Rhinology, 19, 149-154, 1981

Nasal airway resistance in children

Akira Saito and Shin-ichi Nishihata, Sagamihara, Japan

SUMMARY

Using anterior rhinomanometry, nasal resistance was measured in 397 Japanese children and students, aged 5 to 17 years. Thereafter the relationship between nasal resistance and age, sex, height and weight was studied. The results are as follows:

1. The nasal resistance of children and students significantly decreases with aging and it reaches almost the same as that of an adult at about 16 years of age. This decrease was confirmed statiscally. However, the difference of sex was not significant in any age group.

2. There is no significant correlation among total nasal resistance, height and weight. So, it would be concluded that the growth of the frame-work of the nasal cavity does not follow the same course as that of the height or the weight.

3. Between ages 13 and 14, it seems that the nasal resistance increases slightly. The change in nasal resistance during this period may be attributed to unbalance of the growth between the nasal turbinates and the frame-work of the nasal cavity.

INTRODUCTION

The study of nasal resistance to air flow is important for understanding the nasal function (Salah et al., 1971). Although a number of studies have dealt with the nasal cycle as one of the normal physiological conditions (Dallimore and Eccles, 1977; Hasegawa et al., 1979; Principato et al., 1970), the relationship between nasal resistance and aging has received scant attention.

In order to investigate how the nasal resistance changes with aging, nasal resistance was measured by anterior rhinomanometry. Subject for this study included about 400 children and students from 5 to 17 years of age. This study was also made to demonstrate how resistance is related to height, weight and sex. From the obtained data, speculation as to how the nasal cavity changes according to the growth were made.

METHOD AND MATERIALS

The subjects for this study were chosen at random from classes of every grade in several schools in Sagamihara city where our university is located (185 males and 212 females, 5-17 years of age). They were without any apparent nasal pathology.

Paper presented at the 8th Congress of the European Rhinologic Society and 2nd ISIAN, Bologna (Italy), October, 1980.

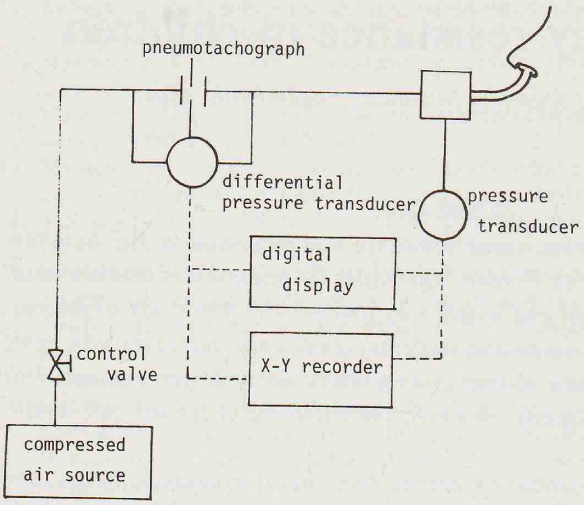

Figure 1. Block diagram of anterior rhinomanometry (NART of Morgan Ltd.).

Actually, more nasal resistance was measured than 397 children and students, but those pressure-flow curves were found unstable, and consequently excluded from the data.

The device which was used in this study consists of the nasal airway resistance tester (NART of P. K. Morgan Ltd. of England), X-Y recorder for recording the pressure-flow curve and air storage cylinder. These components are installed on a carrier specially made for easy conveyance as a unit. The block diagram of this system is shown in Figure 1.

In order to achieve the measurement, the subject was instructed to sit down. A tube was gently inserted into one of the subject's nostrils with a cuff to prevent unpreforable air-leakage. The subject was then instructed to open his mouth slightly and to stop respiration for approximately 5 seconds after gentle oral breathing. A gradually increasing air flow is inducted into the subject's one nostril and then passes through the nasal cavity to the open mouth while the subject holds his breath. The device monitors the flow rate and detects the pressure created by the flow. Nasal resistance is derived from a slope of the line produced by plotting the flow rate against the pressure. The resistance at a flow rate of 3 l/min is automatically computed and displayed on the digital meter of the device. The measurement was repeated three times for each nasal cavity and the mean of resistance was calculated.

