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Is endonasal insufflation of Xenon^{133} a fiable functional assessment of nasal cavities?

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SUMMARY

The ventilation of nasal cavities has been examined according to the method of Bisschop et al. (1983). The test was performed on 32 healthy volunteers, free of symptoms with normal standard X-rays of their sinuses.

Half-times of the wash-out curves were calculated and adopted as a measure of ventilation. For sitting persons these values were lower than other authors reported, the values in sitting or lying persons were comparable.

We dit not find a significant difference between values of sitting or lying persons. There was no significant difference neither in the half-times obtained in persons with normal clinical background and persons with septal deviations.

The experiment was not optimally reproducable.

INTRODUCTION

Permeability of the ostia of nasal sinuses is the principal pathophysiological causal factor in sinusitis (Drettner and Aust, 1977). Obstruction of the ostium provokes a decrease of the amount of oxygen in the sinus. The ensuing negative effect on mucociliary transport promotes stasis of secretions (Drettner and Aust, 1977). Functional assessment of nasal cavities, in other words, ventilation of sinuses, is thus an important aspect of clinical examination. Unfortunately, most methods of assessment of nasal cavities provide only a static image of the situation.

X-rays, echographia and specially C.T. scanning enable us to obtain very precise anatomical images and minute details about presence or absence of secretions and pathological alterations of mucosal or bone structures. However, these examinations cannot procure information about the permeability of the ostia and sinusal ventilation. Simultaneous measuring of differences in pressure in nasal and antral cavity during nasal respiration is a fiable functional assessment of the maxillary cavity (Drettner, 1965). This measure is however relatively traumatic as it requires sinusal puncture. Theoretically it is possible to examine in the same way frontal and sphenoidal cavities but not the ethmoidal sinuses.

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Several authors injected by puncture a contrastmedium or Xenon^{133} into a nasal cavity and measured in this way the permeability of the ostium in function of the elimination of the injected substance. (Aust and Drettner, 1976; Zippel and Streckenbach, 1979). The results of these tests suggested to other authors the idea to use Xenon^{133} in a non-traumatic way by endonasal insufflation into sinuses. (Bisschop et al., 1983; Christie and Robinson, 1979). In this study the latter method was adopted.

MATERIAL AND METHODS

Only persons free of symptoms were primarily admitted to the study. 32 insufflations were performed on 26 persons. Ventilation was measured in lying position in 23 persons, in sitting position in 9 persons. With 6 persons insufflation was performed twice, in sitting and in lying position in order to obtain an idea of the test's reproducability. Standard X-rays of the sinuses were performed before insufflation; only people with normal X-rays were admitted to the study. On basis of clinical examination and anamnesis the persons were divided in two groups: one group with normal results in examination and anamnesis (Group 1, 16 persons) and another group with septal deviations or records of allergic or vasomotorial perturbances (Group II, 10 persons).

The insufflation method of Bisschop et al. (1983) was applied.

The person inhales profoundly and inserts an "olive" in each nostril. These olives are each connected by a threeway tap to a 50 cc syringe; both taps are connected to a central threeway tap communicating with the insufflation syringe. This construction permits the creation of negative pressure in the cavum nasi with the two syringes and insufflation of Xenon. After insufflation the air withdrawn with the two syringes is quickly reinjected into the nose. Meanwhile the person swallows to obtain maximal penetration of Xenon into the sinuses. Before insufflation the test was performed twice with air to accustom the person to the test. After insufflation two Vasalva's manoeuvres were performed and the person was asked to respire several times through the nose in order to eliminate the surplus of Xenon^{133}. The nose was closed of and the person was placed with fixed head before a gamma-ray camera. During the test a twoway tap admitted fresh air to the mouth, the exhaled mixture air/Xenon^{133} was deflected by a tube out of the camera field.

Xe^{133} emits gamma-rays with an energy of 81 KeV and a half-life of 5.3 days. The insufflated dose was about 5 mCi, corresponding to an irradiation level of the sinusal mucosa of 0.35 rad (Bisschop et al., 1983; Christie and Robinson, 1979). Measures were performed during 20 minutes. During this period the activity of the insufflated sinus was measured 60 times during 20 seconds and a time-activity curve was established. The curves were supposed to be mono-exponential and half-times were calculated.

RESULTS

Table 1. Half-times of wash-out curves in 32 persons (sitting or lying).

number of sinuses	sinus	time in min.	1 standard deviation
45	maxillary	8.31	5.06
50	ethmoidal (+ sphenoidal)	6.06	4.13
30	frontal	6.80	3.76

Table 1 shows the half-time of wash-out curves in 32 persons. These values are statistically similar to those obtained by Bisschop et al. (1983) and Christie et al. (1979). Most authors performed the test in sitting position. Aust et al. (1975) found a significant difference in the ventilation of maxillary sinuses in sitting or lying position. We performed the test in 9 persons in sitting position to confirm these results (Table 2).

