when using a body-pletysmograph.

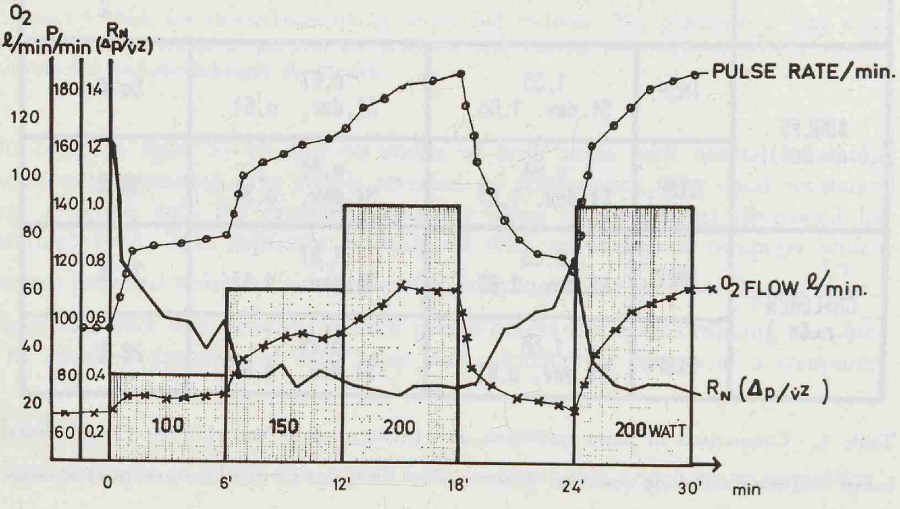
To explain our results it must be assumed that in adults the ability of the decongestive effect of the turbinates has in some way a greater influence on nasal resistance. This might be due to the structure of the nose in childhood where the valve area is extremely small as we noted. More investigations should be performed in order to confirm our findings.

Nasal resistance under physical exercise

The influence of physical exercise on the nasal resistance is well known and described in the literature several times (van Dishoeck, 1942; Proetz, 1953; Aschan, 1958; Richerson and Seebohm, 1968; Baumann and Masing, 1970). We were interested to investigate the relationship between nasal resistance, pulse rate and flow rate in well trained sport-students under strong physical exercises.

The investigations were performed by means of a bycycle-ergometer. The nasal resistance was measured with the described method. The pulse rate was recorded

Figure 3. Relationship of nasal resistance, flow and pulse rate under physical exercises (ergometertest) in 31 well trained sport-students. Notice the change of the values in interruption of the test for 6 min.



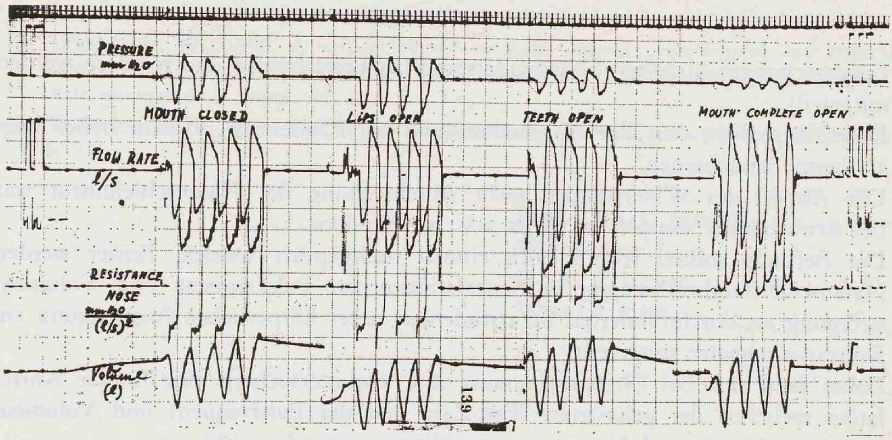


Figure 4. Record of pressure difference, flow rate and nasal resistance in additional mouthbreathing. Anterior Rhinomanometry. First value inspiration, second value exspiration. Mouth closed: R_N 0.52/0.34 lips open R_N 0.31/0.32; teeth open R_N 0.15/0.18 mouth complete open R_N 0.05/0.10 E.R. ♂ 21 years.

with an Elektrocardiograf-recorder. 31 well trained male sport-students aged 20-25 from the faculty of Sport-physiology, University of Erlangen having no breathing difficulties of the nose were examined and tested in this way. The test consisted 50 minutes of increasing the physical work every six minutes. The results are given in Figure 3.

An almost linear correlation between the increase of physical work up to 200 Watt and the pulse and flow rate was found. The test was interrupted after 18 minutes and continued after more 6 minutes. During the interruption all values returned almost to the point of the start of the test.

According to Richerson and Seebohm (1968) the effect is due to the sympathetic nerve discharge. In comparing our present results with our previous investigations (Baumann and Masing, 1970) the vascular system and alar muscles of the nose seems to react faster in well trained persons. The nose being an organ with extreme possibilities in changing resistance can probably be trained like any other organ of the human being.

The bycycle- or step-test might be used as a function test for nasal conductivity under special circumstances. Pure nose breathing might not be suitable and sufficient for the organism in order to establish oxygen consumption during strong physical exercise. Additional mouth breathing is required in such cases.

Nose and mouth breathing was investigated by Uddströmer in 1943. Slightly opening of the mouth still guarantees a proper nasal ventilation according to our measurements (Figure 4). This might be important for the still acting protective task of the nose. We are therefore recommending our sport-students to use in case of hard training a slight additional mouth breathing with enough resistance not to loose the nasal airflow.

ZUSAMMENFASSUNG

Untersuchungen über den Nasenwiderstand bei Erwachsenen und Kindern werden mitgeteilt.

Dabei zeigt sich, dass der Nasenwiderstand bei Kindern signifikant höher liegt als beim Erwachsenen.

Der Abfahl des Widerstandes nacht Abschwellung der Nasenschleimhaut war bei Erwachsenen doppelt so gross wie bei Kindern.

Die Befunde sollten jedoch noch einmal nachgeprüft werden. Ferner werden Nasenwiderstandsmessungen in Korrelationen zur Pulsfrequenz und Volumenströmung an durchtrainierten Sportstudenten unter körperlicher Anstrengung am Fahrrad-ergometer mitgeteilt.

Dabei fand sich bei Übereinstimmung mit Voruntersuchern eine lineare Korrelation zwischen der geleisteten Watt-Zahl und der Pulsfrequenz und Volumenströmung. Mund- und Nasenatmung schliessen einander nicht aus.

Bei leicht geöffnetem Munde ist die Nasenatmung stest noch beteiligt, wie in einer weiteren Messreihe nachgewiesen werden konnte.

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