This method does not permit simultaneous measurement of bilateral nasal resistance. Therefore, the total nasal resistance composed of bilateral resistance was worked out on the basis of the formula proposed by La Court et al. (1971). This

formula is as follows:

$$Rn = \frac{R \times L}{R + L}$$

(Rn = total nasal resistance, R = right nasal resistance, L = left nasal resistance).

RESULTS

Figure 2-A shows the variation of the total nasal resistance calculated by the previous formula for each age group. This graph illustrates that total nasal resistance

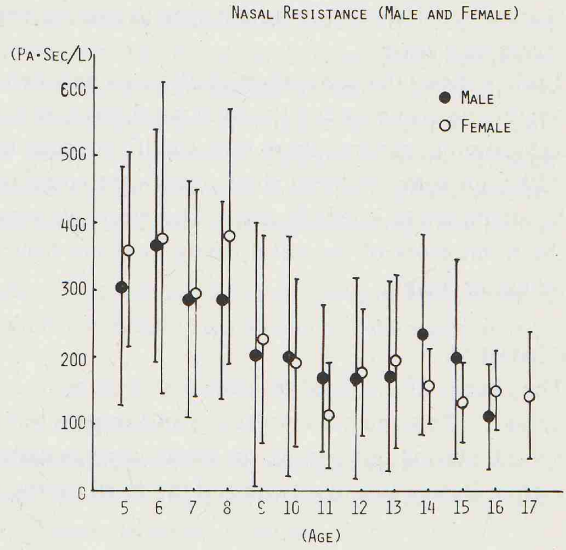

Figure 2-A.
Graph showing the variation of total nasal resistance for each age group. The mean ± 1 SD are depicted.

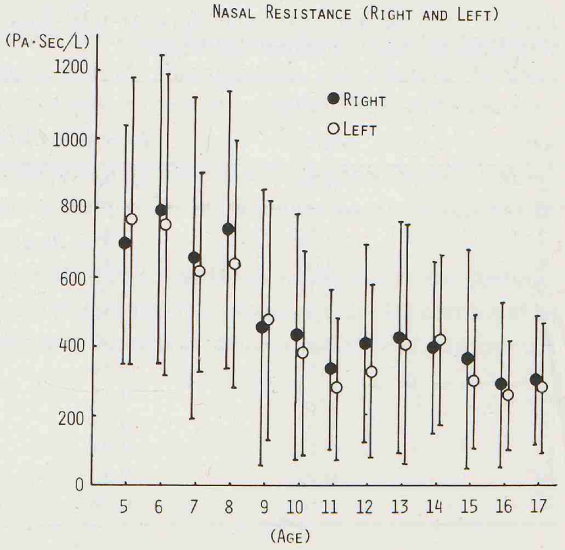

Figure 2-B.
Graph showing the time course of the unilateral nasal resistance against each age group. The mean ± 1 SD are depicted.

decreases with age. This decrease was confirmed statistically. (F ratio = 9.23, based on variance analysis). However, the difference of sex was not significant in any group.

Although the decrease of total nasal resistance with aging has been confirmed, in order to observe details of the resistance change, the data obtained from the actual measured value were utilized. Figure 2-B shows the time course of the unilateral nasal resistance against each age group. The graph indicates a high unilateral nasal resistance approximately 700 Pa/l/sec from 5 to around 8 years old but it gradually declines to approximately 300 Pa/l/sec thereafter until about 16 years of age. However, between ages 13 and 14, it seems that the nasal resistance increases a little.

Table 1 shows the correlation coefficients between the total nasal resistance and height and also between the total nasal resistance and the weight by sex in each age group. In general, there is no significant correlation among the three factors. Although some of them show significant correlation coefficients, they should be attributed to scientific error. Therefore, we may conclude that the growth of the frame-work of the nasal cavity does not follow the same course as that of heihgt or weight.

