

Influence of sinusitis on respiratory function

K. Togawa, A. Konno, T. Fujiwara, S. Miyazaki and S. Hanazawa, Akita, Japan

Many investigators (Lüscher, 1930; Sercer, 1952; Ogura et al., 1966; etc.) have revealed that the disturbance in nasal breathing affects the pulmonary function in various degrees. The degree of deteriorating of the pulmonary function depends on the pathogenesis of the nasal disturbance. Sinusitis was a greater influence than simple mechanical obstructions.

In this paper the relationship between chronic sinusitis and the lower respiratory tract function is re-evaluated and discussed.

METHODS

1. A set of pulmonary function tests was carried out concerning patients with moderate or severe chronic sinusitis and compared with subjects with normal nose. Patients who had simple mechanical nasal obstruction in the same degree were also examined. Pulmonary function tests include maximal flow-volume curve recordings, the measurement of lung volume and respiratory resistance. Normal values of these tests were obtained from 43 male and 46 female subjects, ranging in age from their 20's to the 60's who had no detectable abnormalities both in the upper and the lower respiratory tracts. Based upon these data the regression equations between the pulmonary function and the age were calculated. The same tests were performed on 36 male and female subjects with chronic sinusitis and on 18 male subjects with simple mechanical obstruction. The data obtained analyzed statistically comparing the regression lines with the normal group:
 - a. Distributions along both sides of the normal mean-lines in each parameter of normal and pathological noses were compared using the χ^2 -test.
 - b. Distribution beyond the range of $2 \times$ standard deviation of normal and pathological noses were also compared.
2. Respiratory function during sleep was examined with a polysomnography; intraesophageal pressure, airflow, FO_2 and FCO_2 , $PtcO_2$ and $PtcCO_2$, ScO_2 , EEG and ENG were recorded.

3. Patients who had suffered from sinusitis for many years underwent sinusectomies via combined transantral and endonasal approaches. On these patients respiratory function tests were performed repeatedly during their waking and sleeping hours.

RESULTS

1. Influence of sinusitis on pulmonary function.

- a. In the male sinusitis group, vital capacity (VC) and maximal peak flow (\dot{V}_{max}) distributed below the line were significantly greater than in the normal nose. Functional residual capacity (FRC), residual volume (RV), percent residual volume (%RV), closing volume (CV) and closing capacity (CC) distributed above the line were significantly greater than in the normal nose. In the female sinusitis group, all parameters distributed below the mean lines were not significant except for \dot{V}_{25} and $\dot{V}_{50}/\dot{V}_{25}$ (Table 1a, b). In the mechanical nasal obstruction group, only the RV, %RV and \dot{V}_{max} showed a significant deviation in distribution from those in the normal nose group.

Table 1. Comparison of numbers distributed on one side of the mean.

	mechanical obstruction		chronic sinusitis			
	N	P	male		female	
			N	P	N	P
a. VC	18	NS	36	•	15	NS
FEV ₁	18	NS	36	NS	15	NS
FEV ₁ %	18	NS	36	NS	15	NS
FRC	16	NS	28	•••	13	NS
FRC%	16	NS	28	••	13	NS
RV	16	•••	28	•	13	NS
RV%	16	•••	28	•	13	NS
RR	18	NS	35	NS	15	NS
b. \dot{V}_{max}	17	•	34	••	15	NS
\dot{V}_{50}	17	NS	34	NS	15	NS
$\dot{V}_{50/H}$	17	NS	34	NS	15	NS
\dot{V}_{25}	17	NS	34	NS	15	•••
$\dot{V}_{25/H}$	17	NS	34	NS	15	•••
$\dot{V}_{50}/\dot{V}_{25}$	17	NS	34	NS	15	•••
CV	10	NS	21	•••	12	NS
CV%	10	NS	21	NS	12	NS
CC	9	NS	17	••	12	NS

Note: P < 0.05 •• P < 0.01 ••• P < 0.005

- b. Distributions beyond the range of $2 \times SD$ were significantly greater in male sinusitis group for FRC, %FRC, RV, %RV, %CV, %FEV₁ and \dot{V}_{max} . In the female sinusitis group, distributions beyond the range of $2 \times SD$ were significant

only in $\dot{V}_{50}/\dot{V}_{25}$ and RR. In the mechanical obstruction group, the only significant distribution was the \dot{V}_{\max} .

2. Influence of sinusitis on respiratory function during sleep. When the subjects with normal noses fell asleep, the intraesophageal pressure-change increased slightly for getting the necessary amount of air through the narrowed pharyngeal space caused by muscular relaxation, but not so much as to cause snoring. P_{tcO_2} and S_{cO_2} were relatively constant. P_{tcCO_2} elevated as sleep deepened. On the EEG, the depth and variation-pattern of sleep were normal. In the moderately obstructed case, respiratory intraesophageal pressure-change increased considerably for maintaining the necessary air ventilation. In passing air through the narrowed air-passage at a high speed, a constant monophasic or biphasic snore occurred. Variations in P_{tcO_2} and P_{tcCO_2} were small. EEG-pattern was also nearly normal.

In the heavily obstructed cases, periodic respiratory patterns appeared. That is, with the ordinary amount of respiratory intraesophageal pressure-change as that in the normal nose, no flow was created, so that P_{aO_2} decreased and P_{aCO_2} increased with concomitant arousal reaction on the EEG. Consequently, great increase of intraesophageal pressure-change occurred reflexively. This increased pressure pushes air through the narrow, slit-like oral passage in and out at a high speed, which was accompanied with episodes of snoring. When the blood gas condition normalized, the subject fell asleep deeper. Breathing effort also tranquilized. At this point, intraesophageal pressure-change lessened, which was not enough for driving the respiratory air through the narrowed air-passage. Again hypoventilation was created, causing shallower sleep and increasing respiratory effort. Thus, the breathing-pattern showed periodicity. The polysomnographic recording of a 45 year-old male with bilateral nasal polyps shows this periodicity (Figure 1).