Table 2. Half-time of wash-out curves in 9 sitting persons.

number of sinuses	sinus	time in min.	1 standard deviation
17	maxillary	6.82	5.53
17	ethmoidal (+ sphenoidal)	3.85	2.20
9	frontal	5.22	3.15

These half-times are all significantly lower ($p \leq 0.05$) than the values obtained by Christie et al. (1979) and, with exception of maxillary sinuses, also lower ($p \leq 0.05$) than those obtained by Bisschop et al. (1983). We have compared half-time values in sitting or lying position (Table 3).

Table 3. Comparison of half-time values of wash-out curves in 23 persons in lying and 9 persons in sitting position.

sinus	time in min. in lying position followed by number of sinuses	time in min. in sitting position followed by number of sinuses
maxillary	9.17 ± 4.69 (28)	6.82 ± 5.53 (17)
ethmoidal (+ sphenoidal)	7.33 ± 4.33 (33)	3.58 ± 2.20 (17)
frontal	7.47 ± 3.86 (21)	5.22 ± 3.15 (7)

Only for the ethmoidal sinuses we obtained lower values in sitting position 9.17 ($p \leq 0.05$). Finally we compared ventilation curves in Group 1 and Group 2 (Table 4).

Table 4. Differences between half-time values of wash-out curves in normal persons (Group 1) and persons of Group 2.

	number of sinuses in lying position		number of sinuses in sitting position		difference	
sinus	group 1	group 2	group 1	group 2	sitting	lying
maxillary	19	7	13	4	NS ($p \geq 0.05$)	NS ($p \geq 0.0$)
ethmoidal (+ sphenoidal)	23	10	13	4	NS ($p \geq 0.05$)	NS ($p \geq 0.0$)
frontal	17	4	6	3	NS ($p \geq 0.05$)	S ($p \leq 0.0$)

NS = not significant, S = significant .

Although all symptom free persons showed normal X-rays, several half-time values of the ventilation curve exceeded one hour. As the error in estimating the exact half-time value became too great, these values were not included in the calculation of the average half-time value of the sinus. Hereby a comparison of the frequency of this event in sitting and lying persons (Table 5).

Table 5. Percentage of sinuses with a half-time value exceeding one hour in sitting and lying persons.

	sitting		lying	
sinus	number of sinuses	%	number of sinuses	%
maxillary	0	0	16	36
ethmoidal (+ sphenoidal)	0	0	7	17
frontal	5	35	11	34

Table 6. Percentage of sinuses with a half-time exceeding one hour in lying position: comparison between Group 1 and 2.

	group 1		group 2	
sinus	number of sinuses	%	number of sinuses	%
maxillary	7	27	9	56
ethmoidal (+ sphenoidal)	3	11	4	29
frontal	6	26	5	55

The number of half-time values exceeding one hour is in percentage greater in Group 2 and in lying persons with exception of frontal sinuses (Table 6). We tested the reproducability of the experiment in 6 persons of Group 1

by repeating the test twice. We verified if the same sinuses showed each time a good activity. In two of these persons we obtained no similar results, certainly not for all sinuses, after repeating the test. In four persons the results were similar. In all these persons the half-time of the wash-out curves were generally lower in sitting position compared to the lying position with a few exceptions.

DISCUSSION

The examination of the sinuses with Xe^{133} is well tolerated and exposes the patient to a very low amount of radiation.

The average half-time values obtained in our experiment are similar to those obtained by other authors, with exception of the values obtained in sitting persons where lower values were found. We observed that in normal persons, symptom free and with normal sinusal X-rays the half-time values of certain sinuses are either normal or exceeding one hour. We did never find intermediate values.

In a normal population there is generally no significant difference between the half-time values of sitting or lying persons or between persons pertaining to Group 1 or 2. This phenomenon is probably due to the rather great spreading of results. Also must be mentioned that the experiment is not effected in normal physiological circumstances (no nasal respiration). The test is not optimally reproducable. Insufflation of all sinuses is not always acquired.

After this study we performed the test on 6 persons suffering from acute coryza or radiographically confirmed sinusitis. We obtained either no sinusal activity or wash-out curves all exceeding one hour. As conclusion we confirm that if half-time values correspond to the values of a normal population, sinusal ventilation is good. Half-time values exceeding one hour are not necessarily associated with sinusal pathology, especially if the test is performed in lying position. Sitting position of the patient is certainly to be preferred.

RÉSUMÉ

La ventilation des cavités nasales a été étudiée suivant la méthode de Bisschop (1983). Les 32 sujets testés n'ont pas de plaintes et montrent des radiographies des sinus tout à fait normales. Le calcul du demi-temps des courbes d'élimination a servi comme mesure de la fonction des sinus. Les valeurs obtenues chez tous les sujets debouts (debouts ou couchés) étaient du même ordre de grandeur. Nous n'avons trouvé aucune différence significative entre les sujets debouts et les sujets couchés. De même nous n'avons trouvé aucune différence significative entre les valeurs obtenues chez des sujets ayant un examen clinique banal et celles obtenues chez des sujets souffrant d'une déviation de la cloison. L'expérimentation n'était pas parfaitement réproductible.

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