COMMENT

The change of the nasal resistance with aging is considered to be divided into 3 periods. The stage between ages 5 and about 8 was arbitrarily defined as the first period. During this period, the nasal cavity is narrow and the nasal resistance is higher. Beside this narrowness of the nasal cavity, we should consider the influ-

Table 1. Correlation coefficients between total nasal resistance and weight and also between total nasal resistance and height.

Age	Height		Weight	
	Male	Female	Male	Female
5	−0.29	−0.29	−0.25	−0.31
6	−0.19	0.53	−0.35	0.43
7	−0.36	−0.44	−0.31	−0.23
8	0.03	0.33	−0.31	0.59
9	−0.21	0.20	−0.37	0.33
10	−0.03	0.20	0.15	0.33
11	0.09	0.02	0.00	0.35
12	−0.43	0.19	−0.40	0.02
13	−0.13	0.11	−0.21	0.58
14	0.33	−0.05	0.40	−0.07
15	−0.18	0.04	−0.30	−0.14
16	0.03	0.50	−0.07	0.02
17	-	−0.28	-	0.18

ence of adenoid and hypertrophic tonsils. About the ages of 9 to 12, adenoid and tonsils gradually diminish in size and the capacity of the nasal cavity as well as the epipharynx increases with the cephalic growth, which results in an observed decrease in the nasal resistance. This period was defined as the second period. After this period until about age 16, the nasal resistance reaches almost that of an adult. This period was defined as the third period. During this period, we can see the temporal increment of the nasal resistance between 13 and 14. Although the cause for the change of the nasal resistance during this period is not clearly known, it may be attributed to the following reasons: Since the higher nasal resistance may be caused by narrow airways in the nasal cavity, the meatus that serves as an air passage seems to be narrowed by relatively larger nasal turbinates that prevent a passage in this period. This also means that around this time the development of nasal cavity as an airway goes out of balance. In other words, although the growth of the nasal cavity is supposed to be parallel to the cephalic growth, the growth of the turbinates is independent from the cephalic growth. After this period, the capacity of the nasal cavity may restore balance like in that of an adult.

The variations of the nasal resistance with aging is an assumptive interpretation at the present moment. Further extensive research work using the roentgenometric method should be conducted.

RÉSUMÉ

Utilisant la méthode de rhinométrie anterieure, la resistance nasale a été mesurée chez 397 enfants japonais, agés de 5 à 17 ans. De plus a été étudiée la relation entre la resistance nasale l'âge, le sexe, le poids, la taille.

Les resultats suivants ont été obtenus:

1. La resistance nasale chez l'enfant decroît de façon significative avec l'âge pour atteindre une valeur proche de la normal chez l'adulte, vers l'âge de 16 ans. Cette decroissance a été confirmée statistiquement, cependant la difference en fonction du sexe n'est pas significative.
2. De plus il n'y a pas de correlation significative avec le poids et la taille. Aussi nous pouvons conclure que la croissance de l'architecture nasal ne suit pas la même evolution que le poids ou la taille.
3. Entre l'âge de 13 et 14 ans il semble que la resistance nasale augmente quelque peu. Ceci pouvant être attribue à la difference de croissance entre les cornets et la pyramide nasale. Après cette période, la capacité des cavités nasales retrouve un equilibre identique à l'adulte.

REFERENCES

1. Dallimore, N. S. and Eccles, R., 1977: Changes in human nasal resistance associated with exercise, hyperventilation and rebreathing. Acta otol. 84, 416-421.
2. Hasegawa, H. et al., 1979: Dynamic changes of nasal resistance. Ann. otol., 88, 66-71.
3. La Court, G. and Polger, G., 1971: Interaction between nasal and pulmonary resistance in newborn infants. J. Appl. Physiol. 30, 870-873.
4. Principato, J. J. et al., 1970: Cyclical changes in nasal resistance. Arch. otol. 91, 71-77.
5. Salah. D. S. et al., 1971: Nasal resistance; Description of a method and effect of temperature and humidity changes. Ann. otol. 80, 736-743.

Akira Saito, M.D.
Dept. of O.R.L.
School of Medicine
Kitasato University
1-15-1 Kitasato
Sagamihara, Kanagawa
228 Japan