3. Effect of surgical relief of sinusitis on respiratory function. After surgery, the intraesophageal pressure-change during sleep decreased markedly, accompanied with restoration of regular breathing pattern and constancy of the blood gas levels, except for a subject who was moderately obese.

Pulmonary function tests were repeated at a specified period of time after surgery. The results showed decreases in FRC, %FRC, RV, %RV, CV and RR in the majority of the cases. VC and \dot{V}_{\max} increased in most cases, whereas $FEV_1\%$, \dot{V}_{25} and \dot{V}_{50} decreased (Table 2a, b).

Patients who had received the radical sinus surgery pointed out the disappearance of dryness in the mouth and pharynx, improvement in their snoring, expectoration and asthenopia, refreshing of their head, sounder sleep, and activation in their daily lives.

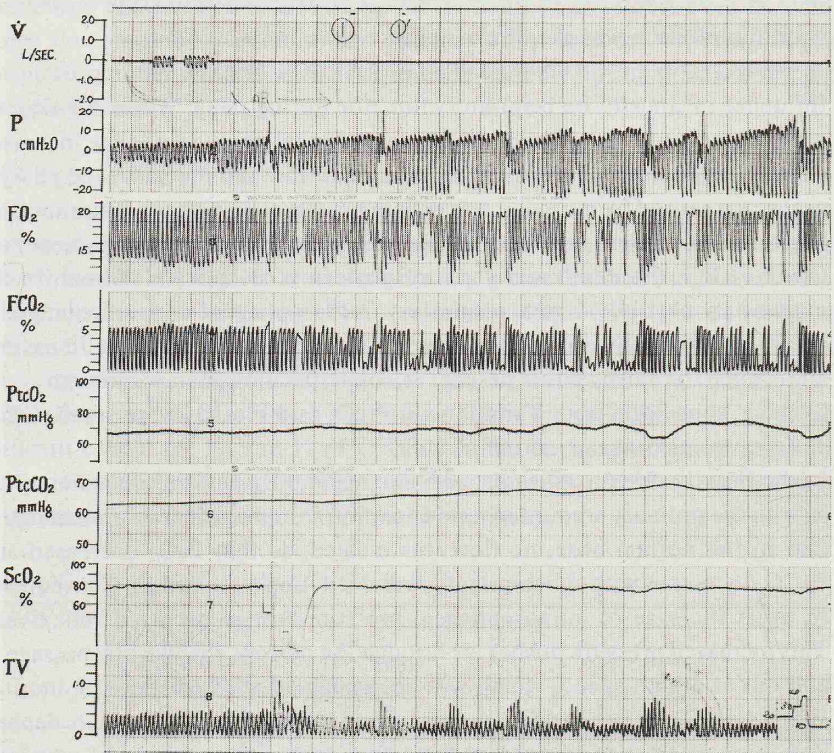


Figure 1. Polysomnographic recording; 45 year-old male, sinusitis with bilateral nasal polyps. Increased intra-esophageal pressure, fluctuations of breaths and blood gasteension are observed.

Table 2. Comparison of pre- and postoperative data in the same subject.

parameter	total	increased	same	parallel	decreased
a. VC	20	11	4	3	2
FEV ₁	20	7	1	4	8
FEV ₁ %	20	5	0	1	4
\dot{V}_{max}	18	16	1	0	1
\dot{V}_{50}	18	2	0	1	15
$\dot{V}_{50/H}$	18	3	0	0	15
\dot{V}_{25}	18	1	2	0	15
$\dot{V}_{25/H}$	18	1	2	0	15
b. FRC	13	9	0	0	4
FRC%	13	11	0	0	1
RV	13	11	0	0	2
RV%	13	11	0	0	2
CV	9	6	1	0	2
$\dot{V}_{50}/\dot{V}_{25}$	18	5	0	0	13
RR	19	12	0	2	5

COMMENT

Malefficient effects of chronic sinusitis on the lower airways has been called "sino-bronchitis" (Leicher, 1972). Our research has revealed objectively the unfavourable influence of chronic sinusitis upon respiratory function. The difference in the influence on respiratory functions between sinusitis and simple mechanical obstruction may probably be due to the aspiration of postnasal discharge during sleep as previously reported (Konno et al., 1980). Minimal amount of Lipiodol dripped into the nasopharynx of subject with large adenoids during sleep, and localized miliary shadows were found on the chest X-ray taken the following morning. Great increase in respiratory intraoesophageal pressure-change for ventilatory effort during sleep drew secretion into the trachea. We observed this phenomenon with a fiberscopy inserted through the nose.

Difference in the influence of sinusitis between the sexes may be attributed to the differences in smoking habits, daily circumstance and breathing patterns, and still unknown factors. From statistical analysis of the postoperative results of respiratory function tests, the following observations can be made: By removing the sinusitis foci and improving nasal breathing, respiratory resistance was normalized: however, the condition of the small airways did not improve so much as appeared on the test data, or was irreversible due to longlasting influence of nasal obstruction and postnasal discharge. Loss of absorbing ability of irritants and harmful gases in the nasal mucosa also may play a part. Suitable treatment of sinusitis, both local and general, in the younger age group is the most important and effective way for restoration of normal respiratory function.

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K. Togawa, M.D.
Department of Otolaryngology
Akita University School of Medicine
1-1-1, Hondo, Akita-shi 010 Japan